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Productivity of the English National Health Service: 2020/21 update

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Executive Summary

This report forms part of the time series of the English National Health Service (NHS) productivity growth calculated at the Centre for Health Economics, University of York. In this report, we focus on growth from 2019/20 to 2020/21. The COVID-19 pandemic had a dramatic impact on the provision of healthcare during this time. This has a number of critical implications for measurement of the productivity of the NHS. These are summarised in this executive summary and explored in more detail in the main report.

Between 2019/20 and 2020/21, overall NHS output, when adjusted for quality, decreased by 16.05%. NHS inputs grew by 8.95%, when measured using a mixed (direct and indirect) approach, and by 10.49%, when measured using an entirely indirect approach. The growth in NHS inputs is at a historically high level, having averaged 2.63% and 2.69% per annum since 2004/5, respectively for the mixed and indirect approaches.

As a consequence, NHS productivity decreased by 22.95% when using the mixed measure of NHS input growth and by 24.02% when using a fully indirect measure of NHS input growth. The large decline in total factor productivity in the NHS is not echoed by a similar decline in growth of the UK economy as a whole, as measured by either the Gross Value Added per Hour (labour productivity, LP) or the Multi-Factor Productivity (MFP) measures. This difference is likely to be due to a number of factors, including the explicit requirement for elective care to be curtailed and the use of furlough and other policies to support employment in most other sectors of the economy (Office for National Statistics, 2020).

All NHS settings, except for Community Prescribing and Renal dialysis, recorded negative output growth between 2019/20 and 2020/21. The largest proportional decrease is recorded for Ophthalmology and Dentistry services at 62.94%. However, as these settings are a relatively small part of NHS output, their contribution to overall NHS output growth is modest at 0.82%. The most substantial contribution to overall output growth (36.99% of spend) is within Hospital Inpatient activity. Growth in this sector is reported at a 23.26% decrease, when using the cost-weighted Laspeyres measure, and 22.21% decrease after adjusting for quality of hospital care. More details are given in section 6.

NHS labour inputs, excluding agency and bank staff, grew by 8.30%, when using the indirect input growth approach and by 4.93% when using the direct input growth approach. NHS labour remains the main contributor (49.36%) to overall NHS input growth and has the highest share of overall spend (45.58%) in 2020/21 (section 7). Materials also recorded a sharp increase (16.65%) between 2019/20 and 2020/21, and are the second largest contributor to NHS input growth.

In considering these findings, it is critical to recognise that this update covers the COVID-19 pandemic. In this period, the National Health Service faced an unprecedented health crisis. The sector underwent major disruptions to healthcare delivery in both elective and emergency care, accompanied by the need to care for an increasing number of COVID-19 patients. Further, the health sector experienced substantial changes in the way care was delivered to patients because of the need to protect the public and the healthcare workforce from the risk of contracting the SARS-COV-2 virus. This, for example, resulted in a move to remote consultations wherever possible and appropriate. Where care continued to be provided face-to-face, new safety measures, such as the use of PPE for patient facing staff, and enhanced cleaning procedures were introduced, to contain the spread of the virus. Finally, new services, such as COVID-19 testing, tracing and vaccination, were delivered.

As well as representing a colossal challenge for the NHS, the COVID-19 pandemic also has key implications for measuring productivity. The use of direct (volume based) approaches to measuring productivity is generally preferred and recommended by the System of National Accounts (European Commission et al., 2009) and the European System of Accounts (Eurostat, 2013) for non-market goods such as health services. This implies that a fall in volume represents a less productive system. However, this interpretation must be considered with caution when a fall in volume arises directly to improve overall health, the ultimate goal of the health system.

As well as the headline figures described above, we provide an in-depth analysis of each NHS setting in this report, highlighting where appropriate, the specific challenges faced in constructing the output growth measure, for example, around data quality. We also provide month-by-month analyses for those settings for which we have access to monthly data, to track the impact of the pandemic and how the restrictions imposed affected the provision of care (section 6).

Further highlights of this report:

- New quality indicators: as experimental statistics, we include two new quality indicators, emergency readmissions and hospital acquired infections, Clostridium Difficile (C-Diff) and Methicillin Resistant Staphylococcus Aureus (MRSA). Methods on this new quality adjustment as well as their impact on overall NHS output and productivity growth are presented in section 3.
- Hospital inpatient activity: we present detailed comparisons of inpatient total volume, unit cost and expenditure for combined physical and mental health in the inpatient setting for each month of 2019/20 and 2020/21 in section 6.2.7;
- Hospital outpatient activity: we sense check the impact of including non-face-to-face 80th percentile waiting time in our quality adjustment for outpatient activity, as during the COVID-19 pandemic, the proportion of non-face-to-face first outpatient appointments rose from a negligible to a small but substantive level (section 6.3.1);
- Primary Care: the waiting times quality adjustment, first introduced in Arabadzhyan et al. (2022), is now part of the baseline Laspeyres output growth estimate for primary care. To account for the shift to remote consultations (telephone and video/online) during the pandemic, we assign the same cost weight to GP face-to-face appointments, telephone and video/online appointments. Our measure of primary care output includes COVID-19 vaccinations carried out by GPs and/or PCNs. Further, we include month by month comparison to understand how the composition of attended appointments changed during the pandemic period compared to the previous year (section 6.6.3). Finally, two sensitivity checks are performed, one using specific cost weights for the two types of remote consultations and one implementing the methodology developed by the Department of Health and Social Care (DHSC) to account for the move to remote consultations (section 6.6.5);
- Community Prescribing: we refined the methods used to identify outliers, to account for both within and between years outliers (section 6.7.1). We also present detailed comparisons of total volume, unit cost and expenditure for each month of 2019/20 and 2020/21 to monitor the effect of the COVID-19 pandemic on prescribing patterns (section 6.7.3);
- Given the quality issues affecting the 2019/20 National Cost Collection (NCC) data, and summarised in Arabadzhyan et al. (2022), we continue to calculate the output growth in settings covered by the NCC dataset by limiting our analysis to NHS Trusts reporting data in both years. This means we have a like-for-like comparison, which is not the case if Trusts reporting data in one of the two consecutive years are included. Our approach assumes that growth observed is representative of the NHS as a whole. We are confident in this assumption,

as the coverage of the activity of Trusts reporting information in both years is very high (above 94%).

Glossary of acronyms

A&E	Accident & Emergency
AD	Admitted
CCG	Clinical Commissioning Group
CHD	Coronary Heart Disease
CIPS	Continuous Inpatient Spell
CSU	Commissioning Support Unit
DHSC	Department of Health and Social Care
ESR	Electronic Staff Record
EQ-5D	EuroQol five dimensions standardised instrument for measuring generic health status
FCE	Finished Consultant Episode
FOI	Freedom of Information
FTE	Full-time Equivalent
GPPS	GP Patient Survey
HCHS	Hospital and Community Health Services
HES	Hospital Episode Statistics
HRG(4/4+)	Healthcare Resource Group (version 4/4+)
ISHP	Independent Sector Health Care Provider
IAPT	Improving Access to Psychological Therapies
MH	Mental Health
NAD	Not admitted
NCC	National Cost Collection
NHS	National Health Service
ONS	Office for National Statistics
PCA	Prescription Cost Analysis
PCN	Primary Care Network
PCT	Primary Care Trust
PROMs	Patient Reported Outcome Measures
PSSRU	Personal & Social Services Research Unit
QOF	Quality and Outcomes Framework
RDNA	Regular Day and Night Attendance
TAC	Trust Accounts Consolidation

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1. Introduction

This report forms part of the time series of English National Health Service (NHS) productivity growth calculated at the Centre for Health Economics, University of York. In this report, we focus on growth from 2019/20 to 2020/21. An analysis of the longer time series is also provided in Bojke et al. (2017).

NHS productivity growth (growth in the value of outputs divided by growth in the expenditure on inputs) is calculated by means of a Laspeyres volume chain index. In this way, different NHS inputs and outputs are valued in terms of their cost in the first (base) year, in order to identify volume changes in the next year. As our method employs a chain index, the base year changes with each new update. We also employ available measures of quality where possible, in recognition that the value of outputs may not be entirely reflected in the cost of their provision, especially outside of a competitive market context. Specifically, we use short-term survival rates for both elective and non-elective hospital care, changes in health status, and waiting times for elective hospital care only. In addition, activity delivered in the primary care setting is adjusted based on the changes regarding blood pressure monitoring.

In this report we also consider additional characteristics of health care provided compared to previous reports, by including two new adjustments: emergency readmissions and hospital acquired infections (HAIs), namely Methicillin Resistant Staphylococcus Aureus (MRSA) and Clostridium Difficile (C-Diff). These new quality adjustments are to be considered experimental, and NHS output and productivity growth measures will be reported both with and without them. Further details on both emergency readmissions and HAIs, including methods used, can be found in section 3.

The York NHS outputs, inputs and productivity growth measures follow national and international accounts' recommendations (Eurostat, 2001). In particular, we implement the direct approach of volumes of each unit of input or output included whenever possible, aggregated using their respective unit costs. When only expenditure data are available, we disentangle changes in terms of volume and inflation by using appropriate deflators. Direct measures are used for NHS outputs and for NHS staff. Indirect measures are used for bank staff, agency staff, materials, and capital. Finally, NHS input measures are calculated as both a mixed measure, i.e. using a direct NHS labour growth measure alongside an indirect measure for all other inputs, and a purely indirect measure, where all labour inputs are considered in terms of expenditure.

The years focused upon in this NHS productivity update have been heavily affected by the SARS-CoV-2 pandemic. In the following section, we will provide a brief overview of the measures introduced during the pandemic, as well as reflect on its impact on our measures of NHS outputs, inputs and productivity.

1.1. COVID-19 background

In an attempt to contain the spread of the virus, international guidance issued by the WHO (World Health Organization, 2020a, 2020b), as well as medical scientific advice, recommended to avoid any unnecessary contact (containment) and to introduce a system of contact-tracing. NHS England also issued a series of guidelines on safe working. GP practices were issued with a series of guidance (on March 5[1] and March 19[2]) to move previously booked face-to-face appointments to telephone or video appointments, and to adopt a total triage system, with all appointments needing to be assessed by either a telephone or online triage procedure. Finally, GP practices were advised to prepare for an

[1] See Letter for primary care from March 5 (last accessed 10/03/2022).
[2] See Letter for primary care from March 19 (last accessed 10/03/2022).

increase in home visits, which did not, however, manifest itself. The temporary pandemic-related measures demanded of GP practices were followed by the reassurance that they would continue to receive the same income, independently of the amount and type of care provided, and with the temporary suspension of the GP Quality and Outcomes Framework measurement exercise.

These initial measures were followed by the introduction of a national lockdown starting on March 23 2020, with citizens asked to shelter in place and to socially distance themselves when outside; and by the announcement by NHS England that all NHS Trusts needed to free up the maximum possible inpatient and critical care capacity, with NHS Trusts chief executives requested to implement a series of responses to the pandemic in the immediate future.[3] These measures included:

1. To postpone all non-urgent procedures due to take place from April 15 2020 at the latest for at least 3 months.
2. To wind down non-urgent procedures before April 15 as seen fit by individual Trusts, but maximising the use of available capacity before the expected increase in demand for inpatient care from COVID-19.
3. To provide refresher training for all staff to support patients with respiratory needs over the following two weeks.
4. To provide or support virtual outpatient care by staff at higher risk of severe illness as a result of COVID-19.

During the pandemic, COVID-19 testing, tracing and vaccinations were also introduced. The function of the testing programme was to monitor and contain the spread of COVID-19. At first, testing was offered to individuals with COVID-19 symptoms, who were directed to testing centres and results processed by laboratories. Subsequently, testing was also made available to key workers and school students, to allow them to quickly return to work and school, before being rolled out to the population at large. Different types of testing were made available to the public (Office for National Statistics, 2021), with the most commonly used ones being: (i) PCR (polymerase chain reaction) tests, also used at the very start of the COVID-19 pandemic; and (ii) LFD (lateral flow devices) tests. These testing technologies were offered through four ‘pillars’ (Department of Health and Social Care, 2020).

Testing of individuals was accompanied by efforts to trace any other individuals who may have been in contact / close proximity with a person testing positive, and with a request to self-isolate. Some of the contact tracing activity was carried out through telephone calls, but the majority of the tracing was implemented through the NHS COVID-19 app.

Finally, COVID-19 vaccinations were provided to the general public. Provision was in a staggered way based on factors such as age, social and/or physical vulnerabilities, and key workers status (initially this included only people working for the NHS).

The CHE measure of NHS output and productivity does not include COVID-19 testing and contact tracing services because cost information on these activities is commercially sensitive. We do, however, include the total number of vaccinations provided in the primary care setting in our measure of NHS outputs.

It is therefore to be expected that NHS outputs and inputs would be affected by the measures described, and the results presented should be considered very carefully. In order to understand the extent of the negative impact of the COVID-19 pandemic on the operation of the NHS, we have provided monthly analyses for all NHS settings for which we have access to either monthly data (see

[3] See Letter from Simon Stevens and Amanda Pritchard (last accessed 10/03/2022).

sections 6.6 and 6.7, respectively for primary care and community prescribing) or for which we can calculate monthly statistics (see sections 6.2 and 6.3, for hospital inpatient and outpatient activity respectively). We compare these with the same periods in the previous financial year. Finally, we have adapted our measure, especially for primary care consultations, to give the same value weights (unit costs) to care provided remotely, wherever possible and appropriate, as to care provided in-person. See section 6.6.2 for further details.

The remainder of the report is organised as follows: in section 2, we summarise the methods used in calculating the productivity of the English health care system. In section 3, we present the new experimental quality indicators for hospital inpatient activity. Our findings for productivity growth are presented in section 4; we then consider increasingly small constituent parts of this overall result, beginning with NHS outputs and NHS inputs in section 5. Individual items of NHS outputs and inputs are investigated in sections 6 and 7, respectively. Throughout, we highlight where artefacts of the data threaten a like-for-like comparison and how we have managed these cases. Historical results are largely presented as graphs in the main text, with tables of figures limited to the Online Appendix.

In Appendix A, we include supplementary material on the most recent methodological refinement for dealing with outliers, i.e. changes in unit of drugs, in community prescribing data.

A more in-depth description of input deflators used in our analysis, as well as the results for NHS Trusts only, are presented in Appendix B.

2. Methods

The growth in Total Factor Productivity of the healthcare system, ΔTFP,[4] is measured as the ratio of an output growth index (X) and an input growth index (Z), such that:

$$\Delta TFP = X/Z \quad \text{(E1)}$$

To estimate Total Factor Productivity, it is necessary to correctly define and measure both output and input indices.

2.1. Output growth

Quantification of health care output is a challenge because patients have varied health care requirements and receive very different packages of care. To address this, it is necessary to classify patients into reasonably homogenous output groupings, such as Healthcare Resource Groups (HRGs) or Reference Cost (RC) categories. Furthermore, to aggregate these diverse outputs into a single index, some means of assessing their relative value is required. Usually, prices are used to assess value, but prices are not available for the vast majority of NHS services, which are provided free at the point of use. In common with the treatment of other non-market sectors of the economy in the national accounts, costs are used to indicate the value of health services. Costs reflect producer rather than consumer valuations of outputs but have the advantage of being readily available (Eurostat, 2001).

As costs are not expected to fully reflect consumers' valuations, Atkinson suggests supplementing costs with information about the quality of non-market goods and services (Atkinson, 2010, Atkinson, 2005). One way of doing this is by adding a scalar to the output index that captures changes over time in different dimensions of quality. Thus, following Castelli et al. (2007), the output growth index (in its Laspeyres form) can be calculated across two time periods as:

$$X_{(0,t)}^{cq} = \frac{\sum_{j=1}^{J} x_{jt} c_{j0} \left[\frac{v_{j0} q_{jt}}{q_{j0}} \right]}{\sum_{j=1}^{J} x_{j0} c_{j0}} \quad \text{(E2)}$$

We define x_j as the number of patients who have output type j, where j=1…J; c_j indicates the cost of output j; q_j represents a unit of quality for output j, and v_j is the value of this unit of quality; and t indicates the time with 0 indicating the first period of the time series. Our measures of quality include inpatient and outpatient waiting times, health improvements, survival rates following hospitalisation, and primary care blood pressure management.

2.2. Input growth

Turning to the input growth index (Z), inputs into the health care system consist of labour, material goods, and capital. Growth in the use of these factors of production can be calculated directly or indirectly (OECD, 2001). A direct measure of input growth can be calculated when data on the volume and price of inputs are available. In its Laspeyres form, the direct input growth index can be calculated as:

$$Z_{(0,t)}^{D} = \frac{\sum_{n=1}^{N} z_{nt} \omega_{n0}}{\sum_{n=1}^{N} z_{n0} \omega_{n0}} \quad \text{(E3)}$$

[4] Both X and Z are indices with values around one, for example, 1.05 indicates a 5% increase and 0.98 indicates a 2% decrease. Therefore, the productivity growth calculated using them will also be an index, which can be transformed into a percentage by subtracting 1 and multiplying by 100.

where z_n is the volume of input of type n and ω_{n0} is the price of input type n; and t indicates the time with 0 indicating the first period of the time series.

However, data about the volume of inputs are rarely available. It is, therefore, common practice to calculate input growth using expenditure data. Changes in expenditure are driven by both changes in the volume of resource use and in prices. Hence, to isolate the volume effect, it is necessary to wash out price changes by converting 'current' monetary values into 'constant' expenditure using an appropriate deflator π_{nt}. This deflator reflects the underlying trend in prices for the input in question, such that $\omega_{nt+1} = \pi_{nt}\omega_{nt}$.

If expenditure data and deflators are available, the input growth index can be specified as:

$$Z_{(0,t)}^{Ind} = \frac{\sum_{n=1}^{N} E_{nt}/\pi_{n0}}{\sum_{n=1}^{N} E_{n0}} = \frac{\sum_{n=1}^{N} z_{nt}\omega_{nt}/\pi_{n0}}{\sum_{n=1}^{N} z_{n0}\omega_{n0}} = \frac{\sum_{n=1}^{N} z_{nt}\omega_{n0}}{\sum_{n=1}^{N} z_{n0}\omega_{n0}} = Z_{(0,t)}^{D} \qquad \text{(E4)}$$

This is equivalent to using volume data, provided that deflators correctly capture the trend in prices for each input in question.

2.3. Productivity growth

The above equations show output or input growth over two consecutive periods from a base (0) to a current period (t). Usually, there is interest in assessing productivity growth over longer periods. We do this by means of a chained index that involves updating weights in every period, thereby making it possible to account for ongoing changes in the composition of the outputs and inputs being measured (Diewert et al., 2010).

Using the Laspeyres output index as defined in eq. (E2), a chained output index takes the following form:

$$X_{(0,T)}^{cq} = \frac{\sum_{j=1}^{J} x_{jt} c_{j0} \left[\frac{v_{j0} q_{jt}}{q_{j0}}\right]}{\sum_{j=1}^{J} x_{j0} c_{j0}} \times \frac{\sum_{j=1}^{J} x_{jt+1} c_{jt} \left[\frac{v_{jt} q_{jt+1}}{q_{jt}}\right]}{\sum_{j=1}^{J} x_{jt} c_{jt}} \times \cdots \times \frac{\sum_{j=1}^{J} x_{jT} c_{jT-1} \left[\frac{v_{jT} q_{jT}}{q_{jT-1}}\right]}{\sum_{j=1}^{J} x_{jT-1} c_{jT-1}} \qquad \text{(E5)}$$

This can be simplified to:

$$X_{(0,T)}^{cq} = X_{(0,t)}^{cq} \times X_{(t,t+1)}^{cq} \times \cdots \times X_{(T-1,T)}^{cq} \qquad \text{(E6)}$$

where each link is represented by eq. (E2) for the relevant two consecutive years. An analogous construction applies to the chained input index.

2.4. Working days adjustment

Our measure of productivity growth captures the growth in outputs over growth in inputs between two financial years. However, financial years do not always have the same number of working days, with this number being affected by the number of public holidays in each financial year (e.g. financial years may include between zero and four Easter public holidays) and the position of weekends during the year. The total number of days will also vary due to leap years.

It is expected that changes in the number of working days in a given year will impact the level of output produced in the NHS and hence impact the productivity of the system. Therefore, we adjust the Laspeyres output growth measure to capture the effect of changes in the number of working and total days between pairs of years. Expressions (E7) and (E8) present the Laspeyres output growth formulae (for the cost-weighted measure) with working days (WD) and total days (TD) adjustment respectively. For example, if the number of working days in year *t=0* is smaller than the number of working days in year *t=1,* then the working days adjustment should indicate both lower output and productivity growth estimates, with respect to the same measures with no working days adjustment. The same logic applies to the total days adjustment.

$$X_{(0,t)}^{wd} = \frac{\sum_{j=1}^{J} \frac{x_{jt} c_{j0}}{\frac{wd_t}{wd_0}}}{\sum_{j=1}^{J} x_{j0} c_{j0}} \quad \text{(E7)}$$

$$X_{(0,t)}^{td} = \frac{\sum_{j=1}^{J} \frac{x_{jt} c_{j0}}{\frac{td_t}{td_0}}}{\sum_{j=1}^{J} x_{j0} c_{j0}} \quad \text{(E8)}$$

Whilst the productivity of all NHS care settings will be affected by the total number of days in a given year, we conjecture that not all the settings will be affected by the total number of working days. Some settings, such as A&E services or non-elective inpatient care, should not be affected by variation in weekends and public holidays, as it is expected that these operate on a 24/7 basis. Finally, the great majority of NHS inputs, for example, salaried staff and capital costs, are not affected by the number of working days. Therefore, no adjustment is applied to them. Some materials, e.g. bandages, may be affected. However, their contribution to overall NHS input growth is small, and the effect of not adjusting these inputs for the number of working days is negligible.

Table 1 contains the list of NHS settings, as developed for our NHS output growth measure, and indicates whether the working days or total days adjustment is applied. It is important to note that adjusting for working days, by definition, recognises a change in total days.[5]

Table 1: NHS settings and their working days/total days adjustment

Setting	**WD Adjustment**	**TD Adjustment**
Inpatient Elective and Day-cases	x	
Inpatient Non-elective		x
Outpatient	x	
Primary care	x	
Community Prescribing		x
Community Mental Health		x
Community care	x	
A&E		x
Chemo- /Radiotherapy/High Cost Drugs	x	
Specialist Services	x	
Ophthalmology & Dentistry	x	
Radiology	x	
Diagnostic Tests	x	
Rehabilitation	x	
Renal Dialysis		x
Other	x	

[5] A table reporting working and total days for the financial years 2018/19 onwards is presented in Appendix B, section 10.3.

2.5. Alternative approaches to deal with missing NHS Trusts in the National Cost Collection data

The measurement of NHS output in 2019/20 was affected by data quality issues and missing data in the National Cost Collection (NCC) data series (previously known as the National Reference Costs data), which lead to non-comparability with previous years data. NHS England and NHS Improvement indicated that this was due to:

1. the move to the Patient Level Information and Costing System (PLICS), started in 2016;[6]
2. the coverage of NHS Trusts, as 14 NHS Trusts were excluded from the NCC schedule due to their data quality and/or availability in 2019/20.[7]

For the 2019/20 NHS productivity update, we developed four alternative approaches to dealing with missing Trusts data in the 2019/20 National Cost Collection. All approaches made use of the organisational (Trust) level NCC data. However, these data had their own issues because of missing activity (and therefore, unit cost) information, as small numbers (any activity information smaller than eight units) are suppressed by NHS Digital.[8]

The first two approaches developed used national level data for both financial years; thus avoiding the need for artificially imputing missing activity information, which would be the case when using Trust level NCC data. The remaining two approaches relied on the use of Trust level NCC data, and consequently include the imputation of missing numbers for volumes of healthcare activity.

As we calculate a Laspeyres output growth measure, cost weights are taken from the base year ($t = 0$, in this instance 2019/20), which therefore do not need to be imputed. However, there is the possibility that small numbers are suppressed for new categories of healthcare activity. In these cases, we check whether these new categories are simple re-categorisations of previously reported activity, in which case they will be included in the calculations of the NHS setting specific and overall NHS output growth measures and their unit costs will need to be imputed from unit cost information present in year t (Castelli et al., 2011). If, however, they represent new healthcare services and/or goods not previously provided, these activity categories are dropped from the calculations, as is our standard practice.

We refer to the Arabadzhyan et al. (2022) for further details on each of the four approaches. Our preferred approach (approach 3 in Arabadzhyan et al. (2022)) is (methodologically) the closest to our traditional measure, that is to directly measure the growth NHS outputs, and it also requires only a minimum set of additional assumptions. Its only shortcoming is that we need to impute missing values for some output categories. Further, our preferred approach makes maximum use of comparable, and high-quality data from Trusts with published NCC data, having met the rigorous data quality standard set by NHS England and NHS Improvement. In fact, NHS Trusts submitting data of insufficient quality do not have their data published in the National Cost Collection data. Limiting our analysis to Trusts reporting data in both years also means we have a like-for-like comparison, which is not the case if Trusts reporting data in only one year are included. For the growth rate estimates to be applicable to the NHS as a whole, we assume that observed data are representative of the NHS as a whole. We are confident in this assumption as the coverage of the activity of Trusts reporting information in both years is very high (> 94%).

[6] More information available here (last accessed 10/03/2022).
[7] In addition, four Trusts present in the 2019/20 NCC were absent in the 2018/19 collection.
[8] Note that as of 1st of February 2023 NHS Digital merged with NHS England. However, within this report we will still refer to the organisation as NHS Digital, as the report was finalised before the merger occurred.

3. Experimental quality adjustment for hospital inpatient activity

3.1. General introduction

While the English National Health Service (NHS) is under perpetual pressure to minimise cost and thus improve levels of productivity (outputs/inputs), it is appropriate to recognise that the quality of care provided also matters to patients. The presence of strong incentives to minimise cost, through a prospective payment system, has the potential to create a race to the bottom in terms of costly quality (Chalkley and Malcomson, 1998). At the same time, the NHS Constitution (2015) aspires to provide the best possible outcomes for patients. However, the quality of care still varies across England, with some of this variation being unwarranted.

Key priorities outlined in both the NHS Five Year Forward View, the Next Steps on the NHS Five Year Forward View[9] and the NHS Long Term Plan[10] are investing in the quality of care provided and reducing any existing gaps. Initiatives such as the Right Care Programme[11] and Getting it Right the First Time[12] have also been introduced, with the aim of achieving better health outcomes.

When measuring market output growth, national and international systems of accounts suggest to measure these in terms of the number of commodities produced in a given time period and valued using prices, which not only reflect producers' and consumers' valuation, but also the quality of the commodity measured (Eurostat, 2001). Non-market goods and services, such as the services provided by the NHS, do not usually have prices that reflect their quality. It is therefore recommended that measures of quality are employed in combination with cost data to generate measures as closely related as possible to consumer value. Current practice in accounting for the quality of healthcare services makes use of routinely available information in order to capture the Quality Adjusted Life Years (QALYs) associated with treating patients, by combining information on survival rates, life expectancy and a measure of change in health status before and after treatment. The process of care delivery is also captured by measures of treatment waiting times. This approach may overlook other important characteristics of the quality of healthcare.

A recent review by Bojke et al. (2018) provided the conceptual framework needed to select potentially appropriate characteristics of healthcare goods/services to be included in a measure of NHS output. The Authors assessed quality indicators from the NHS Outcomes Framework indicators and NHS Safety Thermometer[13] indicators against a set of criteria developed by the research team. Depending on the level of consensus among reviewers, a maximum of 17 indicators were short-listed for potential use as quality adjusters for NHS output.

Bojke et al. (2018) identified three quality indicators (negative patient outcomes) as the most likely candidates to be used to augment/extend the quality adjusted NHS output measures: emergency readmissions and two hospital acquired infections[14] (HAIs), Clostridium Difficile (C-Diff) and Methicillin Resistant Staphylococcus Aureus (MRSA). Both of these types of events lead to additional treatment, which the current productivity measure evaluates as additional output, but which de facto do not yield additional benefits to patient care. Our work refines the present NHS output and productivity measure

[9] NHS Five Year Forward View.
[10] NHS Long Term Plan.
[11] Right Care Programme.
[12] Getting it Right the First Time.
[13] NHS Safety Thermometers have been discontinued in 2019.
[14] These are also known as healthcare-associated infections (HCAIs). The acronyms HAIs and HCAIs may be used interchangeably in the report.

by explicitly recognising activity in response to provider induced need, which does not represent additional value from the perspective of the patient.

The choice of emergency readmissions and HAIs is based on (i) the substantial costs associated with individual cases both financially to the NHS and in disutility for patients; (ii) the potential to identify these cases through both administrative data and separately published information from NHS Digital and/or other public sources. We use methods set out in Dawson et al. (2005) to incorporate these additional measures of quality into our output and productivity growth measure.

3.2. Methods (Deadweightloss)

The underlying general principle of the cost weighted index is that costs are proportional to benefits. Therefore, if some costs are unrelated to benefits, then these should be omitted from the index. Thus, so far as costs associated with treating MRSA, C-Diff or emergency readmissions can be identified, these should be omitted from the quality adjusted NHS output measure in the following way (Dawson et al., 2005):

$$X_{(0,t)}^{cq} = \frac{\sum_j x_{jt} c_{jt} \frac{(a_{jt}-k_{jt})\left[\frac{\left(1-e^{-r_L L_{jt}}\right)}{r_L} - \frac{\left(e^{r_W W_{jt}}-1\right)}{r_W}\right]}{(a_{j0}-k_{j0})\left[\frac{\left(1-e^{-r_L L_{j0}}\right)}{r_L} - \frac{\left(e^{r_W W_{j0}}-1\right)}{r_W}\right]} - \sum_j x_{jt}^b c_{jt}^b}{\sum_j x_{j0} c_{j0} - \sum_j x_{j0}^b c_{j0}^b} \qquad \text{(E9)}$$

Where x_j^b is the number of “bad” events, and c_j^b is the cost associated with each event, be it emergency readmission, hospital acquired C-Diff or hospital acquired MRSA.

See sections 3.3 and 3.4 for further details on the methods used to identify emergency readmissions and HAIs, respectively.

The unit cost associated with the “bad” events, considered in this report, is calculated in two distinct ways, due to different data available.

For emergency readmissions, the cost is determined by the cost of the most expensive HRG associated with the emergency readmission CIPS.

For HAIs, the cost is determined by the product of the unit cost of excess bed days and the number of excess bed days. Excess bed days for C-Diff and MRSA are taken from the literature (see Table 2 and Table 3, respectively for C-Diff and MRSA). The unit cost of an excess bed day is the activity weighted mean excess bed day cost of relevant infections (MRSA or C-Diff as appropriate) in HES. For CIPS with multiple HRGs, the HRG with the most expensive excess bed day cost is used. Excess bed day costs are not reported after 2017/18. To estimate this figure, the ratio between the cost and excess bed day cost of the given HRG and activity type (elective or non-elective) is used. For example, if cost was 10x the excess bed day cost in 2017/18, it is assumed that the excess bed day cost would have been one 10th of cost. Therefore, the cost for a HAI is calculated as:

$$c_t^b = \overline{ec}_t^b * d^b \qquad \text{(E10)}$$

Where d^b is the number of excess bed days for either C-Diff or MRSA and $\overline{ec}_t^b$ is the activity weighted mean excess bed day cost calculated from HES for C-Diff or MRSA. As the number of excess days attributed to each infection (MRSA or C-Diff) is taken from the literature, this does not change over time, while the cost of excess bed days can.

Table 2: Evidence on C-Diff excess Length of Stay (Los)

Citation	Excess LoS (days)	Citation	Excess LoS (days)
Dubberke and Wertheimer (2009)	13-21 (review)	Forster et al. (2012)	6
Ghantoji et al. (2010)	2-21 (review)	Van Kleef et al. (2014)	6-7
Mitchell and Gardner (2012)	2.8-16.1 (review)	Mitchell et al. (2014)	0.9
Troughton et al. (2018)	1-29 (review)	Magee et al. (2015)	4.7
Mean of single papers			**5**

Table 3: Evidence on MRSA excess Length of Stay (LoS)

Citation	Excess LoS (days)
Antonanzas et al. (2015)	3-28 (review)
De Angelis et al. (2011)	14.5
de Kraker et al. (2011)	9
Macedo-Vinas et al. (2013)	11.5
Hübner et al. (2014)	17
Mean of single papers	**13**

3.3. Emergency readmissions

Hospital emergency admissions and readmissions have been rising both in England and elsewhere (Blunt et al., 2010, Podulka et al., 2012, Robinson, 2010, Friebel et al., 2018). A report by CHKS published in 2011 found that hospital emergency readmissions amounted to £2.2 billion to the NHS - a cost to society that is often described as avoidable.

However, not all emergencies are necessarily avoidable and therefore not all may be reasonable to consider as a sign of poor quality care. It is important to note that rising trends in emergency readmissions can be driven by a range of factors, which do not always point to lower quality of care provided. These include:

- increasing patients' complexity and medical needs;
- changes in clinical practice, including more recent policies to discharge patients to their home, nursing or care home more promptly;
- changes in patients' preferences;
- changes and variation in reporting practices.

The latter is particularly important in explaining variation at Hospital provider level in England. NHS Digital (NHSD) (2019) highlighted potential variations in the recording/reporting of same day emergency care/ambulatory care/zero length of stay emergency admissions. Some Trusts include this activity in the HES Admitted Patient Care (APC) dataset while others record such cases in the HES Outpatient dataset. Only activity recorded in the HES APC dataset is included in the emergency readmissions indicators.[15] Thus, there is a need to distinguish between **avoidable** and **unavoidable** emergency readmissions based on available data, in order to capture readmissions which are likely to represent poor quality.

[15] Manuscript by NHS Digital.

3.3.1. Emergency readmissions: methods

In order to identify the most appropriate definition of an emergency readmission, we have reviewed four options. These fall into two separate methods:

- Reduction method, which implies using the entire sample of hospital admissions, and removing readmissions which are more likely to be unavoidable;
- Construction method, which implies the identification of specific cases which are the most likely to be avoidable.

All definitions of avoidable emergency readmissions identified use a within 30-day readmission timeframe (of discharge from the index admission).

3.3.1.1. Reduction method

Two definitions fall within this method: the Basic and the NHS Outcomes Framework definition. The Basic definition requires a patient to be simply readmitted as an emergency admission to hospital within 30 days of a previous hospital admission of any kind. That is, all emergency readmissions are treated as if avoidable.

The NHS Outcomes Framework (NHS-OF) (newest) definition requires a patient to be readmitted within 29 days of the last, previous discharge from hospital (index admission). Of this group, patients with a main specialty and primary diagnosis upon readmission coded as obstetrics (tretspef 501, 560, 610 and diagnosis starting with 'O') and those with a diagnosis of cancer (C00*-C97*, D37*-D48*)[16] or chemotherapy for cancer (Z51.1) coded anywhere in the spell, or within 365 days prior to the index admission are excluded.

3.3.1.2. Construction method

This method is taken from Blunt et al. (2015). Their aim was to establish the underlying causes of readmission in order to identify and classify readmissions as those that are avoidable from those that are unavoidable or even planned. From their work we take their definition of probable suboptimal care (probable) and potentially suboptimal care (possible) leading to emergency readmissions.

The probable suboptimal care includes only those cases where the primary readmission diagnosis includes "Complications of surgical and medical care not elsewhere classified"(T80-T88).[17] Whilst the possible suboptimal care, in addition to the above, also includes:

- Cases with the primary readmission diagnosis of common avoidable complications (sequelae of injuries, of poisoning and of other consequences of external causes (T90-T98), venous thromboembolism (I26.0, I26.9, I63.1, I63.4, I74, I80, I81, I82, T79.0, T79.1), pneumonia (J12-J18), pressure sores (L89), poisoning by drugs, medicaments and biological substances (T36-T50));
- Cases with the "symptoms and signs" (Chapter R) diagnoses in the index admission and returned with a more specific diagnosis;
- Cases with one recorded emergency readmission for the same condition (excluding cancer and chronic conditions);
- All cases of emergency readmissions on the same day of discharge.

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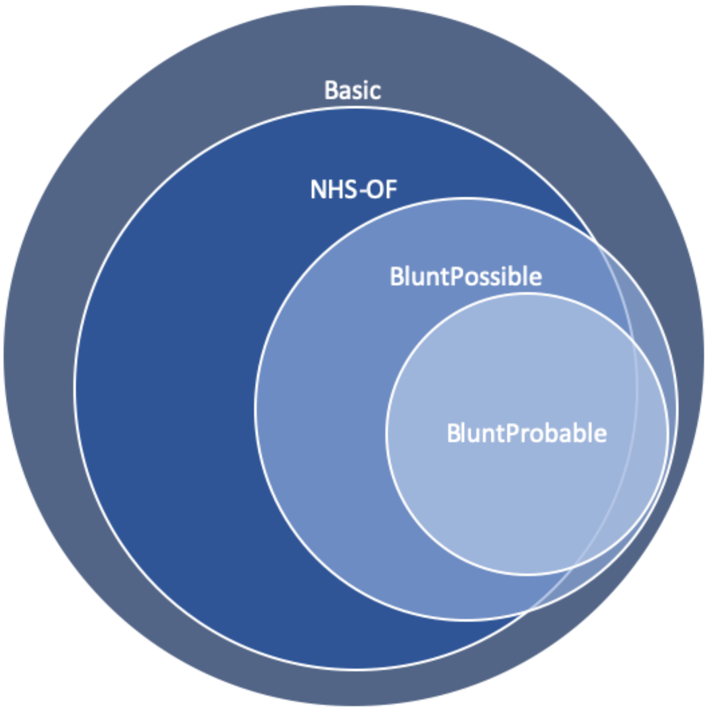
[16] ICD-10 diagnosis codes in parentheses.
[17] ICD-10 diagnosis codes in parentheses.

Finally, not all unplanned readmissions are due to poor quality of hospital care. Some could be the result of restricted access to or insufficient quality of primary care. In order to identify those readmissions that could potentially be related to primary care, Friedman and Basu (2004) suggest using a set of 16 types of hospital admissions with Prevention Quality Indicator (PQI)[18] conditions (such as asthma, complications of diabetes, gastroenteritis, congestive heart failure (CHF), bacterial pneumonia, urinary tract infection, and hypertension). This adjustment (henceforth FB correction) can be applied to all four definitions described above (basic, NHS-OF, probable and possible emergency readmission) by deducting cases with PQI conditions in the primary readmission diagnosis. Note that the 'probable' emergency readmission definition is not affected by the FB correction, whereas the basic definition is, by definition, the most affected in absolute terms.

Figure 1 depicts how the different definitions fit together, while Table 4 summarises the strengths and weaknesses of the definition of avoidable emergency readmissions presented so far.

Figure 1: Overlap between the four definitions of emergency readmissions reviewed



[18] Developed by UCSF-Stanford Evidence Based Practice Centre in 2002.

Table 4: Strengths and weaknesses of Emergency readmission definitions and FB correction

Definition / adjustment	Pros	Cons
Basic	• Simplicity • Prudent estimate (upper bound)	• Too general, may include readmissions not attributable to poor quality hospital care
NHS-OF	• Simplicity • Some refinement in excluding readmissions, which are likely to be "planned" or inevitable	• Not sensitive enough, e.g. considers conditions/methods of admission that could be excluded as not directly linkable to poor quality hospital care • Reason for the emergency readmission might not be related to reason for index admission
Blunt-Possible	• Sensitive, aims to pick up readmissions with diagnosis related to the index admission	• More complex and demanding to construct: requires linking data on both index and readmission based on primary diagnosis • Does not exclude cancer and obstetrics cases as a group, which are unlikely to be avoidable even if within a few days of index admission.
Blunt-Probable	• Sensitive • Simplicity • High precision	• May miss readmissions attributable to poor quality hospital care
FB correction	• Removes cases that are potentially preventable within primary care setting	• Removes some cases that are potentially preventable within secondary care setting

Given that our aim is to identify emergency readmissions that signal poor quality of secondary care, we calculate the number of emergency readmissions using a blended approach. In particular, we take the Blunt-Possible method as the most refined reference point, and introduce two corrections to form the CHE blended definition of emergency readmissions: (i) we exclude cancer and obstetrics cases, and (ii) exclude cases where a readmission follows a self-discharge. Both of these reflect elements of the NHS-OF definition. As we consider each care setting separately and readmissions to secondary care ultimately due to primary care still do not represent additional value from secondary care, we do not include the FB correction.

3.4. Hospital Acquired Infections – MRSA and C-Diff

HAIs pose a serious risk to patients, staff and visitors, increasing morbidity and mortality and incurring significant costs to the NHS. Guest et al. (2020) estimated there were 834,000 HAIs, 28,500 patient deaths, 7.1 million occupied bed days (21% of all NHS bed days) and 79,700 days of absence among front line healthcare professionals in the NHS in 2016/17.

C-Diff and MRSA are the types of infections that have been a particular concern for public health for a substantial period of time. It has been mandatory for NHS acute trusts to report each case of MRSA bacteraemia since the 1st of October 2005; for C-Diff the same requirement has been effective from the 1st of April 2007. These two infections were more likely to be found in acute settings, with mortality rates substantially higher for hospital-onset than for community-onset cases (UK Health Security Agency, 2021), which made them particularly relevant in assessing the quality of acute care; incidence of MRSA and C-Diff are among indicators published within the NHS Outcomes Framework.

3.4.1. HAIs MRSA and C-Diff: methods

Cases of hospital acquired MRSA and C-Diff can be identified through two potential sources: administrative datasets, namely the Hospital Episode Statistics (HES) Admitted Patient Care (APC) dataset; or surveillance data provided by the Health Security Agency.

Existing literature (Jones et al., 2012, Das et al., 2016, Nekkab et al., 2017) suggests that administrative datasets may underestimate the count of HAIs. We set out to calculate the count of HAIs due to MRSA and C-Diff as recorded in the Hospital Episode Statistics dataset and compare it with counts reported by surveillance data (HSA). To this end, first we need to determine a set of criteria on which to identify patients whose record shows that they have acquired either MRSA or C-Diff whilst in hospital. The first step was to search for existing, published, identification strategies. These make use of ICD codes in order to identify the onset of either MRSA or C-Diff.

In sections 3.4.1.1 and 3.4.1.2, we report the identification strategies adopted respectively for MRSA and C-Diff.

3.4.1.1. MRSA identification strategy

In order to identify the presence of MRSA, two key elements need to be established: (i) the presence of the bacterium Staphylococcus aureus (SA), and the bacterium needs to be resistant to methicillin (MR). Two ICD-10 codes explicitly identify the SA bacterium: A41.0 “Sepsis due to staphylococcus aureus” and B95.6 “Staphylococcus aureus as the cause of diseases classified to other chapters”; whilst the resistance to MR is identified by the ICD-10 code U82.1 “Resistance to methicillin”.

Therefore, observation of both the SA and MR elements are considered as necessary and sufficient conditions to identify MRSA. Guidance[19] produced in Scotland gives five specific examples of coding MRSA in different circumstances, which are summarised in Table 5.

The final key element is to identify where MRSA was acquired. This can be either in the community or in a hospital as a consequence of a hospital stay. We are interested in only those cases where an infection was acquired whilst in hospital. To this end, we use the ICD-10 code Y95X “nosocomial condition”, which identifies a condition which is hospital acquired.

[19] Further details can be accessed on the guidance, which was published by NHS National Services Scotland.

Table 5: MRSA definition and ICD-10 codes

Type	ICD-10 codes
MRSA infection of surgical wound on abdomen	• T81.4 Infection following a procedure, not elsewhere classified • B95.6 Staphylococcus aureus as the cause of diseases classified to other chapters • Y83.9 Surgical procedure, unspecified • (U82.1 Resistance to methicillin)
MRSA infection of traumatic wound	• T79.3 Post-traumatic wound infection, not elsewhere classified • B95.6 Staphylococcus aureus as the cause of diseases classified to other chapters X59.9 Unspecified accident • (U82.1 Resistance to methicillin)
MRSA sepsis	• A41.0 Sepsis due to Staphylococcus aureus (U82.1 Resistance to methicillin)
MRSA infection MRSA positive/carrier	• A49.0 Staphylococcal infection, unspecified (U82.1 Resistance to methicillin) • Z22.3 Carrier of other specified bacterial diseases (U82.1 Resistance to methicillin)

The CHE method for the identification of hospital acquired MRSA cases uses the following three criteria:

- presence of ICD-10 code A41.0 (Sepsis due to staphylococcus aureus);
- presence of diagnostic ICD-10 code U82.1 (Resistance to methicillin);
- inclusion of ICD-10 code Y95X - hospital onsetting of infection (nosocomial condition);
- No admission including MRSA within 14 days of admission.[20]

These criteria were validated in consultation with experts from the HSA.

3.4.1.2. C-Diff identification strategy

The key ICD-10 code for the identification of C-Diff is A04.7, defining “Enterocolitis due to Clostridium difficile (Foodborne intoxication by Clostridium difficile, Pseudomembranous colitis)”. Similarly to MRSA, the other key element is to identify whether C-Diff was acquired in hospital. To this end, we use the ICD-10 code Y95X. Further, we implemented a methodology, developed by the National Records of Scotland, to identify the underlying cause of death registered in Scotland and due to C-Diff, using ICD-10 codes. The codes included are ICD-10 codes A41.4 (Sepsis due to anaerobic) and A49.8 (Other bacterial infections of unspecified site), but these are accepted only if the wording of a death certificate also states that specific infection.

[20] The HSA considers an infection of the same patient to be new only if this occurs at least 14 days after a previously reported infection.

Therefore, the CHE method for the identification of hospital acquired C-Diff cases uses the following three criteria:

- presence of either ICD-10 code A04.7 (Enterocolitis due to Clostridium difficile (Foodborne intoxication by Clostridium difficile, Pseudomembranous colitis)) or ICD-10 code A41.4 (Sepsis due to anaerobes) or ICD-10 code A49.8 (Other bacterial infections of unspecified site);
- inclusion of ICD-10 code Y95X - hospital onsetting of infection (nosocomial condition).

3.5. Impact of incorporating new measures on NHS output and productivity growth measures

In this section we present a summary of the volume and costs associated with the two new quality indicators, and the impact of including them in the NHS output and productivity growth measure/

3.5.1. Emergency readmissions

Table 6 presents the volume and unit cost between 2018/19 and 2020/21 using four definitions of avoidable emergency readmissions of the five presented in section 3.3.1: the Basic, NHS Outcomes Framework (NHS-OF), the Blunt-possible and our preferred definition, the Blended. Independently of definition, the volume of avoidable emergency readmissions increased from 2018/19 to 2019/20 but falls between 2019/20 and 2020/21. The fall between 2019/20 and 2020/21 reflects the substantial reduction in the volume of inpatient care in 2020/21 in response to the COVID-19 pandemic.

In terms of unit costs, these have been increasing over time for all four definitions. However, between 2019/20 and 2020/21, these have increased at a much faster rate, 40% compared to the 8-9% year-on-year growth registered previously The sharp increase in unit costs of avoidable emergency readmissions between 2019/20 and 2020/21 is partly a reflection of increased unit costs between these two years in general. It may also arise from a shift in the distribution of care provided as a readmission towards more complex cases in 2020/21. In considering the impact of avoidable emergency readmissions on NHS inpatient output growth, we consider solely our preferred, blended, definition.

Table 6: Volume and unit cost of avoidable emergency readmissions

	2018/19		**2019/20**		**2020/21**	
	Volume	Average cost (£)	Volume	Average cost (£)	Volume	Average cost (£)
Basic	1,373,432	£1,854	1,428,772	2,015	1,118,373	2,839
NHS-OF	672,452	£1,719	696,583	1,872	548,256	2,651
Blunt- possible	368,450	£1,935	387,594	2,081	299,879	2,937
Blended	308,533	£1,888	323,294	2,031	249,199	2,889

3.5.2. Hospital Acquired Infections: MRSA and C-Diff

Table 7 presents volumes and unit costs of the hospital acquired infections MRSA and C-Dif. Cases of MRSA have remained low and relatively stable over the years presented (2018/19-2020/21). However, their unit cost is substantial relative to the average for inpatient care, especially following an increase of over 40% between 2019/20 and 2020/21, which is most likely due to a shift towards a more complex casemix. The high unit cost of MRSA cases arises partially from patients staying 13 additional days in hospital if they contract this infection, based on external literature. The unit cost of C-Diff indicates an upward trend over time and cases of this infection are much larger than that of MRSA. Though the unit cost of C-Diff from additional days in hospital is more similar to the unit cost for inpatient care overall, the total burden, i.e. total costs, of C-Diff infection, is over five times larger than that of MRSA.

Table 7: Volume and unit cost of hospital acquired infections

	MRSA		C-Difficile	
Year	Volume	Average cost (£)	Volume	Average cost (£)
2018/19	271	3,886	4,201	1,470
2019/20	260	4,00	4,712	1,531
2020/21	279	5,760	4,251	2,109

3.5.3. Impact on NHS output and productivity growth

The impact of including avoidable emergency readmissions and HAIs on measured NHS inpatient growth between 2019/20 and 2020/21 is very modest.[21] This is due to the very low share of the total deadweight loss associated with the two new quality indicators in the overall value of NHS activity.

[21] The impact of the deadweight loss adjustment on both the NHS output and productivity growth rate is detectable only at the fifth decimal percentage point.

4. Productivity Growth

Overall NHS productivity growth between 2019/20 and 2020/21 was -22.95% when using the mixed measure and -24.02% using the indirect measure. Our preferred measure for the 2020/21 NHS productivity update, will be based on the indirect measure. This is because financial accounts appear to correctly reflect the expenditure on NHS staff, as the Department of Health and Social Care noted delays in updating the staff and pay-roll systems by NHS Trusts.

In Table 8 we present the productivity growth measures, both mixed and indirect, for the financial years 2018/19 – 2019/20 and 2019/20 – 2020/21, adjusted for the number of working and total days in both financial years. Productivity growth figures for previous years, beginning with growth from 2004/05 to 2005/06, can be found in Online Appendix.

Table 8: NHS Productivity Growth[22]

Years	Mixed	Indirect
2018/19 – 2019/20	-2.14%	-2.11%
2019/20 – 2020/21	-22.95%%	-24.02%

The two productivity measures are quite different for the latest link (2019/20 – 2020/21), which is due to differences between the mixed and indirect input growth measures. See section 5.2 for details.

The stark negative growth registered in 2020/21 is mainly due to the COVID-19 pandemic,[23] as NHS Trusts were advised to suspend all elective care activity, and patients were increasingly seen, if at all, through remote consultations. The shift to remote consultations also affected the primary care sector, but we were able to adapt our measure to reflect the change in mode of delivering care. However, this was not enough to counteract the sharp decrease in output delivered to NHS patients, in any setting, which was recorded in the first months of the COVID-19 pandemic. However, in 2020/21, a concurrent increase in NHS inputs is also recorded. The growth in NHS inputs is at an historically high, having averaged at 2.63% and 2.69% per annum since 2004/5, respectively for the mixed NHS input growth measure and the indirect NHS input growth measure. This in part reflects the extra resources that were injected in the NHS to deal with the COVID-19 pandemic. The details of changes in both NHS outputs and inputs are shown in Figure 2, indexed to 2004/05 – 2005/06.

Figure 3 presents the cumulative NHS outputs, inputs, and productivity indices over time, using 2004/05 as the index year (year 0). The stark difference between the growth in inputs and outputs is to be expected. The NHS faced extreme challenges related to the COVID-19 pandemic, with the introduction of national policies to postpone all elective activity. At the same time, NHS Trusts moved to block grants to counteract the potential loss in income which would have been associated with decreased levels of activity, and at the same time provide them with enough financial resources to introduce the safety measures required to deal with COVID-19 patients.

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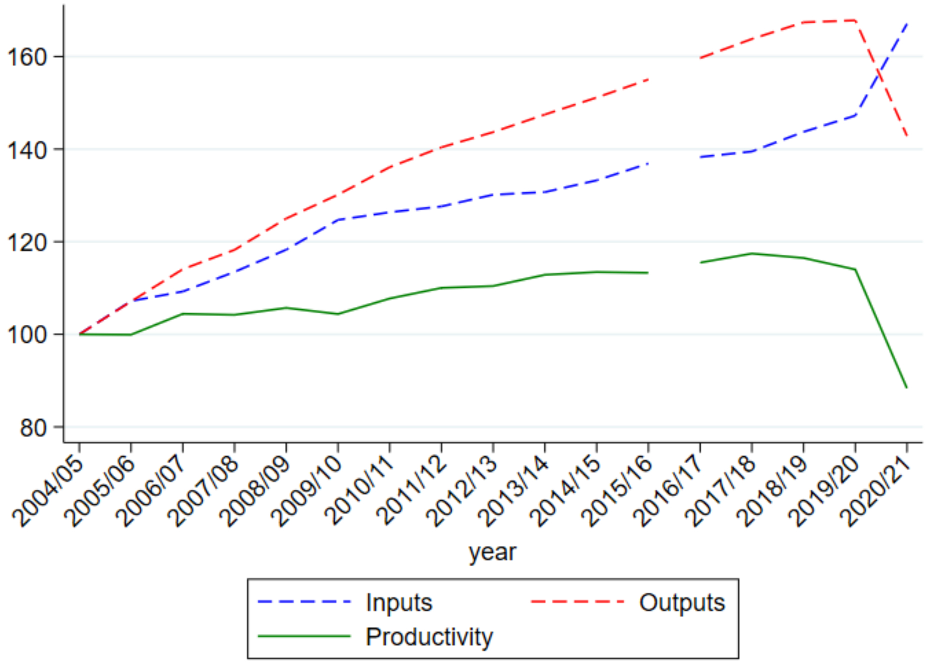
[22] Working and total days adjusted figures. The productivity growth rates for 2017/18 – 2018/19 differ from those reported in Arabadzhyan et al. (2021) as we have re-calculated the input growth for this link to correct for a coding error and updated the back series for bank and agency expenditure.

[23] Note that the pandemic affected not only the 2020/21 financial year, but also the end of 2019/20 financial year, i.e. the month of March. The drop in NHS productivity observed in 2020/21 should therefore not be interpreted as a change in productivity entirely induced by the pandemic, as we are comparing two years which were both affected by it, although to different extents.

Figure 2: NHS Output and Input Indices 2004/05-05/06 to 2018/19-2019/20[24]

Figure 3: Cumulative NHS Output, Input and Productivity Indices Over Time[25]



[24] Up to 2018/19-2019/20 the mixed input growth is used as the baseline and depicted in this graph, for the 2019/20-2020/21 link the indirect growth rate is used as the baseline. The interruption of the series reflects re-calculation of the figures due to a coding error corrected (first noted in Arabadzhyan et al., 2021).

[25] Up to 2018/19-2019/20 the mixed input index is used as the baseline and depicted in this graph, whilst the indirect input index is used for 2019/20-2020/21 link. The interruption of the series reflects re-calculation of the figures due to a coding error corrected (first noted in Arabadzhyan et al., 2021).

Finally, we compare the productivity growth of the NHS to the growth of the UK economy as a whole. Productivity growth in the wider economy can be measured both using the Gross Value Added per Hour (LP) measure, a measure of Labour Productivity of the whole economy, and the Multi-Factor Productivity (MFP) series, both produced by the Office of National Statistics (ONS). The latter is a measure of productivity comprising all inputs (labour, capital, and materials), but is limited to the market sector. Both are important productivity statistics produced by ONS, and while the methodology differs across sectors, the overall objectives are the same as our NHS specific measure.[26,27,28]

The Multi-Factor productivity index in 2020/21 decreased from 100 to 96.88, whereas the Overall Economy (LP) index did not change in 2020/21 compared to 2019/20. If we instead use, e.g. output per worker, the index would decrease from 100 to 91.93.

An article by ONS[29] suggests that labour productivity of the UK economy was not severely affected during the pandemic year, because “changes in the composition of labour have provided a counterweight to the fall in output per hour during the lockdown”. In particular, in the article it is stated that furlough-related policies and the fall in the number of hours worked affected different categories of workers in different ways. Workers on lower wages (young people and people with less qualifications) were impacted more by the pandemic, as they usually work in jobs requiring fewer skills and thus provide lower value added to the economy. These workers would have also been more affected by the furlough policies, thus resulting in a decrease in hours worked, which will have pushed up the proportion of hours worked by higher-paid workers.

Finally, the article states that the discrepancy between LP per hour and per worker, is due to the fact that "output per worker fell more than output per hour as hours worked fell but the number of workers was sustained by the government “furlough” schemes".

With regard to the MFP growth rate of the whole economy, the same ONS article states that MFP was affected by the so-called “allocation effect”, which pushed up the whole economy growth rate by 6.5 percentage points, thus “offsetting the majority of the declines observed within the individual industries themselves” with less productive sectors of the economy contracting more than sectors which normally have a higher productivity.

[26] See ONS note on GVA and GDP (last accessed 9/03/2022).
[27] See ONS labour productivity data (last accessed 9/03/2022).
[28] See ONS multifactor productivity estimates (last accessed 9/03/2022).
[29] The information was taken from ONS (2020).

5. Overall output and input growth

5.1. Output growth

Output growth is measured by combining activities of different types into a single index, using costs to reflect their values. We report in Table 9, the cost-weighted and quality-adjusted output growth measures, both also adjusted for the number of total and working days.

Between 2019/20 and 2020/21, both the cost-weighted and cost and quality adjusted NHS output growth rates are negative, as reported in Table 9.

Quality adjusting NHS output impacts positively the overall NHS output growth. Our analyses of the contribution of quality indicators to the overall quality-adjusted NHS output growth measure show that this is mainly driven by life expectancy, in combination with the treatment of a younger cohort of patients in 2020/21 compared to 2019/20. This result may be an overestimate of quality improvement, as we used the 2019 life tables also for 2020/21, and it might be expected that life expectancy in 2020/21 to have been lower than in 2019/20.

Table 9: Output growth

Years	Cost-weighted Growth (CW)	Quality-adjusted CW growth
2018/19 – 2019/20	0.38%	0.25%
2019/20 – 2020/21	-16.69%	-16.05%

5.1.1. Contribution by settings

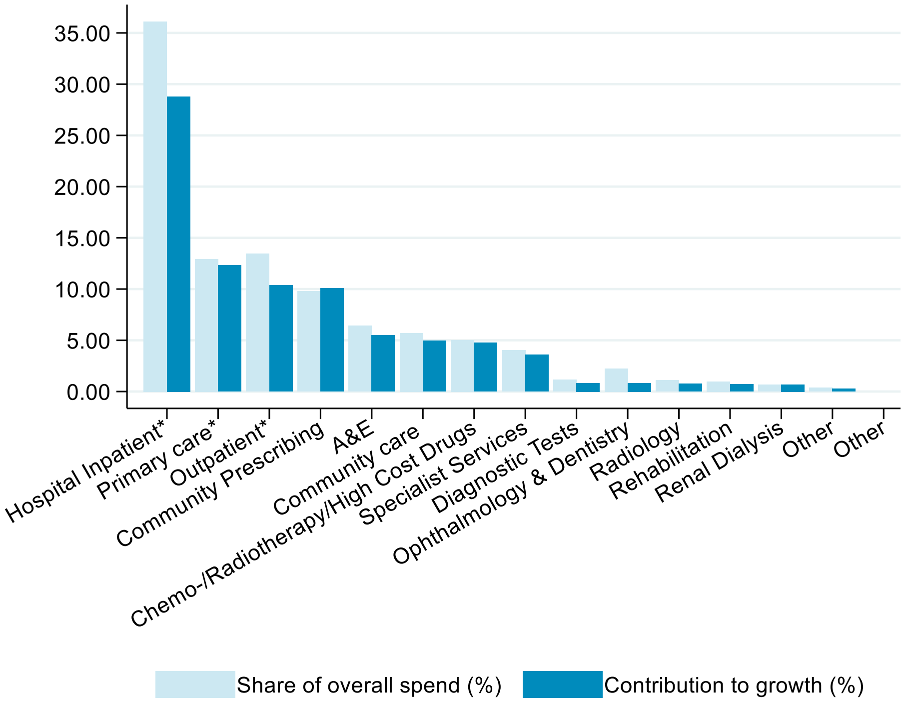
Not all settings contribute equally to the output index. Figure 4 shows the share of overall spend for each of the settings as well as their contribution to growth, calculated as a share of overall spend multiplied by the output growth of the setting, using growth rates obtained when estimating missing Trust activity.

Table 10 includes more information on the contribution to overall NHS growth by setting.[30] Similarly to the 2019/20 update, the growth rates for the NHS settings covered by the National Cost Collection data, are obtained following our preferred approach in accounting for missing Trust activity (see section 2.5 of this report or Arabadzhyan et al. (2022) for the full details). The output growth rates for the Hospital Inpatient, Outpatient, Primary Care, Community Prescribing, and Ophthalmology & Dentistry settings are not affected by missing NHS Trusts activity data. As previously explained, not correcting for missing Trust NCC data, will result, on average, in uncorrected growth rates being downward-biased.

Overall, the largest contributor to the output index is Hospital Inpatient activity, with a share of about 30% of overall output growth (36% of total spend). Other sizable contributors (in order of overall contribution to output growth) are Primary care, Outpatient and Community Prescribing. All other settings each contributed less than 6% to the total value of output growth. A detailed breakdown of output growth for each setting is presented in section 6.

[30] Community mental health setting has been excluded from our analysis (see section 6.4.2 for further detail).

Figure 4: Contribution to output growth by setting, 2020/21



* Hospital Inpatient, Outpatient and Primary Care activity are quality-adjusted.

Table 10: Contribution to overall NHS output growth by NHS setting, 2020/21

Setting	Growth	Setting specific growth index	Value of Activity (19/20 prices)	Share of overall spend	Contribution to overall growth rate**
Hospital Inpatient*	-22.21%	77.79%	34,755,226,220	36.12%	28.78%
Primary care*	-2.68%	97.32%	11,985,569,329	12.93%	12.42%
Outpatient*	-22.80%	77.20%	12,477,570,000	13.47%	10.25%
Community Prescribing	3.00%	103.00%	9,058,690,936	9.78%	9.93%
A&E	-14.38%	85.62%	5,939,362,195	6.41%	5.41%
Community care	-13.18%	86.82%	5,291,763,516	5.71%	4.89%
Chemo-/Radiotherapy/High Cost Drugs	-5.35%	94.65%	4,658,729,042	5.03%	4.69%
Specialist Services	-10.81%	89.19%	3,726,035,018	4.02%	3.54%
Ophthalmology & Dentistry	-62.94%	37.06%	2,082,473,569	2.25%	0.82%
Diagnostic Tests	-27.19%	72.81%	1,061,501,770	1.15%	0.82%
Radiology	-32.11%	67.89%	1,037,994,821	1.12%	0.75%
Rehabilitation	-27.03%	72.97%	906,494,092	0.98%	0.70%
Renal Dialysis	3.75%	103.75%	612,417,434	0.66%	0.68%
Other	-30.80%	69.20%	359,733,388	0.39%	0.26%
Total/NHS output growth rate			**93,953,561,330**		**-16.05%**

* Hospital Inpatient, Outpatient and Primary care activity are quality-adjusted.
** The contribution of each setting to growth in 2020/21 is expressed as a percentage of the total output in 2019/20. Where numbers in this column are lower than numbers in the preceding column, this represents negative growth in outputs for that setting.

5.2. Input growth

Table 11 presents the growth in inputs for the last two links, 2018/19 – 2019/20 and 2019/20 – 2020/21, using the mixed and indirect methods.

The mixed method uses Electronic Staff Record (ESR) data to calculate growth in NHS labour inputs and combines this information with expenditure data from published accounts for the remaining inputs used in the production of healthcare goods and services. We explicitly account for bank staff expenditure, thus allowing us to relax the assumption that growth in bank staff is similar to growth in NHS staff.

The indirect method uses expenditure data for all types of inputs, derived from Hospital Trusts' and other NHS organisations' financial accounts. We use appropriate deflators to obtain an estimate of input volume growth. Since 2018/19 a specific deflator for agency staff expenditures has been produced by DHSC within the NHS Cost Inflation Index, allowing us to obtain a more precise estimate of agency staff expenditure growth in real terms (see Appendix B for more details on the agency deflator).

Table 11 reports both the mixed and the indirect input growth rates, which differ quite substantially for the 2018/19 – 2019/20 link.

Table 11: Input growth[31]

Years	All NHS	
	Mixed	**Indirect**
2018/19 – 2019/20*	2.44%	2.41%
2019/20 – 2020/21	8.95%	10.49%

*Indirect growth rate calculated excluding additional employer NHS pension contributions (see Arabadzhyan et al. (2022) for details).

From intelligence obtained through the Department of Health and Social Care, the direct labour measure might have been affected by delays in updating the staff and pay-roll system of NHS Trusts, during the height of the COVID-19 pandemic, as extra staff were employed to support NHS Staff in their efforts in dealing with COVID-19 patients, as well as staff shortages due to COVID-19 related sickness. The financial accounts of NHS Trusts do, however, reflect the increased expenditure on staff, and as such will be used as our preferred baseline measure for the 2020/21 NHS productivity update.

In terms of the major contributors to overall input growth, these were, in order, labour, materials and primary care.

[31] The productivity growth rates for 2017/18 – 2018/19 differ from those reported in Arabadzhyan et al. (2021) as we have re-calculated the input growth for this link to correct for a coding error and updated the back series for bank and agency expenditure.

6. Growth in output categories

6.1. Measuring output

Our NHS output index is designed to capture all activities provided to NHS patients, whether by NHS or private sector organisations.[32] Table 12 summarises the data sources used to measure activity, quality and costs. It should be noted that we have two alternative sources of volume of activity for outpatient output: the Hospital Episode Statistics (HES) outpatient dataset, and the National Costs Collection (NCC) database. In this report, we compare outpatient activity derived from both datasets, but use the HES outpatient figures in our NHS output growth measure. Summaries for each output type and any data issues are detailed in sections 6.2 to 6.7.

Table 12: Summary of NHS output data sources

Output type	Activity source	Cost source	Quality
Elective	HES	NCC	In-hospital survival; health outcomes & waiting times
Non-elective	HES	NCC	In-hospital survival & health outcomes
Outpatient	HES (or NCC)	NCC	Waiting times
Mental health	HES & NCC	NCC	In-hospital survival; health outcomes & waiting times
Community care	NCC	NCC	N/A
A&E	NCC	NCC	N/A
Other*	NCC	NCC	N/A
Primary care	QResearch (up to 2008/09); General Lifestyle Survey (2008/09-09/10); GP patient survey (from 2009/10) NHS Digital Appointments in General Practice data (from Nov 2017)	PSSRU Unit Costs of Health and Social Care + other sources	QOF data (up to 2018/19; 2019/20 had a change in the way indicators were recorded; no QOF data collected in 2020/21) Waiting times
Prescribing	Until 2017/18, Prescription cost analysis system (PCA) From 2018/19, NHS Business Service Authority (BSA)	PCA system & BSA	N/A
Ophthalmic and dental services	NHS Digital	NHS Digital	N/A

* Radiotherapy & High Cost Drugs, Diagnostic Tests, Hospital/patient Transport Scheme, Radiology, Rehabilitation, Renal Dialysis, Specialist Services.

[32] NHS activity provided by non-NHS providers was included in the output growth series up to 2010/11.

6.2. Hospital physical and mental health inpatient

- **Overall cost-weighted and working days adjusted Laspeyres output growth for hospital inpatient activity was -23.26% between 2019/20 and 2020/21.**
- **Measures of quality improved over this period, leading to a growth rate of -22.21% after quality-adjustment.**

Day-case, elective and non-elective hospital inpatient care is calculated from the HES Admitted Patient Care (APC) dataset. Information in this dataset is recorded at the Finished Consultant Episode (FCE) level. An FCE represents a period of treatment under the same hospital consultant. The dataset includes both physical and mental health inpatient care.[33] In 2020/21, just under 17 million inpatient FCEs are recorded, a decrease of 22.4% compared to 2019/20. This is similar to the decrease reported by NHS Digital.[34]

Table 13 presents activity in terms of FCEs across different provider types. In 2020/21, nearly 98% of FCEs occurred within Trusts, an increase from 2018/19 of nearly 1 percentage point. Reductions in FCEs are especially marked among Private providers, 43% lower in 2020/21 than in 2019/20. The proportional change in FCEs carried out by Other providers is dramatic, but due to still overall very low activity, the impact of this on FCE volume overall is negligible. Details of a longer time trend can be found in Online Appendix.

Table 13: Organisational coverage of HES activity, FCEs

Year	NHS Trusts	Private providers	Other	Total
2018/19	21,571,984	625,734	115	22,197,833
2018/19*	21,603,364	625,830	115	22,229,308
2019/20*	21,736,110	633,579	404	22,370,093
2019/20**	21,736,268	633,558	404	22,370,228
2020/21	16,993,468	359,880	2,715	17,356,868

* Presents figures for this financial year following the translation of code from SAS 9.2 to STATA 17 and minor refinements detailed in Arabadzhyan et al. (2021), section 6.2.1.

** Presents figures for the financial year reflects updated patient identifiers provided by NHS Digital.

6.2.1. Methodology

The differing types of NHS activity performed in an inpatient setting are identified through HRGs. Output within a HRG is the count of Continuous Inpatient Spells (CIPS) allocated to that category. A CIPS can contain multiple FCEs. This occurs if a patient is transferred to the care of a different hospital consultant within the same Trust or a different Trust as part of their care. We construct CIPS following our own algorithm, which is similar to the official algorithm published by NHS Digital.[35, 36]

The cost of each CIPS is the highest cost reported for an individual FCE within it. Costs are reported in the National Cost Collection (NCC) data (previously known as the National Reference Costs data) (Bojke et al., 2017). The NCC dataset reports a separate unit cost for day-case, elective care, and non-elective care activity for each HRG. As we use unit costs as a proxy for the relative health value of

[33] Consistently with previous publications of this series, we continue to exclude patients categorised to HRGs which are not included in the tariff ('Zero Cost HRGs').

[34] See here (last accessed 14/12/2022).

[35]NHS Digital CIPS and Spells methodology can be found here (last accessed 26/10/2021).

[36] A note detailing the differences between the CHE and the NHS Digital algorithms to construct CIPS is available as supplementary material published alongside the NHS productivity update for 2018/19 (Arabadzhyan et al., 2021).

different activities, we reflect the expectation that appropriate day case care is as valuable as elective care by giving the value of elective care to both types of activity (Bojke et al., 2016).[37] Having assigned a cost to each CIPS, we then calculate the national average cost per CIPS in each HRG.

It can be that some HRGs do not have associated costs in consecutive years, due to new HRGs being introduced (old HRGs being retired). This can also arise if there was no activity in a given HRG for a specific year. This second possibility is of particular importance in considering the year 2020/21, where the general reduction in activity necessitated by the COVID-19 pandemic also meant some more rarely performed activities did not occur at all. In such cases we deflate (inflate) costs in order to impute missing values (Castelli et al., 2011). In 2020/21, there were 21 new HRGs with total expenditure of around £1.7 billion. Of these, the two largest in terms of expenditure were for COVID-19. These represented £584 million. There was a single dropped HRG in 2020/21 compared to 2019/20.

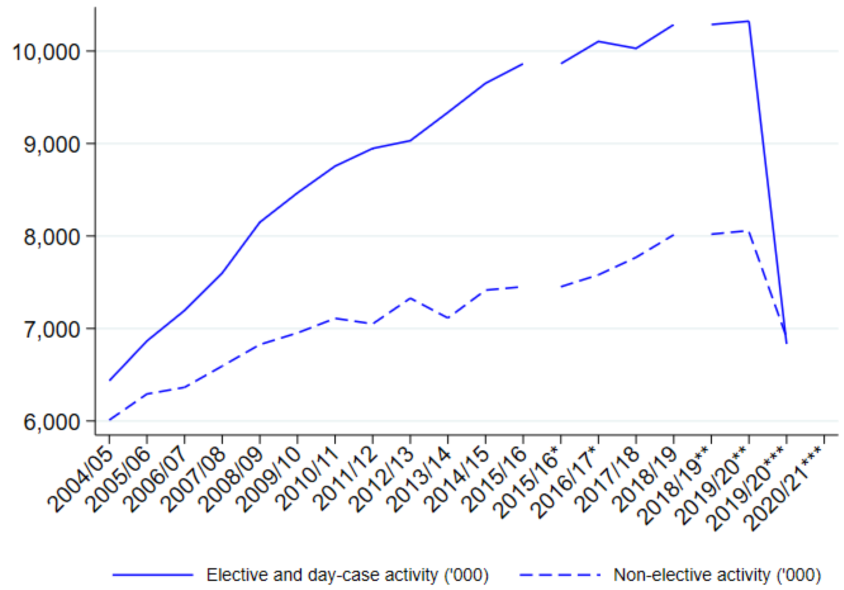
6.2.2. Elective, day-case, and non-elective activity

- **Cost-weighted and working days adjusted Laspeyres output growth for elective and day-case physical care was -36.46% between 2019/20 and 2020/21. Non-elective physical care Laspeyres output growth was -6.13% over the same period, leading to overall NHS cost-weighted and working days adjusted activity output growth of -23.36%.**
- **Measures of quality indicated an improvement between 2019/20 and 2020/21, leading to growth of –36.06% for elective and day case physical care, -4.21% for non-elective physical care and -22.31% for physical health care overall after adjusting for changes in quality.**

Between 2019/20 and 2020/21, the combined volume of day-case, elective and non-elective physical healthcare fell substantially, by around 25%. This fall was heavily concentrated within elective and day-case care (a 34% fall compared to 14% for non-elective care). This reflects the requirement to minimise care as much as possible in response to the COVID-19 pandemic. This was by definition most applicable to elective care, while cases of COVID-19 were by nature non-elective. Figure 5 places these changes in a historical context back to 2004/05. In contrast to steadily increasing volumes of activity over time, elective and day-case care in 2020/21 was similar to that of 2005/06 and non-elective activity similar to that of 2009/10. Activity information is also presented in Table 14 along with mean costs. It can be seen from this table that the mean cost of elective and non-elective care rose substantially between 2019/20 and 2020/21. From £1,900 to £2,542 (equivalent to a 33.79% growth) for elective care and from £1,852 to £2,627 (equivalent to a 41.85% growth) for non-elective care. These are very large uplifts following smaller but still substantial increases in unit cost between 2018/19 and 2019/20. This may reflect a combination of a shift in case-mix and the allocation of the cost of individual treatments as a proportion of a fixed overall budget. That is, higher unit costs reflect the fall observed in volume of activity without a reduction in spend.

[37] This equal weighting ensures that the output index is not biased downwards if delivery of treatment moves from overnight to day-case settings over time.

Figure 5: Changes in elective and day-case and non-elective activity



* The HES variable 'admission method' underwent changes in the coding; thus from 2015/16 we implemented those changes in the methodology used to group FCEs into CIPS.
** Calculation of activity was translated from SAS 9.2 to STATA 17 and minor refinements made, making figures for 2018/19 not comparable with those from 2019/20. See Arabadzhyan et al. (2022), section 6.2.1, for details.
*** Activity calculated with updated patient identifier provided by NHS Digital.

Table 14: Number of CIPS and average cost for electives and non-electives

Year	Elective and day-case activity		Non-elective activity	
	# CIPS	Average cost (£)	# CIPS	Average cost (£)
2018/19	10,285,238	1,632	8,012,583	1,693
2018/19*	10,286,530	1,632	8,019,603	1,693
2019/20*	10,322,730	1,901	8,057,921	1,852
2019/20**	10,322,560	1,900	8,044,921	1,852
2020/21**	6,830,556	2,542	6,901,554	2,627

* Calculation of activity was translated from SAS 9.2 to STATA 17 and minor refinements made, making figures for 2018/19 not comparable with those from 2019/20. See Arabadzhyan et al. (2022), section 6.2.1, for details.
** Measures calculated using the updated patient identifier provided by NHS Digital.

Cost-weighted and working days adjusted Laspeyres output growth for elective and day-case physical care output was -36.46% between 2019/20 and 2020/21. Non-elective output grew by -6.13% over the same period, leading to an overall NHS cost-weighted and working days adjusted activity output growth of -23.36% for inpatient physical care.[38] This represents similarly substantial falls and similar patterns to the changes in raw volume discussed above.

6.2.3. Elective, day-case, and non-elective activity: quality adjustment

For our main measure, we use four metrics to adjust for changes in the quality of care provided in the inpatient setting, which is calculated at the HRG level, and separately for elective and non-elective care. Specifically, we account for:

1. **In-hospital survival rates and mean life expectancy** to capture changes in the expected discounted sum of lifetime Quality Adjusted Life Years (QALYs) conditional on treatment survival. Information on in-hospital survival rate is obtained directly from the HES APC dataset and mean life expectancy is taken from mid-year life tables published annually by ONS.[39] As life tables are not available for the year 2020, we assume a common life expectancy, conditional on sex and age, between the 2019/20 and 2020/21 years.
2. **Waiting times** to account for adverse health implications of delayed treatment along with direct patient dissatisfaction from waiting for care. We use the 80th percentile of waiting time, also calculated from HES APC, and apply this as a scaling factor. That is multiplying the health effect (Castelli et al., 2007). This adjustment applies only to elective and day-case activity.
3. **Estimated change in health outcomes following hospital treatment** to assess the impact that treatments have on patients' health status over time, we use changes in the ratio of health status before and after care. Smaller ratios represent a larger health improvement associated with the treatment. We use two separate data sources:
   i. Patient Reported Outcome Measures (PROMs) for all patients undergoing unilateral hip and knee replacement.[40] This survey is offered to all patients shortly before surgery and six months following treatment. It includes the generic EQ-5D measure, which can be converted to QALYs through an official valuation from the general population of health states. Change in the ratio of before divided by after procedure EQ-5D QALY scores are used where available.
   ii. For treatments (HRGs) where no such information is available, or the proportion of activity with PROMS information for a given HRG is small and unlikely to be representative in either year considered (< 100 observations) we assume that the ratio is constant over time and equal to 0.8 for elective care/day-cases and 0.4 for non-elective care (Dawson et al., 2005). We also assign the above constant ratios to CIPS with error code UZ01Z (Castelli et al., 2019).

Table 15 and Table 16 present average values of the measures for the quality elements for the years 2018/19, 2019/20, and 2020/21. Table 15 highlights that life expectancy has fallen, on average, between 2019/20 and 2020/21, especially for non-elective care (0.9 years drop compared to 0.2 years for elective care). This implies treatment of older patients on average. This might arise from younger patients especially avoiding or postponing contact with inpatient care for conditions perceived as less urgent or serious. At the same time, waiting times have substantially increased at the 80th percentile

[38] The cost-weighted output growth for elective and day-cases without the working days adjustment was equal to -36.71% and for non-elective care equal to -6.39%. This gives an overall cost-weighted output growth of -23.62% before working days adjustment. Working days adjustment differs between elective and non-elective care as elective care is expected to occur on weekdays and not on bank holidays, while non-elective care is expected to occur on all days. However, non-elective care is still affected in comparing 2019/20 with 2020/21 due to 2020 being a leap year with an extra day.
[39] ONS life tables can be found here (last accessed 26/01/2023).
[40] From 2018/19, PROMs for varicose vein surgery and groin hernia repair were discontinued.

(from 72 to 97 days). Survival rates also fell, especially for non-elective care, from 98.36% to 97.82%, while remaining very similar for elective care. It is important to stress that these values are averages and mask considerable variation in the value observed for single HRGs and for each HRG across years. We, therefore, report in Table 15 details of the impact of individual and combinations of quality measures and discuss their implications in section 6.2.6.

Table 15: Quality adjustment for elective and day-case and for non-elective activity

Year	Elective and day-case activity			Non-elective activity	
	In-hospital survival rate	Mean life expectancy	80th percentile waiting times	In-hospital survival rate	Mean life expectancy
2018/19	99.94%	22.7	86	97.52%	32.7
2019/20	99.94%	22.2	85	97.46%	32.0
2019/20*	99.96%	22.1	72	98.36%	31.8
2020/21*	99.95%	21.9	97	97.82%	30.9

* Measures calculated using the updated patient identifier provided by NHS Digital.

Table 16 indicates a decrease in the ratio of pre to post health from hip replacement by 0.08, but an increase for knee replacement of 0.06. These are substantive changes. However, the impact on overall inpatient growth is limited, as these measures are applied only to elective care for two narrow procedure groups.

Table 16: Ratio of pre to post health status, based on EQ-5D

Year	Hip replacement	Knee replacement
2018/19	0.34	0.40
2019/20	0.39	0.44
2019/20*	0.39	0.44
2020/21*	0.31	0.50

* Measures calculated using the updated patient identifier provided by NHS Digital.

Including adjustments for quality leads to a slight improvement in elective and day-case output growth to -36.06% and a substantial increase in non-elective care growth to -4.21%. Overall, changes in quality indicate an improvement in Laspeyres growth by 1.05 percentage points to -22.31% for physical health.[41]

6.2.4. Inpatient mental health

- **The cost-weighted and working days adjusted Laspeyres mental health inpatient output growth measure between 2019/20 and 2020/21 was -8.57%.**
- **After accounting for changes in quality, the total Laspeyres output growth of NHS mental health activity rose slightly to -8.46%.**

[41] The quality-adjusted Laspeyres output growth measure for hospital inpatient (physical care) output is equal to -22.56% without the working days adjustment.

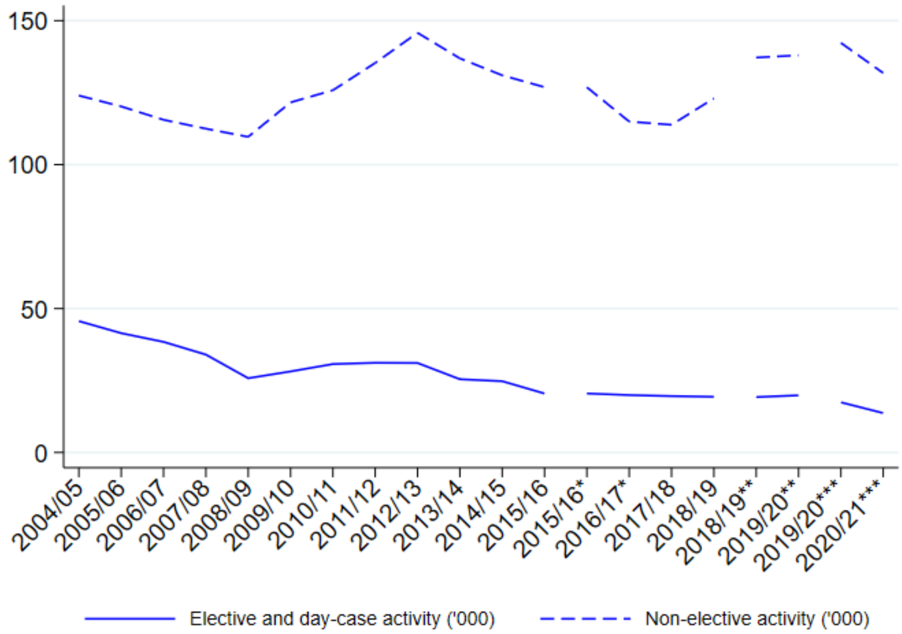
Table 17 shows the number of CIPS and average costs for equivalent activity in the years 2018/19 to 2020/21. This highlights that volume changes in mental health care are substantial, but much more modest than within physical health. Figure 6 reinforces the point that compared to physical health (presented in Figure 5), changes in the volume of mental health care were far less dramatic between 2019/20 and 2020/21, being more in line with fluctuations over previous years.

Table 17: CIPS and average cost for inpatient mental health patients

Year	Elective and day-case activity		Non-elective activity	
	# CIPS	Average cost (£)	# CIPS	Average cost (£)
2018/19	19,333	1,474	123,013	1,495
2018/19*	19,235	1,474	137,185	1,495
2019/20*	16,846	1,494	137,974	1,516
2019/20**	17,360	1,494	142,321	1,516
2020/21**	13,679	1,506	131,865	1,528

* Calculation of activity was translated from SAS 9.2 to STATA 17 and minor refinements made, making figures for 2018/19 not comparable with those from 2019/20. See Arabadzhyan et al. (2022), section 6.2.1, for details.
** Activity calculated based on the updated patient identifier provided by NHS Digital.

Figure 6: Number of CIPS for elective, day-case, and non-elective mental health patients over time



* The HES variable 'admission method' underwent changes in the coding; thus from 2015/16 we implemented those changes in the methodology used to group FCEs into CIPS.
** Calculation of activity was translated from SAS 9.2 to STATA 17 and minor refinements made, making figures for 2018/19 not comparable with those from 2019/20. See Arabadzhyan et al. (2022), section 6.2.1, for details.
*** Activity calculated with updated patient identifier provided by NHS Digital.

The cost-weighted and working days adjusted Laspeyres mental health inpatient output growth measure between 2019/20 and 2020/21 was -8.57%.[42] While compared to changes in physical health this figure appears relatively modest, in a non-COVID-19 period, this would stand out as a substantial reduction in activity.

6.2.5. Inpatient mental health: quality adjustment

Table 18 presents quality adjustment measures for mental health inpatient care. The same set of quality adjustment measures is used as for inpatient physical care. Compared to 2019/20, survival rates were lower in 2020/21, while the 80th percentile waiting time increased substantially (by 17 days). Life expectancy rose slightly among elective patients, but fell sharply among non-elective patients (+0.1 compared to -0.5 years). As noted in section 6.2.3, these mean values are made up of highly variable values at the HRG level within the year, which also change over time.

Table 18: Quality adjustments for mental health activity

Year	Elective and day-case activity			Non-elective activity	
	In-hospital survival rate	Mean life expectancy	80th percentile waiting times	In-hospital survival rate	Mean life expectancy
2018/19	99.50%	31.1	43	98.24%	24.6
2018/19*	99.50%	31.0	49	98.37%	25.5
2019/20*	99.44%	30.9	41	98.22%	24.6
2019/20**	99.63%	30.8	43	99.10%	24.4
2020/21	99.48%	30.9	60	99.05%	23.9

* Calculation of activity and therefore the set of observations drawn on to calculate quality measures was translated from SAS 9.2 to STATA 17 and minor refinements made, making figures for 2018/19 not comparable with those from 2019/20. See Arabadzhyan et al. (2022), section 6.2.1**,** for details.
** Activity calculated with the updated patient identifier provided by NHS Digital.

After accounting for changes in quality, the total Laspeyres output growth of NHS mental health activity becomes -8.46%.[43] This represents a modest impact from quality adjustment at 0.1 percentage point. The impact of individual quality measures is discussed for physical and mental health in the following section.

6.2.6. Breakdown of quality measures for inpatient care

In sections 6.2.3 and 6.2.5 we presented descriptive statistics for quality adjustment measures for inpatient physical and mental health respectively, along with the overall impact of these quality adjustments on Laspeyres growth. Table 19 presents growth rates when adjusting solely for cost (cost-adjusted column) and for different combinations of these quality measures.

From the breakdown of impacts of specific quality measures, the main driver of improved growth when including quality for physical care arises from higher life expectancy. Quality adjusting for life expectancy alone gives the highest (though always strongly negative) output growth. This suggests a younger cohort of patients was treated in 2020/21 than in 2019/20, given the age and sex specific life expectancy between the two years is fixed by definition. Further, this adjustment may be an overestimate of quality improvement, as it might be expected that life expectancy in 2020/21 was actually lower than in 2019/20.

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[42] The cost-weighted growth in mental health output is equal to -8.88% when not adjusted for working days.
[43] The quality-adjusted mental health Laspeyres output growth rate is equal to -8.78%, when not adjusted for the number of working days.

Adjusting for survival alone indicates a small improvement overall and for all subgroups within physical care. This contrasts with slight reductions in survival rate from descriptive tables. This suggests a more complex case-mix were treated in 2020/21 than in 2019/20. Including a PROMs adjustment also indicates a further slight increase in output growth for all of these groups. Mental health patients experienced slightly lower growth after adjusting for survival and PROMs. Observed increase in waiting time for patients receiving physical and mental health care is reflected in the same or lower output growth after adjusting for waiting time and life expectancy, compared with adjusting for life expectancy alone.

Overall, the table suggests an improvement in the quality of care measured overall, bolstered by life expectancy especially, mitigated by lengthening waiting times.

Table 19: Quality adjustment breakdown with working day/total day adjustment 2019/20 – 2020/21

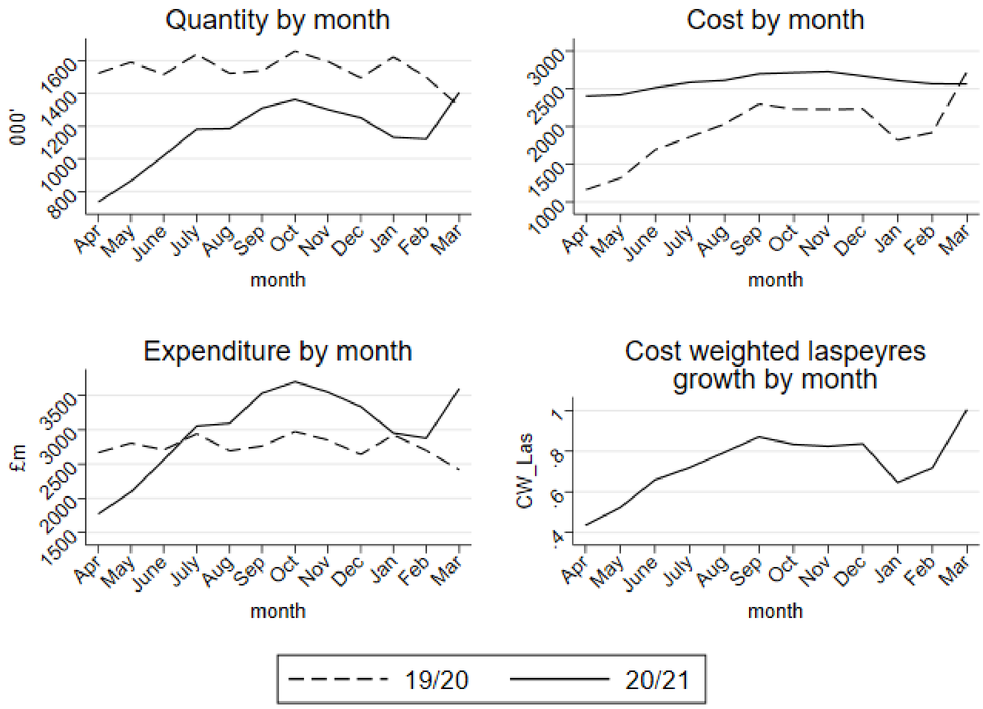
	Cost-adjusted	Quality-adjusted (Survival, PROMs, LE & WT)	QA only Survival	QA only Survival + PROMS	QA only LE	QA only WT & LE
Physical + Mental Health Inpatient (all)	-23.26%	-22.21%	-23.19%	-23.16%	-22.17%	-22.40%
Physical Inpatient (all)	-23.36%	-22.31%	-23.29%	-23.26%	-22.27%	-22.50%
Physical Inpatient (Elective)	-36.46%	-36.06%	-36.34%	-36.29%	-35.87%	-36.28%
Physical Inpatient (Non-Elective)	-6.13%	-4.21%	-6.12%	-6.10%	-4.37%	-4.37%
Mental Health Inpatient (all)	-8.57%	-8.46%	-8.60%	-8.67%	-8.35%	-8.37%

6.2.7. Month by month comparison

A critical feature of the year 2020/21 was the advent of the COVID-19 pandemic and the various policies intended to mitigate it. The pandemic and responding policies had a major impact on activity in the health sector and importantly changed substantially over time. Very broadly, beginning with a national lockdown in late March which was gradually eased over the following months, but then gradually restored until similar restrictions had largely returned by January 2021. In this section we provide a month by month comparison of the years 2019/20 and 2020/21, to explore how this changing environment was reflected in inpatient activity.

Figure 7 presents total volume, unit cost and expenditure for combined physical and mental health in the inpatient setting for each month of 2019/20 and 2020/21. The Laspeyres growth rate for the inpatient setting, comparing each month in 2020/21 with its equivalent in 2019/20 is also presented. The quantity graph strongly reflects the pattern of lockdown policies in the U.K., with a huge drop in activity in April 2020 (to just over 40% of April 2019), which gradually rose to a peak of around 80% of 2019/20 activity in October, before falling again as restrictions were reintroduced. The only month for which the quantity was higher in 2020/21 than in 2019/20 was March, where the pandemic had already had some impact in 2019/20. These changes in quantity over 2020/21 are so substantial as to make undulations in 2019/20 appear limited. The reverse is so when considering unit costs. Here the cost per CIPS in 2020/21 is relatively stable, while it moves substantially in 2019/20. This may reflect both greater changes in case-mix between months of 2019/20. Even with variation in activity, the greater use of block contracts and importance of fixed costs in 2020/21 may also have reduced the degree of variation in 2020/21 by month. Unit costs in 2020/21 are also generally substantially higher than in 2019/20. The expenditure plot reflects the shifts in quantity of activity in 2020/21 and the generally higher unit costs. Expenditure in 2020/21 is initially substantially below that of 2019/20, but ultimately rises above 2019/20 expenditure in the same month and remains above this level for the rest of the year. Finally, month by month Laspeyres volume growth mostly strongly reflects the pattern of quantity, which might be expected given the focus of this measure on considering changes in volume and removing changes in cost. As the growth measure never passes 1, this suggests growth by March of 2021 had returned to a similar level to an already pandemic affected NHS rather than a pre-pandemic one.

Figure 7: Month by month comparison of inpatient activity



6.3. Hospital outpatient setting

- **The cost-weighted and working days adjusted Laspeyres output growth measure for outpatient activity between 2019/20 and 2020/21 was -22.80%.**
- **After adjusting for waiting times, the Laspeyres output growth measure between 2019/20 and 2020/21 remained the same to two decimal points.**

As in previous reports on productivity, we draw on two sources of data for measuring growth in the outpatient setting. We use the HES Outpatient (OP) dataset to calculate activity and the National Cost Collection (NCC) (formerly National Reference Costs) for unit costs of that activity. This is our preferred approach, making maximum use of available data and quality adjustment. In section 6.4, we present an alternative approach where activity and unit costs are both taken from the NCC dataset. Activity in HES OP and NCC data are not directly comparable due to different recording methods. See Castelli et al. (2019), Castelli et al. (2018) for a summary of the main differences between the two data sources.

Table 20 shows outpatient activity fell substantially, by 17.76%, between 2019/20 and 2020/21. At the same time, the mean cost of care increased by 34.64%. This even larger proportional increase in price reflects a general increase in costs for outpatient activity in 2020/21 compared to 2019/20. The median increase in costs at category of care level is 52%.

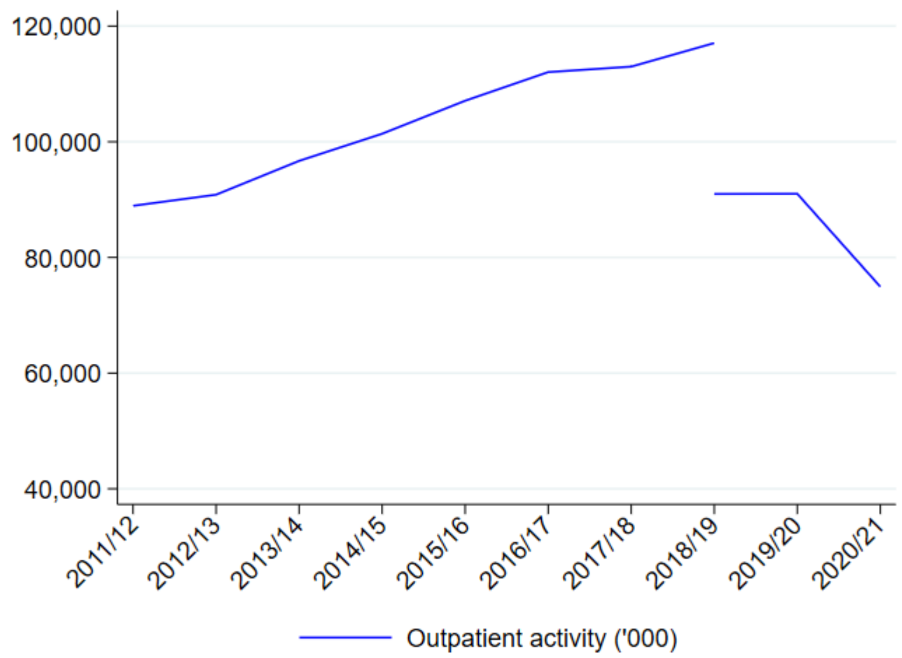
Table 20: HES outpatient volume and average cost over time

Year	HES Outpatient Activity	
	Volume	Average cost (£)
2018/19	117,066,614	132.67
2018/19*	90,972,391	131.67
2019/20*	91,004,047	137.11
2020/21	74,941,740	184.61

* Due to refinements made in identifying outpatient activity described in detail in section just above, activity and mean costs in 2018/19 are repeated with these refinements included, so as to be comparable with information for 2019/20 and 2020/21.

It can be seen from Figure 8 that the fall in activity between 2019/20 and 2020/21 is a stark deviation from the generally upward trending volumes of previous years.

Figure 8: Trends in HES outpatient activity, 2011/12 – 2019/20

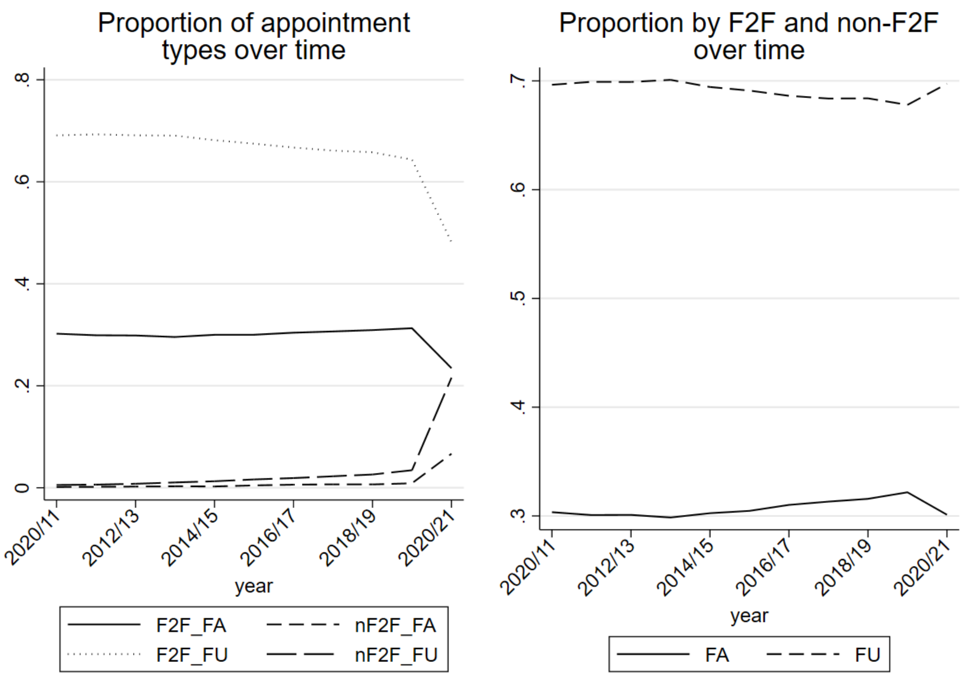


The cost-weighted Laspeyres growth in outpatient activity amounted to -23.11% before adjusting for the number of working days and -22.80% after this adjustment is made. The larger reduction in cost-weighted growth than volume suggests a shift towards less complex and costly care in 2020/21 compared to 2019/20. The substantial increase in unit costs over the same period, noted above, has a very limited impact on the Laspeyres index, as costs from 2020/21 are only used as part of the imputation method when activity is new in 2020/21 so a cost from 2019/20 is not available.

6.3.1. HES outpatient: quality adjustment

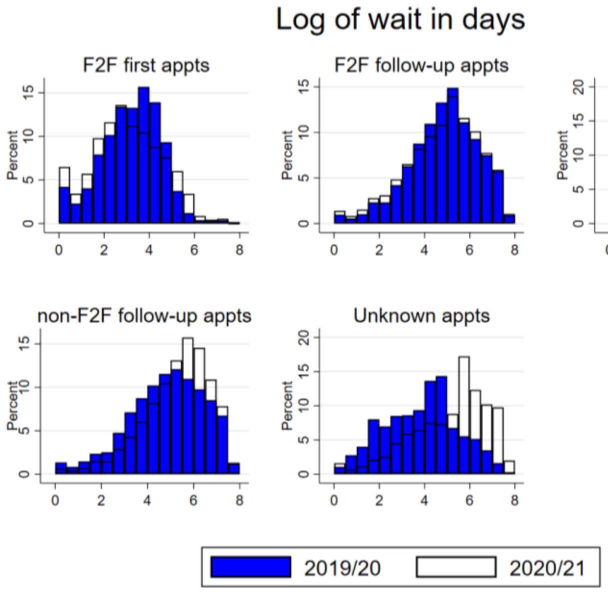
Similarly to the hospital inpatient setting, we adjust outpatient activity for the 80th percentile of waiting times. In previous reports we have specifically considered face-to-face first appointments in evaluating changes in quality in terms of waiting time. This is a good measure of quality for outpatient care overall, as it represents the accessibility of outpatient care when initially referred by a GP. This is similar to considering a CIPS in the inpatient setting as a single period of care. We also observe follow-up outpatient appointments, but these can be expected to be related to a specific first attendance, making the appropriate waiting time less clear cut and potentially leading to double counting more complex patients if included in calculating changes in waiting time. Further, the public conversation around access to clinical care generally centres around face-to-face appointments, which also dominate outpatient care. However, with the advent of COVID-19, the proportion of non-face-to-face first outpatient appointments rose from a negligible to a small but substantive level. This can be seen in Figure 9, which shows the proportion of face-to-face first appointments, face-to-face follow-up appointments, non-face-to-face first appointments and non-face-to-face follow-up appointments over time. This figure also shows that the proportion of first appointments overall remained stable even in 2020/21. This suggests there was a shift from face-to-face to non-face-to-face outpatient appointments between 2019/20 and 2020/21, in line with maintaining social distancing when possible during the COVID-19 pandemic. Therefore, in this report, we also consider changes in the 80th percentile of waiting time for all first appointments (face-to-face and non-face-to-face) as a sensitivity analysis. The main analysis remains changes in the 80th percentile of waiting time for face-to-face first appointments.

Figure 9: Proportion of outpatient appointments by type



Mean and 80th percentile waiting times are presented in Table 21. Between 2019/20 and 2020/21, mean waits for face-to-face first appointments increased by 7 days (from 48 to 55) while the 80th percentile of waits fell by 1 day (from 68 to 67). When considering all first appointments, both mean and 80th percentile waits increased by 9 days between 2019/20 and 2020/21. The difference in changes between the mean and 80th percentile of face-to-face first appointment waiting time in this year is striking and is explored in more detail in Figure 10. This figure presents histograms of the log of waits for each appointment type in 2019/20 and 2020/21. From this it can be seen that the distribution of face-to-face appointments was flattened in 2020/21. A higher proportion of appointments occurred very quickly, but a higher proportion also waited longer than usual. In contrast the wait for non-face-to-face appointments shifted to the right in 2020/21 compared to 2019/20. This may reflect a shift in the case-mix of face-to-face and non-face-to-face outpatient care. Specifically, retaining the most urgent cases as face-to-face appointments (increasing the proportion of short waits) while moving less urgent cases to non-face-to-face forms of care where waits might be longer. The need to substantially increase the volume of activity delivered in a non-face-to-face way may also have impacted the speed at which patients could be seen.

Figure 10: Histograms of the log of waits by appointment type



An additional key feature of the waiting time measure is that we only observe the waiting time of patients who received care. Elective care was substantially impacted by policies to limit the spread and impact on healthcare services of COVID-19. The repercussions on waiting times, especially for longer waits, may therefore be better seen in subsequent years. Changes in waiting times driven by the requirement to reduce activity is outside of the control of the NHS. However, this does not reduce the impact of waiting times on the health and wellbeing of patients, which we seek to capture in this report. As such, the different information provided by the cost-adjusted and quality (in terms of waiting times) adjusted Laspeyres Index are especially important in this extraordinary year and potentially future ones as well.

After adjusting for waiting times of face-to-face first appointments and working days, growth in outpatient activity remained the same to two decimal points at -22.80%.[44] When using the change in 80th percentile of all first appointments, quality and working day adjusted growth was -22.83%. The small impact of the observed change in waiting times is due to the fact that waiting times were discounted and at a relatively high level in 2019/20.

[44] The quality-adjusted growth of outpatient activity is equal to -23.10% when not adjusted for working days.

Table 21: Mean and 80th percentile outpatient waiting times

Year	Face-to-face first appointments		All face-to-face appointments	
	Mean	80th Percentile	Mean	80th Percentile
2018/19	50	71		
2018/19*	45	63		
2019/20*	48	68	48	67
2020/21	55	67	57	76

* In the 2019/20 update, the calculation of activity and therefore the set of observations from which waiting times information was derived, was updated. See Arabadzhyan et al. (2022), section 6.3, paragraph 2, for details.

6.3.2. Month by Month Comparisons

While the COVID-19 pandemic has been a constant feature of the 2020/21 year, levels of COVID-19 infection, healthcare and other policies employed in response changed substantially. The results in this section provide month by month descriptive statistics, which highlight some of the myriad impacts of the pandemic on hospital activity. Figure 11 presents month by month comparisons of types of activity within the Outpatient setting, categorised into: first appointments, separately for face-to-face, non-face-to-face; and follow-up appointments, also separately for face-to-face and non-face-to-face. This figure shows an initial dramatic drop and then recovery of activity in the Outpatient setting (Quantity by month). Over the same time period, there has been an immediate dramatic and persistent increase in non-face-to-face appointments. Face-to-face appointments follow a pattern more similar to overall volume of outpatient activity, but face-to-face activity in March 2021 is below that of March 2020, despite March of 2020 itself being partially impacted by COVID-19.

Figure 12 presents month by month comparisons of unit costs, expenditure, waiting times and Laspeyres growth rate along with activity level. Mean unit costs (costs by month) show an upward shift (meaning higher average monthly unit costs in 2020/21), which is persistent and similar in scale over the whole of the financial year, despite the changes in categories of activity over time observed in Figure 11. This is in line with a general uplift in reported unit costs across activity categories. Expenditure in contemporaneous costs is initially lower (April and May 2020 compared to April and May 2019), but is then consistently higher in the 2020/21 financial year than in 2019/20, especially when comparing March 2021 with March 2020.

Mean waiting time for face-to-face first appointments over the year 2020/21 is more volatile than during 2019/20. Mean wait in 2020/21 is initially lower than in 2019/20, before rising to a peak over the summer and early autumn (August-November), then falling to a more similar but still higher level. In contrast, the 80th percentile of this waiting time measure peaks in June and July of 2020, before falling below the equivalent level in the 2019/20 year in September 2020.

Finally, the Laspeyres growth rate is lowest when comparing April 2020 with April 2019, with the initial clearing of patients from hospitals largely complete. The growth rate is highest when comparing March of 2021 with March 2020, the only comparison with both months at least partially impacted by the pandemic. The volatility in waiting time mean and 80th percentile especially, may reflect the range of shifts in policy, COVID-19 infection and hospitalisation levels over the 2020/21 year.

Figure 11: Types of activity by month

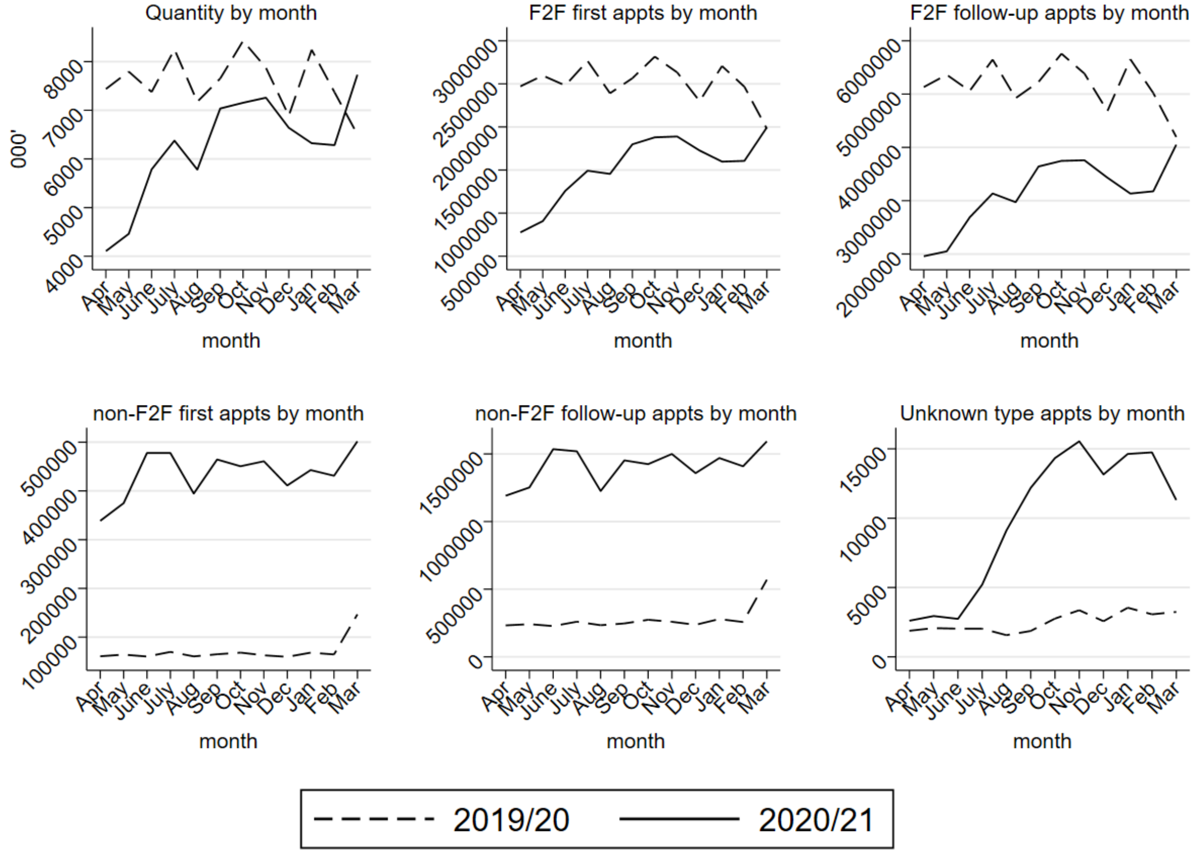
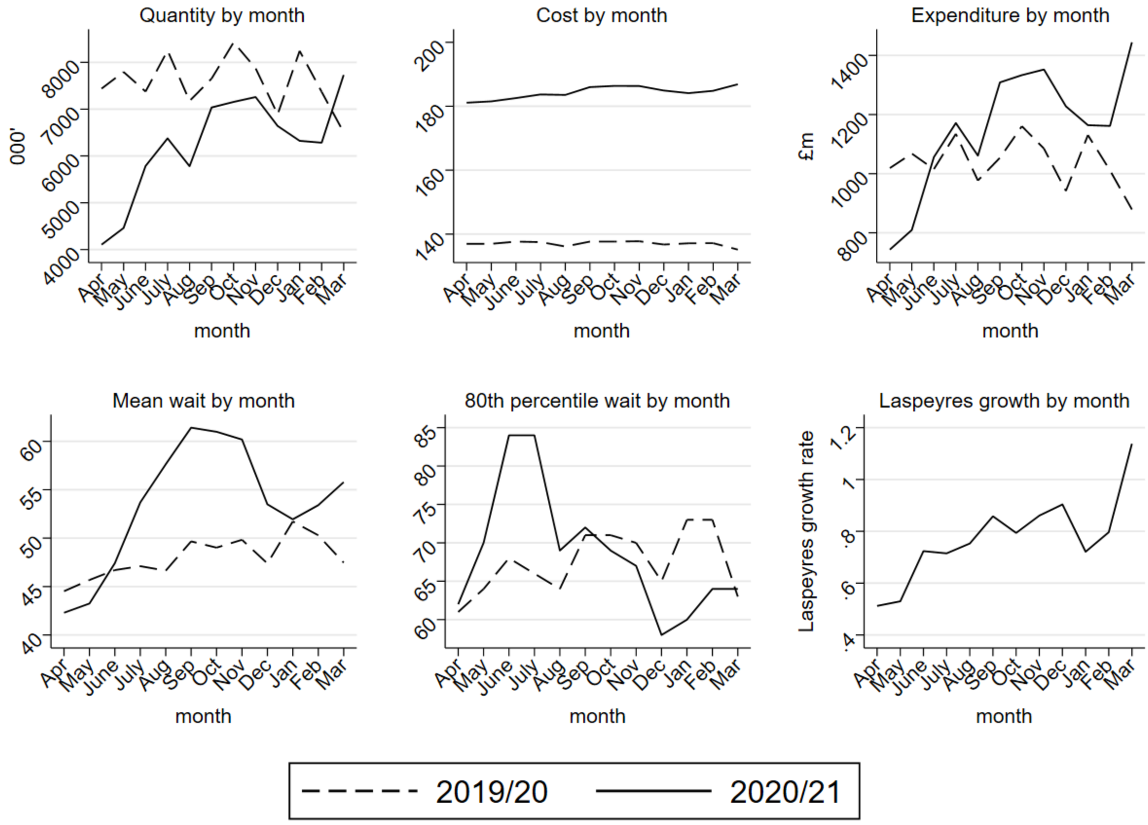


Figure 12: Activity, Expenditure, Waiting Time and Laspeyres Index by Month



6.4. National Costs Collection data

National Cost Collection (NCC) data (previously known as the National Reference Costs data) are used in the NHS output and productivity series to capture activity delivered outside primary care, outpatient departments, and hospital inpatient settings. In particular, it captures activity conducted in accident and emergency (A&E) departments, including ambulance services, mental health, and community care settings, and diagnostic facilities. Activities are reported in various ways: attendances, bed days, contacts, and number of tests.

NCC data also provide information on average unit costs for all recorded activities, including activity performed in hospitals in both inpatient and outpatient settings. NCC data are checked for both accuracy and activity coverage.

The 2020/21 NCC publication was not accompanied by supporting documentation, which typically indicates if some settings or sub-settings are not comparable due to changes in data collection, grouping or any other quality related issues. We therefore rely solely on our internal data quality checks to determine data comparability across years.

Overall, we find the 2020/21 cost collection data to be reconcilable with those produced for 2019/20. This implies that several activity types excluded from the 2019/20 productivity update have now been reintroduced into our analysis, namely:

- High Cost Drugs setting now includes the previously dropped IVF* codes;[45]
- High Cost Devices are now included in the Chemo/Radiotherapy and High Cost Drugs setting as a separate sub-setting;
- Audiology sub-setting now includes the previously dropped ‘CA37* – CA43*’ codes;
- Ambulance services now include the ‘Other’ category which replaced the ‘Calls’ category in 2019/20 and was excluded from the previous update.

The Cystic Fibrosis setting has also been reintroduced in the 2020/21 NCC, however, due to the absence of the 2019/20 comparator, we do not include this activity into the analysis. We also excluded the PD13* and DZ13* currency codes, since they are now recorded across both the Cystic Fibrosis and Regular Day and Night Attendances settings.

Community Mental Health activity continues to be omitted from our analysis, since we have no information on the consistency of data recording across the old format and PLICS between 2019/20 and 2020/21. In particular, comparing the NCC schedules across the latest two financial years suggests that the total expenditure on activity recorded in the old format dropped by 35%, whereas that reported from PLICS has gone up by 45%. This is likely due to increasingly more activity being recorded using the PLICS method. Therefore, we are unable to obtain meaningful estimates of the Community Mental Health setting output growth rate, since the data collected in two different formats are not comparable (Arabadzhyan et al., 2022).

In section 6.4.1, we present the results of our internal data quality checks, whereas section 6.4.2 reports detailed overviews of activity and unit costs trends, and output growth for each NHS setting, as captured by the NCC data, i.e. not corrected for the number of Trusts.

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[45] For details on activity recorded under excluded codes see the National schedule of NHS costs (last accessed 11/10/2022).

6.4.1. Quality checks

Mandatory and non-mandatory validations of the NCC data reported by NHS Trusts have been carried out since their introduction by the then Department of Health in 2011/12 (Department of Health, 2012) until 2019/20. The latest NCC data have not been accompanied by a report detailing any quality assurance checks.

We have therefore implemented, as per usual practice, our own validation process (Bojke et al., 2014), which focuses on identifying large changes in either volume or unit costs of activity for all non-acute services. In particular, our quality assurance process consists of four steps:

- **Step 1:** We check whether a large change in either the total volume (>500,000 units) or the total value (>£25,000,000) of NHS activity/HRG codes as reported in the NCC data is observed. The check compares volumes of activity, unit costs, and total costs of the last two financial years in the national productivity series.

- **Step 2:** We check whether cases of NHS activity/HRG codes, meeting at least one of the criteria in Step 1, do not appear to be genuine. This step may lead to the identification of a subset of HRG/service codes related to NHS activity requiring further investigation. Limited to the HRG/service codes flagged up as requiring further investigation, we implement two further steps.

- **Step 3:** This step has normally included a cross-check of flagged up HRG codes against the codes listed in the HRG4+ Reference Costs Grouper Roots file. However, in both 2019/20 and 2020/21 NHS Digital did not publish an updated HRG4+ Reference Costs Grouper Roots file, and therefore, all checks were carried out via web searches and careful reading of the NCC costing guidance publication.[46]

- **Step 4:** If flagged HRG/service codes have not changed in terms of labelling, definition, or categorisation, we analyse the data in greater detail to identify the possible source of any potential large changes in either volume or value of activity.

The 2020/21 data are characterised by a very large number of categories flagged up as large changes in either volume and/or volume of activity, compared to any of the previous years' checks. Below we describe which settings and individual service categories within these settings were flagged up as having a large value and/or volume change, and the likely reasons behind the patterns we find. Some of the large changes recorded will be due to the COVID-19 pandemic.

[46] NCC 2021 costing guidance can be found here (last accessed 13/10/2022).

A&E and ambulance

This is one of the settings for which we have found the largest value and volume changes for a single service. Due to the limited hospital capacity, at the height of the COVID-19 pandemic, one could expect a decrease in attendances followed by a hospital admission and an increase in non-admitted attendances with no significant change in the unknown type. However, in the data we observe a huge increase in the unknown A&E categories, accompanied by decreases in A&E attendances subsequently being admitted, and in non-admitted attendances. This suggests that hospitals have changed their recording and reporting practices, probably as a result of constraint working capacity, e. g. under-staffing.

Finally, we also observe significant positive value changes in the Ambulance services, in particular, in the 'See and treat or refer' and 'See and treat/convey'.

Outpatient

In the outpatient setting, large value and volume changes are driven mostly by massive shifts between face-to-face and non-face-to-face activities. This is in line with our expectations about the changes in healthcare provisions, which were implemented to contain the spread of the SARS-CoV-2 virus. As this is an expected change, we use the data in the analysis as given.

Community care

Similarly to the outpatient setting, some of the healthcare services delivered in the community have seen significant decreases in value and/or volume changes due to the switches implemented to deliver face-to-face care as non-face-to-face. In fact, the NCC data report a decrease in the face-to-face activities and a growth in those with a non-face-to-face delivery mode. A large positive volume change was also detected for vaccinations performed in the community care setting, which is also to be expected.

Specialist services

Large value changes were mainly detected in the sub-setting 'critical care', which is likely the result of the higher volumes of patient needing this type of care, but especially the costs of treating COVID-19 patients.

Diagnostic tests

While diagnostic services did not see drastic increases in unit costs, this setting has a high number of services where large negative volume changes were detected. This is also an expected consequence of the pandemic, as diagnostic tests and procedures are usually carried out in person.

Radiology

Similarly to diagnostic tests, ultrasound scans have seen a large decrease in volume and value.

It is worth noting that a large number of services saw a significant increase in unit costs, which is likely to be a consequence of decreased number of activities with similar or higher levels of total spend. While it does not present concerns for this report, the next productivity update will have to take into account that the unit costs derived from the 2020/21 NCC data may not correctly represent service-related costs and may require some correction.

Finally, similarly to the 2019/20 update, there is a difference in the number of providers included in the NCC schedule. In 2019/20, 209 out of 223 providers were included in the dataset, whilst in 2020/21 this number went up to 215 out of 216 organisations.[47] Missing NHS Trusts' activity in 2019/20 may result in an overestimation of both the NHS output and productivity growth rates, and of raw volumes of activity; hence, the growth rates reported in the following sections should be seen as an upper bound of NHS output growth.

6.4.2. Growth in NHS activity captured in the National Cost Collection data

In this section, we present the results for the three most recent financial years of NHS activity captured by the NCC data. Tables reporting the full time series for both activity and average costs can be found in Tables A8 – A19 in the Online Appendix.

Between 2019/20 and 2020/21, the working / total days adjusted Laspeyres output growth for NHS activity as captured by the NCC data was -13.65%, if the outpatient setting is included, and -10.07% otherwise. The negative growth, however, masks a more varied picture across the settings covered by the NCC data, as shown in the remainder of this section, where each of the settings is explored in further detail.

The negative growth, however, masks a more varied picture across the settings covered by the NCC data. Table 22 provides an overview of the activity volumes and average unit costs for the last three years, as well as the raw and Laspeyres volume growth rates (as measured by the original NCC data and corrected for the number of Trusts). Note that the Community Mental Health setting was excluded from the analysis, similarly to the previous year.[48]

As appears from Table 22, all settings saw a negative growth between 2019/20 and 2020/21, with the exception of Renal dialysis. The largest drops were recorded for Directly accessed diagnostic services, Radiology and Other NHS activity. Between 2019/20 and 2020/21, the working / total days adjusted Laspeyres output growth for NHS activity as captured by the raw NCC data was -13.65%, if the outpatient setting is included, and -10.07% otherwise.

Table 23 presents the same information in a more disaggregated way for selected settings (A&E and Ambulance, Chemo-, Radiotherapy, High Cost Drugs and Devices, Specialist Services and Other NHS activity). In the remainder of this section we describe in more detail the activity structure and other relevant information, where applicable.

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[47] The difference in the total number of NHS Trusts between 2019/20 and 2020/21 is due to several mergers and acquisitions, which involved Trusts present in the dataset in both years. The only provider missing in the 2020/21 collection was also missing from the 2019/20 dataset.

[48] Activity and unit costs data for Community Mental Health have undergone a complete overhaul in 2019/20, mainly because the 2019/20 Mental Health data within the NCC collection are largely based on PLICS (Patient Level Information and Costing System), with some providers submitting data in the old format (see p.10 in NHS ENGLAND & NHS IMPROVEMENT 2021. *National Cost Collection 2019/20 Report*, NHS England.). The transition process is still ongoing, and since PLICS is not costing activity in the same way as the previous costing methodology, direct year-to-year comparisons are not possible even for total quanta. For historic trends in Community Mental Health activity see Table A14 in the Online Appendix.

Table 22: Activity volumes, average unit costs and growth rates for the settings measured by NCC.

	2018/19		2019/20		2020/21		2019/20-2020/21		
	Volume of activity	Average cost (£)	Volume of activity	Average cost (£)	Volume of activity	Average cost (£)	Raw volume growth rate	Laspeyres growth rate	Laspeyres growth rate corrected for # of Trusts
Outpatient	87,944,919	130	84,849,738	137	72,213,955	187	-14.89%	**-20.91%**	**-24.09%**
Community Care	81,794,290	64	76,106,927	70	72,359,084	86	-4.92%	**-8.35%**	**-13.18%**
Directly accessed diagnostic services	7,613,040	33	7,053,907	36	4,588,685	52	-34.95%	**-34.18%**	**-39.51%**
Directly accessed pathology services	426,076,050	2	392,755,757	2	306,866,304	3	-21.87%	**-19.07%**	**-23.34%**
Radiology	9,961,010	98	11,524,610	90	7,829,191	149	-32.07%	**-29.21%**	**-32.11%**
Rehabilitation	2,298,007	378	2,250,425	403	1,630,522	574	-27.55%	**-26.44%**	**-27.03%**
Renal dialysis	4,275,328	135	4,240,238	144	4,411,120	155	4.03%	**3.76%**	**3.75%**
A&E and Ambulance	See Table 23 for details on volumes and average costs							**-12.18%**	**-14.38%**
Chemotherapy, Radiotherapy, High Cost Drugs and Devices								**-0.68%**	**-5.35%**
Specialist Services								**-8.36%**	**-10.81%**
Other NHS activity								**-29.6%**	**-30.80%**
Total NHS activity measured by NCC								**-13.65%**	**-16.92%**
Total NHS activity measured by NCC (excl. Outpatient)								**-10.07%**	**-13.39%**

Note: Laspeyres growth rates are adjusted for working days.

Table 23: Activity volumes, average unit costs and growth rates for the A&E and Ambulance, Chemo-, Radiotherapy, High Cost Drugs & Devices, Specialist Services and Other NHS activity settings

		2018/19		2019/20		2020/21		2019/20-2020/21		
		Volume of activity	Average cost (£)	Volume of activity	Average cost (£)	Volume of activity	Average cost (£)	Raw volume growth rate	Laspeyres growth rate	Laspeyres growth rate corrected for # of Trusts
A&E and Ambulance									**-12.18%**	**-14.38%**
Emergency Departments	AD	3,738,454	263	2,911,499	314	13,417	333	-21.01%	-15.80%	-19.43%
	NAD	12,215,524	171	10,238,989	185	41,134	187			
	Unknown	-	-	2,317,415	206	12,163,403	340			
	Total	15,953,978		15,467,903		12,217,954				
Other A&E services	AD	48,101	116	93,774	170	23,869	174	-30.07%	-24.95%	-28.17%
	NAD	4,388,481	72	3,834,871	76	1,032,662	111			
	Unknown	-	-	603,672	81	2,113,039	141			
	Total	4,436,582		4,532,317		3,169,570				
Ambulance services	Calls	10,039,191	7	-	-	-	-	-	-4.75%	-4.75%
	Hear and treat/refer	799,332	47	950,906	52	793,116	85	-16.59%		
	See and treat/refer	2,480,819	209	2,705,547	206	2,919,214	268	7.90%		
	See and treat & convey	5,421,377	257	5,362,217	292	4,881,719	357	-8.96%		
	Other	-	-	1,778,309	70	1,590,487	90	-10.56%		
Chemotherapy, Radiotherapy, High Cost Drugs and Devices									**-0.68%**	**-5.35%**
Chemotherapy		2,707,943	600	2,606,064	657	2,547,729	805	-2.2%	6.00%	-1.62%
Radiotherapy		1,962,279	213	1,855,549	238	1,562,053	353	-15.8%	-10.78%	-17.98%
High Cost Drugs		2,477,645	799	2,774,471	756	2,627,691	766	-5.3%	1.50%	-1.03%
High Cost Devices		-	-	467,130	933	273,129	1,261	-41.5%	-26.81%	-27.77%
Specialist Services									**-8.36%**	**-10.81%**
Critical Care		2,698,927	1,218	2,483,865	1,347	2,218,159	1,864	-10.70%	-8.17%	-10.68%
Specialist Palliative Care		807,252	181	860,467	181	761,030	259	-11.56%	-16.64%	-17.27%
Cystic Fibrosis		12,208	9,343	-	-	51,770	1,352	-	-	
Cancer Multi-Disciplinary Team Meetings		1,922,238	112	1,890,595	118	1,775,556	146	-6.08%	-5.38%	-8.26%
Other NHS activity									**-29.6%**	**-30.80%**
Regular Day & Night Attenders		328,946	341	331,177	378	240,476	483	-27.38%	-29.95%	-29.17%
Audiological services		3,044,139	61	3,062,711*	74	2,175,264	100	-28.98%	-27.78%	-29.85%
Day Care Facilities		220,424	70	93,698	167	45,078	346	-51.89%	-52.30%	-57.12%

Note: Laspeyres growth rates are adjusted for working days.

Outpatient activity

Outpatient activity, as measured in the NCC database, is classified into three major groups: consultant-led activity, non-consultant-led activity, and procedures. Consultant- and non-consultant-led activity represent broadly the same set of outpatient specific HRG-style codes (currency codes beginning with WF). Outpatient procedure codes represent procedure-related HRGs which may appear in other hospital settings. The shares of outpatient activity by the three major groups described above have slightly changed in 2020/21, with consultant-led activity representing 63% of overall outpatient activity as compared to 60% in 2019/20, the share of non-consultant-led activity staying stable at about 25%, and outpatient procedures going down from 15% to 12%.

A&E and ambulance services

A&E services are provided in both Emergency Departments (EDs) and 'Other A&E' departments.[49] Since 2019/20 attendances at A&E departments are classified into three types: those where patients are subsequently admitted (AD) to an inpatient ward, those where patients are not admitted (NAD), and those with an unknown outcome (Unknown).

The total number of emergency department attendances showed a decline of -21% between 2019/20 and 2020/21. Due to the possible miscoding of admitted and non-admitted attendances as 'unknown' in 2020/21, we cannot make reasonable year-on-year comparisons for these separate categories, but we note that unit costs increased for all three categories, with the most remarkable increase recorded for the 'unknown' (+65%).

'Other A&E services' activity has dropped even more substantially by about 30%. Similarly to ED visits, comparison of activity levels within subcategories across years is hindered by the change in recording, while average unit costs went up, with a considerable increase recorded for the 'unknown' category of about 75%.

Overall, the total volume of A&E activity decreased by 23% between the two most recent financial years.

As regards Ambulance services, with the exception of the 'See and treat/refer' category, which saw a 7.9% increase in activity levels, 'Hear and treat/refer', 'See and treat & convey' and 'Other' activity went down by 16.6%, 9%, and 10.6% respectively, while all the services saw a substantial growth in unit costs.

Chemotherapy, Radiotherapy & High Cost Drugs

In 2020/21, Chemotherapy showed a similar trend to 2019/20, experiencing an activity drop of -2.2%, while Radiotherapy saw a more substantial decrease of -15.8%. High Cost Drugs activity declined by 5.3%, and High Cost Devices saw a massive drop of -41.5%. These drops in activity levels were all accompanied by increases in unit costs.

[49] Emergency departments offer a consultant-led 24 hour service with full resuscitation facilities and designated accommodation for the reception of A&E patients, whilst other A&E departments can be either of the following: 'Consultant-led mono specialty accident and emergency services (e.g. ophthalmology, dental) with designated accommodation for the reception of patients'; 'Other type of A&E/minor injury activity with designated accommodation for the reception of accident and emergency patients' and 'NHS Walk-in Centres'. For a definition see the spreadsheet "9. Attendance Location" of the file "ECDS Enhanced Technical Output Specification (ETOS) v3.1.1.", available at NHS Digital website "ECDS guidance and documents" (last accessed 7/11/2022).

Table 24 reports the contribution to the 2020/21 growth rate of this NHS setting of each of these sub-settings. Positive Laspeyres growth rates for Chemotherapy and Radiotherapy suggest that decreases in volumes of activity occurred among less costly activity types.

Table 24: Contribution of sub-settings to overall growth of the setting 'Chemo-/Radiotherapy/High Cost Drugs'

Sub-setting	Laspeyres Growth rate	Setting specific growth index	Value of Activity in 2019/20	Share of overall spend	Contribution to overall growth rate
Chemotherapy	6.00%	106.00%	£1,683,872,981	36.14%	38.31%
Radiotherapy	1.50%	101.50%	£2,098,310,188	45.04%	45.72%
High Cost Drugs	-10.78%	89.22%	£440,730,796	9.46%	8.44%
High Cost Devices	-26.81%	73.19%	£435,815,079	9.35%	6.85%
Total/overall growth rate			**£4,658,729,044**		**-0.68%**

Note: Individual Laspeyres growth rates are adjusted for working days.

Community care

Community care includes a very diverse array of activities carried out in the community by Allied Health Professionals, Community Rehabilitation Teams, and by Health Visiting and Midwifery personnel, as well as Intermediate Care (incl. crisis responses, care home based services, etc), Medical and Dental care (e.g. community, emergency, and general dental services), Nursing (ranging from school-based children's healthcare service to specialist nursing for various diseases) and wheelchair services for both adults and children.

Between 2019/20 and 2020/21, Community care activity continued to decrease with a 4.92% drop in the volume of activity, while the average unit cost continued an upward trend.

The cost-weighted and working days adjusted Laspeyres output growth rate for community care, when not correcting for missing NHS Trusts activity, was -8.35% between 2019/20 and 2020/21, indicating that the negative growth was more substantial in community care services with higher average unit costs.

Diagnostic tests, pathology, and radiology

Between 2019/20 and 2020/21 diagnostic and screening activities have seen a huge drop: Directly accessed diagnostic services decreased by -34.95%, Directly accessed pathology services by -21.87%, and Radiology by -32.07%, all accompanied by increases in unit costs. Directly accessed diagnostic services is the setting that registered the largest decrease in Laspeyres growth rate.

Rehabilitation and renal dialysis

Between 2019/20 and 2020/21, Rehabilitation and Renal Dialysis showed a very different dynamic. In terms of activity volumes, Rehabilitation saw a decrease of -27.55%, whereas Renal Dialysis activity went up by 4.03%. While average unit costs for both settings went up, the magnitude of the increases was very different: 42.43% increase for Rehabilitation and 7.64% increase for Renal Dialysis.

Between 2019/20 and 2020/21, the cost-weighted and total days adjusted Laspeyres output growth measure for Renal Dialysis was 3.76%, which exceeded the previous year growth rate of 1.57%. Renal Dialysis is the only setting which recorded a positive growth in 2020/21. The cost-weighted and working days adjusted Laspeyres output measure for Rehabilitation was -26.44%, between 2019/20 and 2020/21, indicating that activity decreased proportionally less in less costly activity types.

Specialist services

The setting Specialist services, as defined in this report, comprises the following services: Critical Care,[50] Specialist Palliative Care, and Cancer Multi-Disciplinary Team Meetings. Up to 2018/19, Cystic Fibrosis services were reported in the NCC data as a separate activity and included in the Specialist services setting. In the 2019/20 NCC schedule, this activity was recorded under different NHS settings and the volumes were no longer comparable. In the 2020/21 NCC dataset Cystic Fibrosis activity is reported again in a new format, in a separate schedule. We therefore exclude this sub-setting from the calculations of the Laspeyres output growth rate for the Specialist services setting.

Between 2019/20 and 2020/21, Critical Care services saw an overall decrease of -10.7% in activity volumes, with the highest decrease recorded for Paediatric Critical care (-27.31%), followed by Neonatal Critical care (-13.13.%), and finally Adult Critical Care (-6.6%). Specialist Palliative Care activity went down by a similar magnitude of -11.56%, while Cancer Multi-Disciplinary Team Meetings activity saw a more modest decrease in volumes of -6.08%. All the specialist services recorded an increase in the average unit costs.

Other NHS activity

The total volume of Regular Day and Night Attenders (RDNA) showed a negative growth of -27.39% between 2019/20 and 2020/21, and Audiological Services too recorded a drop of a similar magnitude (-28.98%). Day Care Facilities activity plummeted by -51.9%, which was accompanied by a massive rise in their average unit cost (107%). The volume of activity for audiological services in 2019/20 in Table 23 differs from the one published in our previous report since the CA37* – CA43* codes have been added back in 2020/21 and 2019/20.

6.5. Dentistry and ophthalmology

- **Between 2019/20 and 2020/21, the cost-weighted and working days adjusted Laspeyres output growth measure for**
  - **Ophthalmology was -30.84%;**
  - **Dentistry was -69.96%.**
- **Combining the two activities yielded growth of -62.94%.**

Information about dentistry[51] (activity and costs) is published by NHS Digital. Up to 2019/20, Ophthalmology[52] (activity only) data were published by NHS Digital, but this series has been discontinued with figures for 2020/21 provided directly to us by NHS England and NHS Improvement. Table 25 shows the volume of activity and average costs for both types of outputs, with dental activity differentiated into dental bands for the last three financial years. Unit cost data for Ophthalmological services were provided by the Association of Optometrists up until 2019/20, and those for 2020/21 were taken from the NHS Business Authority website.[53]

[50] Up to 2017/18, CHE NHS productivity updates referred to Critical Care under the 'Adult critical care' label.
[51] NHS Dental Statistics (last accessed 18/06/2021).
[52] Ophthalmic services activity (last accessed 18/06/2021).
[53] NHS Business Authority Cost of NHS Treatment (last accessed 14/12/2022).

Table 25: Ophthalmology and Dentistry

Activity		2018/19		2019/20		2020/21	
		Volume of activity	Average cost (£)	Volume of activity	Average cost (£)	Volume of activity	Average cost (£)
Ophthalmology		13,225,755	21	13,355,060	21	9,199,829	22
Dentistry	**Band 1**	23,386,880	22	23,009,601	23	4,890,432	24
	Band 2	10,631,216	59	9,777,565	62	2,953,317	65
	Band 3	1,941,217	257	1,833,103	269	497,917	283
	Urgent	3,620,927	22	3,637,713	23	3,580,057	24
	Other	136,476	22	123,192	23	62,929	24
	Total	**39,716,716**	**43**	**38,381,173**	**45**	**11,984,652**	**45**

The raw volume of ophthalmic services decreased in 2020/21 by -31.11%, reverting the positive trend recorded since 2015/16, with average costs remaining basically unchanged. In contrast, dental activity recorded a substantial volume decrease of -68.77% in 2020/21, with the largest drops observed for Bands 1 and 3 (respectively, -78.75% and -72.84%). Their contribution to cost-weighted growth of dental services is also among the highest of all the subcategories (6.48% and 7.83% respectively). Average costs of dental activity have increased for all types of dental services.

Combining activity for dental services and ophthalmology, the cost-weighted and working days adjusted Laspeyres output growth measure was -62.94% between 2019/20 and 2020/21.[54]

6.6. Primary care activity

- **Between 2019/20 and 2020/21, the cost-weighted, quality and working days adjusted Laspeyres output growth of primary care activity was -2.68%.[55]**

Since 2018/19, NHS Digital has been releasing the General Practice (GP) appointments dataset, which is used to calculate the output growth of primary care activity (Arabadzhyan et al., 2021).[56,57] NHS Digital releases three separate datasets: (1) a monthly summary of GP appointments data at the national level, (2) a monthly dataset at the CCG level with NHS geographies up to regional local office included, and (3) a CCG-level dataset reporting daily appointment counts in general practices. However, only the monthly and daily appointment datasets at CCG level allow for grouping of GP appointment modes by appointment status and waiting time.

Each monthly data release covers the most recent 30 months, with updated information on the current month and the previous 17 months (18 months in total). The data include activity recorded within the appointment systems for the great majority of General Practices across England, with average patient coverage of about 98% during 2020/21.[58] For the purpose of our NHS productivity calculations, we use the monthly CCG-level dataset to obtain monthly appointment data with a

[54] Their cost-weighted output growth measures, when not adjusted for working days, are equal to -31.11% and -70.08%, respectively for Ophthalmology and Dentistry. When combining the two activities, the cost-weighted output growth measure is -63.08%, when not adjusting for working days.
[55] If COVID-19 vaccination activity is excluded, the Laspeyres output growth rate amounts to -9.27%.
[56] Up to 2017/18, the output growth measure of the primary care setting was calculated using GP Patient Survey data (Castelli et al., 2020, Castelli et al., 2019).
[57] NHS Digital GP appointments data (last accessed 14/04/2022). For the analysis presented in this section, we used the February 2022 publication.
[58] Appointments in general practice: supporting information - NHS Digital (last accessed 14/04/2022) and the report 'Productivity of the English National Health Service: 2018/19 Update' by Arabadzhyan et al. (2021) include further information on data collection.

breakdown by appointment status and waiting time within each appointment mode, and the national-level dataset for the monthly estimates of patient coverage. Since December 2020, the data on COVID-19 vaccinations carried out by GP practices and Primary Care Networks has also been recorded and is included in our analysis.[59]

In this report, we follow the methodology outlined in the previous productivity update (Arabadzhyan et al., 2022), with three changes. First, the waiting times quality adjustment is now introduced into the baseline Laspeyres output growth estimate. Second, when calculating the baseline growth rate, we assign equal value and hence cost weight to appointments delivered face-to-face, via telephone and through video or online. The former method, where specific weights were assigned for the two types of remote consultations, is now presented as a sensitivity check. Finally, when including COVID-19 vaccination activity, we assume that a vaccination appointment has the same cost as other face-to-face appointments. Note that since COVID-19 vaccinations have been recorded only in 2020/21 (since December 2020), as they represent new activity not previously carried out, they are not adjusted for changes in waiting times.

In the remainder of this section: we outline the impact of the COVID-19 pandemic on the delivery of primary care services and the quality of the data recorded; provide a discussion on assigning the unit costs to different appointment modes; report the cost-weighted, quality- and working days adjusted output growth rates of the primary care setting. Finally, we perform two sets of sensitivity analyses. In the first sensitivity analysis, we use unit cost weights specific for different GP appointment modes, as per methodology followed in previous NHS productivity growth updates (Arabadzhyan et al., 2022). In the second, we introduce the further assumption that only a fraction (see section 6.6.5) of telephone appointments carried out in 2020/21 were used as substitutes for face-to-face appointments, and can be attributed the face-to-face appointment unit cost weight.

6.6.1. GP services and the COVID-19 pandemic

The COVID-19 pandemic has provoked a structural shift in both patients' healthcare seeking behaviours (the demand side) and the way care has been provided (the supply side). While patients were avoiding using primary care services either out of fear of contracting the virus or putting pressure on the NHS,[60] GP practices were faced with a task of reorganising service provision to contain the spread of SARS-COV-2. Guidelines issued by NHS England and NHS Improvement[61] led to the adoption of a total triage system by GP practices across the country, with only a few patients asked to attend a GP practice in person to see a GP, nurse or other healthcare professional. This implied that starting from March 2020, GP practices increasingly changed the way they would see patients. A higher proportion of appointments was offered as either a telephone or video/online consultation. Importantly, the changes introduced were accompanied by the reassurance that GP practices would continue to receive the same income as they would have in the business-as-usual scenario.

The pandemic has also affected the GP appointments data collection and its quality. As noted in the GP appointments data publication,[62] the differences in appointment management systems among practices were exacerbated during the pandemic, negatively affecting the quality of the data recorded.

[59] These data are published separately from the main GP appointments data, in the National Immunisation Management Service (NIMS) dataset. NIMS is the System of Record for the NHS COVID-19 vaccination programme in England. The total number of vaccinations provided in England (up to March 2021) was 30,270,999, with 65.6% of these being carried out in the primary care setting.

[60] Fear of contacting GPs during Covid outbreak 'fuelling missed diagnoses' – The Guardian (last accessed 14/04/2022).

[61] See the briefing from 18/02/2022, letters to the GP practices from 5/03/2022 and 19/03/2022 (last accessed 14/04/2022).

[62] Appointments in general practice: supporting information - NHS Digital (last accessed 14/04/2022).

As many appointments are pre-booked, a fraction of face-to-face appointments booked before lockdown restrictions were introduced may have been delivered via either a telephone call or video/online tool. This may be due to a number of reasons: patients presenting with COVID-19 symptoms; patients or healthcare professionals seeking to limit any unnecessary face-to-face contacts. Consequently, the number of face-to-face consultations recorded in the NHS Digital GP appointments dataset is likely to be overestimated. By contrast, telephone appointments numbers might be underestimated to a larger extent than before the pandemic. Underestimates of phone consultations arise partly from block appointment bookings[63] (when several patients are contacted, while only one notional appointment is recorded). This practice may have increased and so exacerbated the issue of undercounting during the pandemic.

These considerations must be taken into account when making inference about the growth rates of primary care activity. Not only do they pose a concern of data comparability across years, but also call for a reassessment of the optimal way of assigning unit costs to different types of primary care consultations. We will discuss this issue in the following section 6.6.2.

Finally, during the pandemic, GP practices started to perform COVID vaccinations. Although we normally do not include new activity types when calculating growth rates, in this case inclusion of vaccination appointments is justified, since they are a type of output delivered by GP practices, and possibly have displaced other types of activity that the GP staff would have normally delivered.

6.6.2. Assigning unit costs to primary care consultations

In order to calculate the primary care cost-weighted output growth measures, we need to use appropriate unit costs for the different types of primary care activity. As it is not possible to fully distinguish between types of healthcare professionals delivering primary care services, we use the cost of patient contact per minute of GP's time as our primary unit.[64] This information is taken from the PSSRU 'Unit Costs of Health and Social Care' reports (Curtis and Burns, 2020, Jones and Burns, 2021).[65] The per-minute cost of GP contact reported for the past three years is the same and equal to £4.30. The second component required to calculate the unit costs for different types of appointment is the duration of each consultation type. To this end, we use the baseline estimates of consultation duration for each consultation type reported in the 2018/19 NHS productivity update (Arabadzhyan et al., 2021) and the cost per-minute of GP time, to obtain the unit costs for each appointment mode reported in Table 26.

However, the COVID-19 pandemic has had profound impacts on the way primary care services were delivered, with some of the changes in work practices to be expected to become the "new normal". This coupled with other considerations led us to take a different approach to assigning unit costs to primary care appointments for this current NHS productivity update. First, data reporting and quality issues highlighted above may introduce a further bias to cost-weighted estimates if there was systemic under/over reporting of some consultation types (face-to-face vs remote). Second, it is important to recall that unit costs are used as proxies for the value of GP services to patients. Thus, special attention should be given to how we weight GP appointments during the COVID-19 pandemic. There are two distinct and important considerations to make: (1) the value given by patients to a GP appointment will have been affected by the pandemic; and (2) as the vast majority of appointments were carried

[63] Appointments in general practice: supporting information - NHS Digital (last accessed 14/04/2022).
[64] A fuller explanation for this decision can be found in Arabadzhyan et al. (2021).
[65] The unit costs are taken from the PSSRU "Unit Costs of Health and Social Care" 2020 (p.126) and 2021 (p. 111) (last accessed 14/04/2022).

out as remote consultations (i.e. were substitutes of face-to-face consultations), the implied total costs associated with a GP appointment will have changed also.

Evidence during the pandemic shows that people with minor/less urgent health needs may have avoided contacting the GP at all.[66] Complex patients, who would previously have been offered and be seen as a face-to-face appointment, were seen only remotely (Joy et al., 2020). Most critically, people needing health services might have foregone care altogether. For example, Quinn-Scoggins et al. (2021) found that nearly 50% of people experiencing potential cancer symptoms did not contact their GP during the first six months of the pandemic. Finally, patients who sought care may have preferred a remote appointment due to safety concerns.

The move to a total triage system has also meant that initial screenings were carried out before an appointment of any type would have been scheduled, with the majority of appointments offered as remote consultations, often as a telephone appointment. A study by Salisbury et al. (2020), conducted pre-pandemic, concluded that "*digital-first access models using online, telephone or video consultations are likely to increase general practitioner workload by 25%, 3%, and 31%, respectively*". This implies an increase in total costs. A report by the Royal College of General Practitioners (2021) on the future role of remote consultations and patient triage states that during the pandemic the majority of triage was carried out by GPs, although they do not have clear-cut evidence of this.

The above evidence suggests that during the pandemic the value that patients placed on a remote primary care appointment, as well as the costs associated with delivering remote consultations, might have increased. Therefore, it is reasonable to assume that the cost/value weights of remote consultations should be on average similar to that of face-to-face ones. Thus, we opted for assigning the unit cost of face-to-face appointments also to telephone and remote appointments. This approach has implications in terms of the output growth index as we are *de facto* assigning cost/value weights to primary care appointments based on assumptions regarding the current financial year, as opposed to the base year.

Finally, it should be noted that changes in the way primary care services were delivered during the pandemic could have affected the total duration of a consultation. For example, telephone consultations may have increased in length as more complex patients were receiving health care via remote means. While the cost implications of such a change are not a concern for the current update, given that the Laspeyres growth rate is based on the unit costs of the previous period (2019/20), empirical evidence on the impact of the pandemic on consultation duration ought to be considered in future productivity updates.

In Table 26, we report the total volume of GP appointments by mode of appointment for the years 2019/20 and 2020/21 and respective unit costs, with the same unit costs for face-to-face, telephone and video/online consultations.

[66] The results of the GP Patient survey suggest that about 40% of respondents avoided contacting GP to protect the NHS or in fear of contracting COVID.

Table 26: Volume of GP activity and unit costs (£)

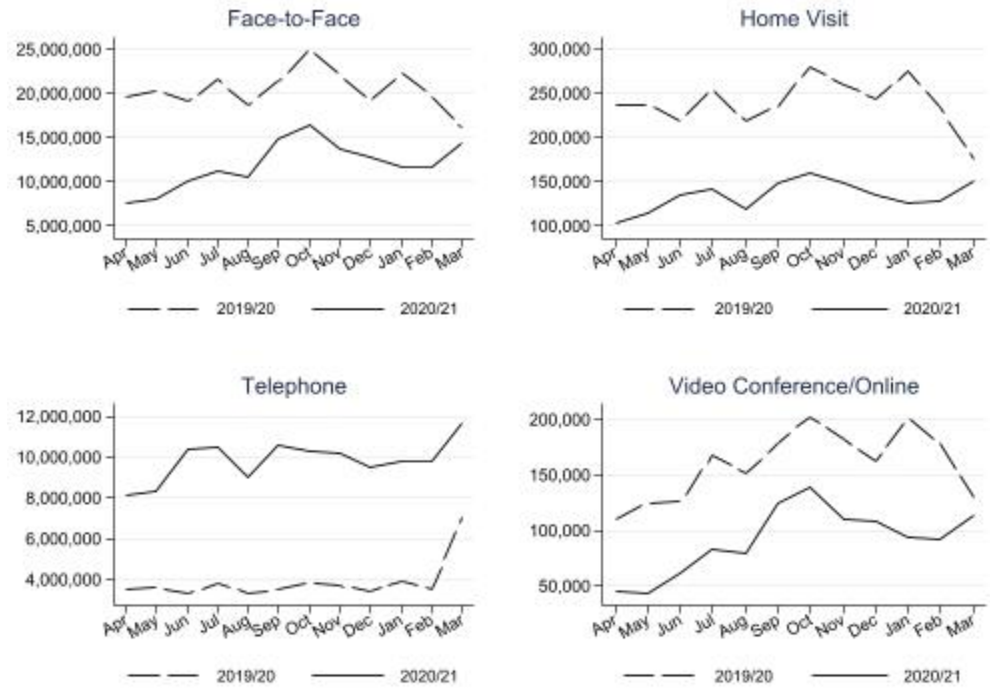
Appointment mode	**2019/20**	**2020/21**	**2019/20 Unit cost (£)**
Face-to-Face	244,918,881	143,040,299	39.65
Home Visit	2,868,106	1,612,794	121.68
Telephone	46 678,238	118,225,447	39.65
Video/Online	1,914,916	1,092,986	39.65
COVID-19 vaccinations	-	19,846,183	39.65
Total GP appointments	**296,380,141**	**283,817,710**	

Overall, primary care output dropped by 4.24%, when considering growth in the raw volume of activity. Face-to-face, home visits and video/online all recorded a negative growth in raw volumes of over 40%, with the largest decrease recorded for home visits (-43.77%). In contrast, telephone appointments increased by over 150%.

6.6.3. Month by month comparisons

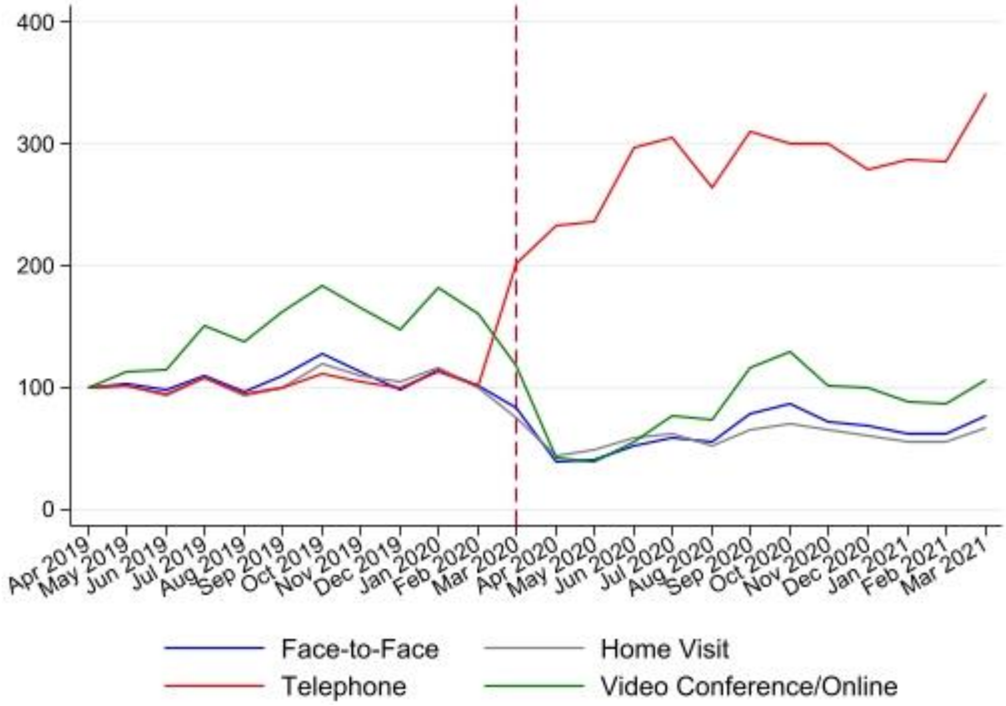
In this section, we analyse the dynamics of appointment counts on a more disaggregated (monthly) level, to understand how the composition of attended appointments changed over time. Figure 13 shows that a substantial increase in the number of telephone appointments was already observed in March 2020 and persisted throughout 2020/21, with a slight dip in August 2020. The slight decrease recorded in August aligns with a seasonal pattern, since such dynamics were also present in August 2019. While we would expect to see a similar picture for the video/online appointment mode, this is not the case. The number of video/online appointments has been decreasing since March 2020, then recovered during September-October 2020, and went down again amid the second wave of the pandemic – very similar to the dynamics of face-to-face consultations.

Figure 13: Monthly trends of appointment counts by mode of appointment (2019/20 and 2020/21)



A further analysis of the relative dynamics of appointment counts is presented in Figure 14, where for each appointment mode we present the changes in the number of consultations indexed to April 2019, thus allowing for a comparison of relative shifts in appointment counts before and during the pandemic. The figure suggests that seasonal fluctuations were similar across different appointment modes before the pandemic, with video/online appointments also exhibiting a positive trend. However, as the pandemic hit, video/online appointments saw the largest proportional drop, though the relative dynamics were still very similar to that of face-to-face consultations and home visits, while telephone consultations showed a rapid near threefold growth. However, as can be seen from Table 26, this growth in telephone appointments did not fully compensate for the drop in consultations observed for all other appointment types.

Figure 14: Appointment counts indexed to April 2019, by mode of appointment



6.6.4. Quality adjustments in primary care

6.6.4.1. QOF quality adjustment

Since 2007, primary care activity has been adjusted for improvement in disease management (blood pressure management), but limited to three conditions: coronary heart disease; history of transient ischaemic attack or stroke; and hypertension. Adjustment was done via an approach developed by Derbyshire et al. (2007). Data on these three conditions and healthy blood measures recording are taken from the Quality and Outcomes Framework (QOF).[67] In particular, the following QOF indicators were chosen:

- CHD 6. The percentage of patients with coronary heart disease (CHD) in whom the last blood pressure reading (measured in the last 15 months) is 150/90 or less;
- STROKE 6. The percentage of patients with a history of Transient Ischaemic Attack (TIA) or stroke in whom the last blood pressure reading (measured in the last 15 months) is 150/90 or less;

[67] The Quality and Outcomes Framework rewards GP practices for achieving a range of different targets.

- BP 5. The percentage of patients with hypertension in whom the last blood pressure (measured in the last 9 months) is 150/90 or less.

In 2019/20, a change in the definition of these indicators was introduced which meant that data from 2019/20 were no longer comparable with previous years. We therefore removed the QOF quality adjustment from our baseline estimate in the 2019/20 productivity update.[68] In 2021, to alleviate primary care workload, the majority of QOF indicators were income protected. That is, the practices received funding independently from their performance.[69] NHS Digital therefore omitted achievement data from the official publication, as comparison across years would be misleading.[70] We therefore are not able to incorporate the QOF adjustment for 2020/21.

We do, however, include a waiting time adjustment as part of the baseline primary care Laspeyres growth estimate.

6.6.4.2. Waiting times quality adjustment

Information on the time between booking date and appointment date, or waiting time (WT) have continued to be collected. In particular, the NHS Digital GP appointment dataset includes information on the number of appointments by time intervals, e.g. same day, 1 day, 2 to 7 days, etc, for each appointment mode.[71]

Similarly to hospital inpatient and outpatient activity, we use the 80th percentile waiting time as our quality indicator. Further, we assume a uniform distribution of appointments within each of the above waiting time intervals and apply the formula below to determine the 80th percentile waiting time for each appointment mode:

$$Wait_{80} = L_{80} + h_{80}\frac{80\%-Cumul_{80-1}}{freq_{80}} \quad \text{(E11)}$$

Here L_{80} is the lower bound of the 80th percentile interval, h_{80} is the length of the 80th percentile interval, $Cumul_{80-1}$ is the cumulative relative frequency of the interval preceding the 80th percentile interval, and $freq_{80}$ is the relative frequency of the 80th percentile interval.

The waiting time quality adjustment is then calculated in the same way as for the outpatient appointments:

$$\frac{\sum_j x_{jt+1} c_{jt} \frac{e^{-r_w W_{jt+1}}}{e^{-r_w W_{jt}}}}{\sum_j x_{jt} c_{jt}} \quad \text{(E12)}$$

Where x_{jt} is the number of consultations of type *j*, c_{jt} is the unit cost of appointment type *j*, r_w is the discount factor equal to 0.015, W_{jt} and W_{jt+1} are the 80th percentile waiting times for appointment mode *j* in years *t* and *t+1* respectively.

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[68] For further details on these changes, see the 2019/20 National Health Service productivity update (Arabadzhyan et al., 2022).
[69] COVID-19: toolkit for GPs and GP practices - BMA (last accessed 27/05/2022).
[70] Further details on Quality and Outcomes indicators, 2021, are available on the NHS Digital website (last accessed 14/04/2022).
[71] The full list of time intervals is as follows: same day, 1 day, 2 to 7 days, 8 to 14 days, 15 to 21 days, 22 to 28 days, more than 28 days, unknown (NHS Digital GP appointment data, 2022).

Table 27 presents the 80th percentile waiting times for each appointment mode for the financial years 2019/20 and 2020/21. It is worth noting that the waiting times distribution is positively skewed: in 2020/21, about 49% of face-to-face appointments; 70% of home visits; 74% of telephone consultations; and 52% of video/online appointments took place within 1 day from the booking date. Importantly, compared to the previous financial year, the waiting times for face-to-face and video/online appointments have decreased substantially. This is likely to relate to the drop in the number of patients being offered these types of consultations, which had a positive impact on the waiting times of those seen. Another potential reason for the reduction in waiting times might be that only patients with more severe conditions requiring urgent assistance were reaching out to get a face-to-face appointment, while less urgent patients preferred not to seek any help at the time (demand-side effect). The 80th percentile waiting time for telephone appointments increased by about half a day: much less than one might have expected given the massive growth in the volume of telephone consultations. For comparison, between 2018/19 and 2019/20 the 80th percentile waiting time for telephone appointments went up from 2.41 days to 3.36 days, i.e. by almost a day. This may indicate that GP practices were able to rearrange available resources to perform telephone consultations in a timely fashion, despite a huge increase in their numbers. Home visits saw the largest growth in waiting times despite the drop in the number of consultations.

Table 27: Waiting times (days) for GP appointments, 2019/20 – 2020/21

Appointment mode	2019/20 80th perc. waiting time	2020/21 80th perc. waiting time
Face-to-Face	14.00	10.95
Home Visit	1	4.456
Telephone	3.36	3.74
Video/Online	17.61	10.57

Finally, we also analyse the monthly dynamics of the 80th percentile waiting times by mode of appointment. Figure 15 shows that the 80th percentile wait, while fairly stable for all appointment types prior to March 2020, varied substantially throughout the pandemic year. In particular, for telephone appointments the data suggest that although waiting times went up significantly in March 2020, they shortened immediately in April and May, before starting to increase again from June 2020. Such a pattern is not entirely aligned with the dynamics observed for the total number of telephone appointments shown in Figure 13. We also note that waiting times for home visits went up in autumn 2019, decreased in December 2019, before starting to increase again in January 2020. They also remained high throughout the pandemic year. Finally, both face-to-face and online appointments show very similar patterns in the waiting times dynamics: during the two main waves of the pandemic, covered by our study period (March – May and November – January), the data show a decrease in waiting times, while over the Summer-Autumn period (easing of lockdown restrictions) the waiting times were at their peak. These dynamics were also consistent with that of the number of appointments: lower waiting times were observed in conjunction with lower volumes of consultations.

Figure 15: Monthly trends of 80th percentile waiting times by mode of appointment (2019/20 and 2020/21)

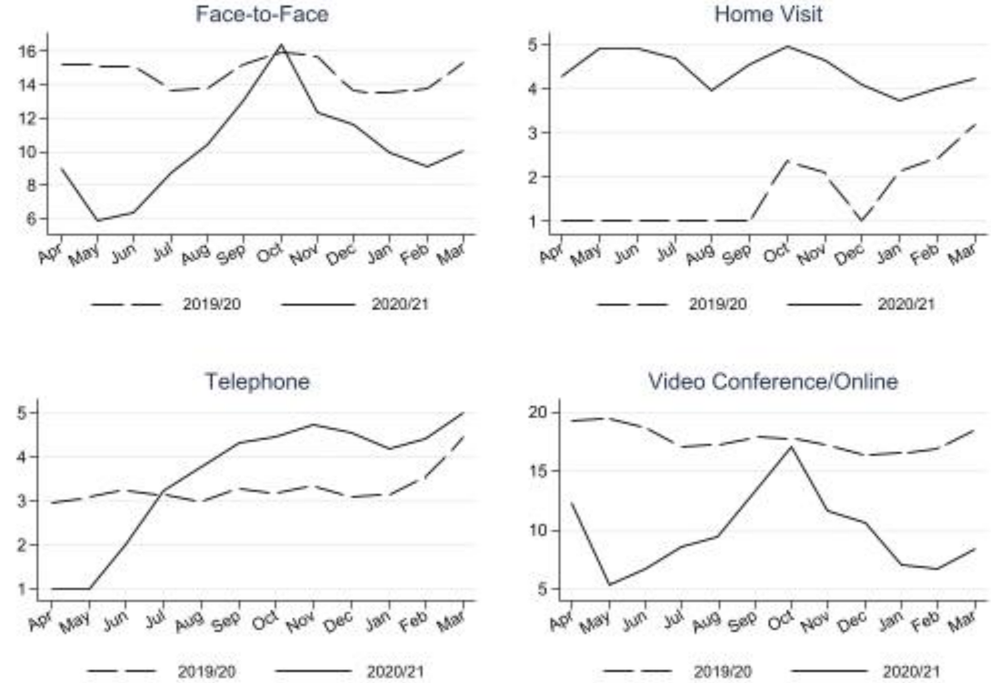


Table 28 reports the cost-weighted Laspeyres output growth rates for the primary care setting when adjusting for waiting time alone and correcting for the total number of working days (WD) for the last two links. Focusing in a first instance on the 2019/20 to 2020/21 growth rate, we find that adjusting for waiting times increases the cost-weighted Laspeyres growth rate from -5.01% to -3.06%. This indicates that the drop in the volume of appointments was partially compensated by an overall reduction in waiting times. Correcting for the total number of working days[72] further increases the growth rate, yielding a -2.68% Laspeyres growth.

Comparing year-on-year changes not only in the simple Laspeyres cost-weighted output growth measure, but also for the quality-adjusted (limited to waiting times) Laspeyres output growth rates, we find that adjusting for both quality (WT) and working days decreased the resulting Laspeyres output growth measure for the 2018/19 – 2019/20 link. Whereas for the pandemic year, both adjustments improved the growth rate. However, the overall impact of the pandemic was both negative and substantial, reducing the cost-weighted, quality and working days adjusted Laspeyres growth rate by about 2 percentage points.

Table 28: Primary Care: growth rates comparison

	2018/19-2019/20	2019/20-2020/21	2019/20-2020/21 w/o COVID-19 vaccinations
Raw PC consultations	1.01%	-4.24%	-10.93%
Laspeyres Cost-weighted (CW)	0.35%	-5.01%	-11.58%
Laspeyres CW and WT-adjusted	-0.30%	-3.06%	-9.63%
Laspeyres CW, WT and WD-adjusted	-0.69%	-2.68%	-9.27%

[72] The number of working days in 2019/20 was 254 compared to 253 in 2020/21.

Note: WT = Waiting Time; WD = Working Days.

6.6.5. Sensitivity analysis

In this subsection we perform two sensitivity analyses. First, we ignore the significant structural changes affecting primary care services delivery during the pandemic and revert back to assuming different unit costs for different types of primary care appointments, i.e following the same approach as in the 2019/20 National Health Service productivity update. This gives unit costs of £21.5 for telephone and video/online consultations, £39.65 for face-to-face appointments and £121.68 for home visits. Column 'Sensitivity 1' of Table 29 reports the results of this analysis, which we compare to our baseline estimates for 2020/21.

Our second sensitivity check, based on the methodology developed alongside colleagues at the Department of Health and Social Care (Wilson et al., 2022), breaks down the telephone appointments into two groups: those appointments which would have normally taken place over the phone, even in the absence of the pandemic, given the previous trends, and those which were in surplus compared to pre-pandemic trends. The first group of appointments are then weighted by the unit cost of telephone appointments, i.e. £21.5, whereas the second group is assigned the unit cost of the face-to-face appointment, i.e. £39.65.

The growth of telephone appointments volumes between 2018/19 and 2019/20 (excluding the month of March, which has already been impacted by the pandemic) was 1.64%. Had this year-on-year trend continued, we would have observed 47,445,820 telephone appointments in 2020/21, as opposed to the actual recorded 118,225,447. Therefore, as opposed to the baseline estimate, we weigh 47,445,820 using the £21.5 unit cost, and the remaining 70,779,628 using the £39.65 unit cost. The results of this exercise are presented in column 'Sensitivity 2' of Table 29. Finally, for the waiting time adjustment, we continue to assign to the proportion of telephone appointments, which we consider as true substitutes of face-to-face appointments, the 80th percentile waiting times recorded for telephone appointments.

Table 29: Primary care output growth measures: sensitivity to the choice of unit costs

	Baseline	Sensitivity 1	Sensitivity 2
Raw consultations		-4.24%	
Laspeyres Cost-weighted (CW)	-5.01%	-16.97%	-5.52%
Laspeyres CW and WT-adjusted	-3.06%	-14.77%	-3.38%
Laspeyres CW, WT and WD-adjusted	-2.68%	-14.44%	-2.99%

Note: WT = Waiting Time; WD = Working Days.

We find, as expected, that assigning lower unit costs to telephone and video/online consultations ('Sensitivity 1') yields a much lower growth rate of the primary care output growth measure. The cost-weighted growth drops to -16.97%; about 12 percentage points lower than our baseline estimate. Adjusting for the number of working days and waiting times improves the growth rate slightly, but the difference with our baseline estimate remains of the same magnitude. When assigning unit costs to telephone appointments, based on the previous year's growth trend ('Sensitivity 2'), the differences with our baseline figures are much smaller. In particular, the cost-weighted estimate decreases by 0.5 percentage points, and quality and working days adjusted Laspeyres growth rate amounts to -2.99% as opposed to our baseline -2.68% figure.

6.7. Community prescribing

- **The Laspeyres cost-weighted and total days adjusted output growth measure for Community Prescribing was 3.00% between 2019/20 and 2020/21.**

In 2020, the NHS Business Services Authority (BSA) took over responsibility for producing Community Prescribing data for the Prescription Cost Analysis (PCA) publication from NHS Digital. A new data warehouse was also used from December 2018, leading to a slight improvement in the precision of the underlying data. The number and cost of prescriptions of different drugs are published monthly and publicly available. The data include information about the Drug code (PropGenLinkCode), Net Ingredient Cost (NIC), Quantity of Drug Dispensed, and Number of Prescription Items. The data are complete and prices are available for all items and years.

6.7.1. Methodological refinements

Over the last two financial years, in calculating the Laspeyres output growth rate for community prescribing, it has been highlighted that results are sensitive to outliers. One source of outliers is changes in the unit a drug is reported in. The community prescribing dataset includes information on total expenditure (E_j) and total volume (x_j) for each drug prescribed (PropGenLinkCode). Outliers can be generated if the unit of a given drug changes within or between years. When quantity changes are very large, it is likely that the comparison being made over time is not like-for-like. That is, very large changes in volume are more likely to be due to a unit of reporting change than a genuine shift in prescriptions. However, we do not wish to enforce a narrow range on the overall measure of prescribing growth by an arbitrary definition of plausibility for individual drugs. Therefore, the following within-year and between-year algorithms are used to identify quantity and expenditure changes which are highly likely to not represent a like-for-like comparison.

6.7.1.1. Within-year outlier methodology

For both quantity and expenditure, we apply the following approach. First, we calculate the ratios of quantity and expenditure for a drug-month to the median quantity or expenditure respectively of that drug across the full year. In this way, unusual changes in quantity or expenditure on a drug in a single month or multiple months can be identified. Then, we calculate a ratio of the two ratios (a ratio of ratios, RoR). That is, for each drug-month we calculate the following expression:

$$RoR = \frac{quantity/median\ quantity}{expenditure/median\ expenditure} \qquad \text{(E13)}$$

This statistic allows us to identify whether changes in quantity for a particular drug-month are very different from changes in expenditure in the same month. A high ratio indicates a sharp increase in quantity and/or decrease in expenditure without a similar change in the other metric. A low ratio indicates a sharp decrease in quantity or increase in expenditure without a similar change in the other metric. A ratio of ratios close to 1 indicates any sharp change in one metric is matched by a similar change in another, which is more likely to reflect a like-for-like comparison. Where RoR is larger than 10 or smaller than 0.1, we drop the drug-month cell from both link-years from our analysis, even if this condition is only met for a drug-month in one of two consecutive years. This is to ensure that the overall numerator and denominator are comparable with each other. The value of 10 and 0.1 are chosen as units are metric, so a unit change will be of at least a multiple or division of 10.

6.7.1.2. Between-year outlier methodology

In Appendix A we show that in some cases, such as a permanent shift in unit of reporting, the within-year algorithm described above is not enough to capture all outliers. Therefore, in addition to this within-year outlier detection methodology, we implement a ratio-based method to detect between-year outliers. This approach employs a cut-off for the ratio of unit costs between years to define outliers as follows

$$r\_c_{(0,1)} = \frac{c_{j1}}{c_{j0}} = \frac{\mathrm{E_{j1}/x_{j1}}}{\mathrm{E_{j0}/x_{j0}}} \quad \text{(E14)}$$

This approach directly compares the ratio of unit costs for the given drug between years, using the same cut-off rule as the within-year outlier methodology. Where $r\_c_{(0,1)}$ is larger than 10 or smaller than 0.1, we drop the drug from both years in calculating growth. A full discussion of this methodology is presented in Appendix A.

6.7.2. Activity and growth rates

Table 30 reports summary statistics for Community Prescribing. In 2020/21, 7,137 distinct Community Prescribed drug items are observed, continuing a gradual downward trend of recent years. The total number of prescriptions made out decreased by 23 million (2.1%), suggesting 2019/20 was an outlier year for this metric. Despite this reduction in prescriptions made out, total spend is around 2% higher, with a smaller increase observed in total items prescribed, at around 0.8%. This suggests an upward shift in cost per prescription issued in 2020/21 compared to 2019/20. This is supported by a substantial increase in the unit cost of activity weighted prescriptions (6%).

The total number of prescriptions and expenditure in 2020/21 is similar but lower than equivalent information reported for England for the 2020 calendar year by NHS Digital.[73]

Table 30: Community Prescribing, summary data 2017/18 – 2020/21

Year	Unique drug codes observed	Total Prescriptions	Total items prescribed	Total Spend	Activity weighted prescription unit cost (£)	Activity weighted prescribed item unit cost (£)
2017/18	7,803	1,106,431,880	89,638,486,058	£9,095,228,060	8.22	0.10
2018/19	7,755	1,109,084,896	87,947,789,280	£8,833,869,014	7.96	0.10
2019/20	7,623	1,132,043,733	88,504,273,870	£9,224,298,376	8.15	0.10
2019/20*	7,589	1,129,503,664	88,499,683,355	£9,215,999,566	8.05	0.10
2020/21	7,137	1,106,274,762	89,217,616,708	£9,403,485,867	8.50	0.11

* With the new outlier detection methodology.

In 2020/21, 461 new drug items are observed, amounting to a total expenditure of £70 million in 2020/21 prices. 814 drugs prescribed in 2019/20 were not prescribed in 2020/21, representing £35.9 million of expenditure in 2019/20 prices. No data items appear incorrect, we, therefore, took the data at face value.

Volume and price indices for Community Prescribing are reported in Table 31. Between 2019/20 and 2020/21, the Paasche Price ratio indicates positive growth. This is the first positive value observed

[73] See NHS Business Services Authority publication here (last accessed 02/07/2022).

since 2004/05.[74] The Laspeyres volume index is also positive between 2019/20 and 2020/21, but substantially lower than between 2018/19 and 2019/20. The Laspeyres cost-weighted and total days adjusted output growth measure for Community Prescribing is 3.00% between 2019/20 and 2020/21, which is on trend with those of previous years[75].

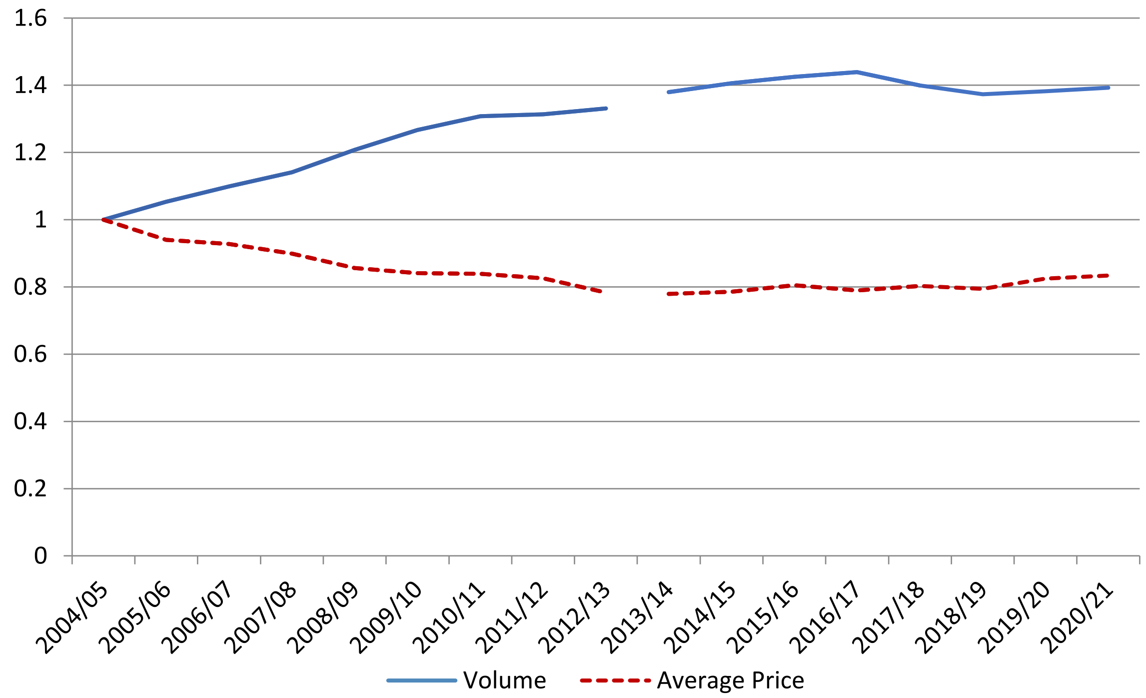
Table 31: Community Prescribing: price and volume indices 2017/18 – 2020/2021

Years	Paasche Price Ratio	Laspeyres Volume Ratio
2017/18 – 2018/19	0.9477	1.0249
2018/19 – 2019/20	0.9992	1.0425
2018/19 – 2019/20*	0.9998	1.0470
2019/20 – 2020/21	1.0106	1.0300

* With the new outlier detection methodology.

From the base year of 2004/05, trends in the volume and prices of items prescribed are shown in Figure 16. This figure highlights that while the increase in volume observed continues an upward trend of the most recent years, the level remains below the peak of 2016/17. The observed increase in average price also continues a recent upward trend but similarly does not overhaul the longer term trend from 2004/05. The increase in mean contemporaneous prices is correlated with an increase in the Paasche Price ratio, which is higher than one, and suggests an increase in the overall prices for community prescription between 2019/20 and 2020/21 financial years.

Figure 16: Price and volume changes for community prescribed pharmaceuticals[76]

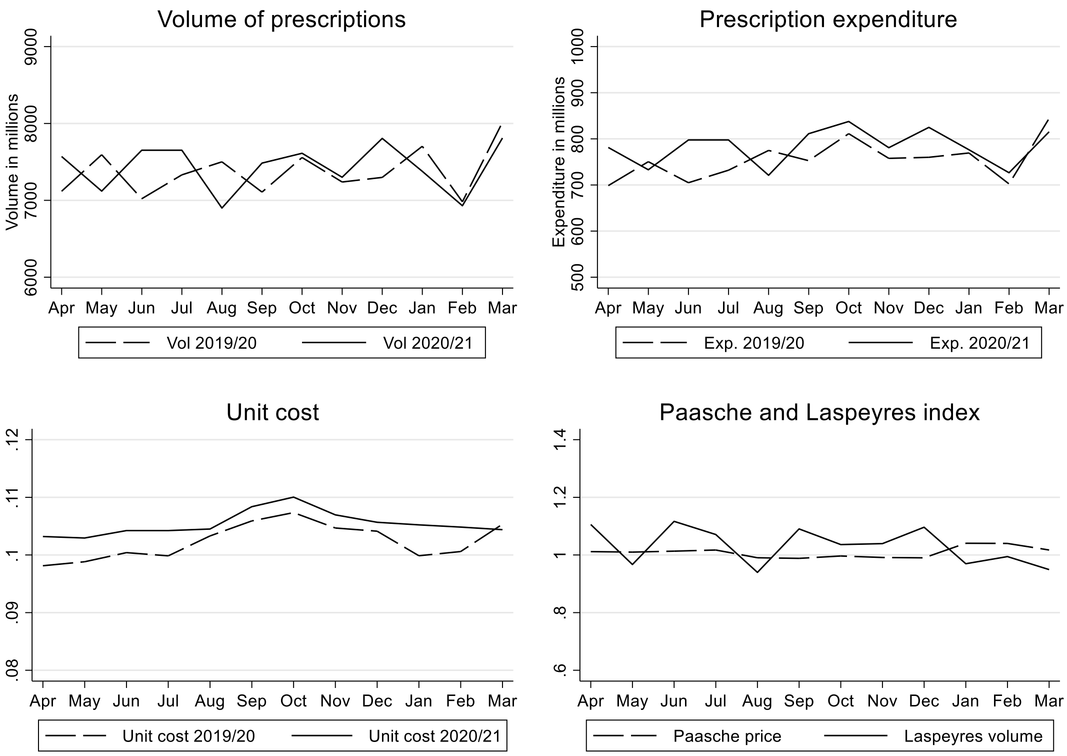


[74] See Table A25 in the Online Appendix for earlier equivalent figures, beginning from 2004/05.
[75] The Laspeyres volume index between 2018/19 and 2019/20 without adjusting for the change in total days is 4.54%.
[76] Figures from 2013/14 onwards are based on the new set of prescribing data released by NHS Digital in February 2017 (first noted in Castelli et al., 2018).

6.7.3. Month by month comparison of Community Prescribing

Figure 17 presents month by month comparisons of volume, expenditure, mean unit costs, and the Paasche Price and Laspeyres Volume indices. Volume, expenditure and mean unit costs are all stable across the two years. The Paasche index is also stable and mostly smaller than 1, when comparing each of the months of Apr-Dec 2019 to Apr-Dec 2020; however, it turns positive when comparing each of the months of Jan-Mar 2020 to Jan-Mar 2021. The opposite occurs with the Laspeyres index, which is well above 1 for the majority of months in the period Apr-Dec, and smaller than 1 during Jan-Mar. There are also sharper month by month fluctuations in the Laspeyres index.

Figure 17: Activity, expenditure, unit cost and Laspeyres index by month for community prescribed pharmaceuticals



7. Growth in input categories

7.1. Direct labour growth measure

- **Between 2019/20 and 2020/21, the cost (salary)-weighted Laspeyres volume growth for NHS staff was 4.93%.**

From 2007/08, the direct labour growth measure is calculated using the Electronic Staff Record (ESR) data, provided by NHS Digital.[77,78,79] This dataset contains monthly provider level Full Time Equivalent (FTE) counts for over 500 categories of labour (occupation codes) and covers all staff employed by the NHS excluding agency and bank staff. Due to precautions taken with the reporting of cells with small numbers, the aggregate figures we obtain will not match precisely with those published by NHS Digital using the same ESR data. [80,81]

National average staff earnings data cover the same staff groups and organisations as counts of staff at the occupation code level, provided by NHS Digital. Basic pay is reported per head and per FTE, whilst non-basic pay is reported per head only. We construct total pay per FTE as the sum of basic pay per FTE and non-basic pay per head times the ratio 'basic pay per FTE/basic pay per head', as per recent reports (Arabadzhyan et al., 2021). This method of imputation relies on the assumption that for each occupation code, the ratio of 'basic pay per FTE/basic pay per head' is a good proxy for the ratio of 'non-basic pay per FTE/non-basic pay per head'.

From 2016, separate information has been provided for FTE count and earnings of staff working at 'core' and 'wider' services.[82] We take an FTE weighted average of wages of staff working in 'core' and 'wider' services, and apply this calculated wage to all staff within the occupation code. In this way, a value by type of work is identified, rather than one also influenced by the type of provider worked for. If wage information is missing for either 'core' or 'wider' service providers for a specific occupation code, we assume the observed wage also reflects the average for equivalent staff in the other organisation group.

Table 32 shows the number of organisations reporting FTE counts information by organisation type.[83] Due to mergers, both Clinical Commissioning Groups (CCGs) and Trusts' figures have been generally decreasing over time. The number of Commissioning Support Units (CSUs) remains the same between 2019/20 and 2020/21. Table 32 also reports total expenditure on staff by organisation type. Expenditure is calculated as the summed products of FTE staff employed in each occupation code and the national average total earnings for each occupation code. Differences in expenditure between 2019/20 and 2020/21 broadly reflect a continuation of existing trends.[84] The total expenditure for

[77] Before 2007/08, the number of staff was extracted from the Workforce Census.
[78] More precisely, NHS Digital shares the ESR and NHS combined Payroll data with us, but these can be accessed from the NHS iView database (last accessed 21/11/2022), which is constructed from the ESR and NHS combined Payroll and Human Resources System.
[79] In March 2016, the data collection method for ESR was updated, leading to improved quality. These changes are discussed in more detail in Castelli et al (2018).
[80] If a provider-staff group cell contains fewer than 5 staff, the provider reports 0 or 5 at random.
[81] NHS workforce statistics (last accessed 18/08/2022).
[82] Core services are made up of hospital Trusts and commissioning bodies. Wider services are made up of central support services such as NHS England and NHS Improvement.
[83] For conciseness, this table includes only the main organisation types, which account for about 97% of FTEs and 98% of total expenditure. The main analysis includes all categories. A time series of equivalent information from 2010/11 is presented in Table A26 in the Online Appendix.
[84] A time series of equivalent information from 2010/11 onwards is presented in Table A27 in the Online Appendix.

CCGs increased due to higher expenditure/CCG. We observe a 12.7% increase in the expenditure of NHS England and NHS Improvement (NHSE&I), higher than the average increase of 8.7%. The increase in expenditure among Trusts is greater in 2020/21 (8.7%) than in 2019/20 (5.5%). See Table A27, in the Online Appendix, for historic trends in expenditure by provider type from 2010/11 to 2020/21.

Table 32: Number of reporting organisations and expenditure by type 2018/19 – 2020/21

Organisation type	2018/19		2019/20		2020/21	
	Orgs	Exp (£m)	Orgs	Exp (£m)	Orgs	Exp (£m)
CCGs	186	895	191**	949**	121	969
CSUs	4	168	4	182	4	198
NHS England & NHS Improvement	1	228	1	321	1	362
Non-geographical staff	1	72	1	76	1	78
NHS Trusts	231	39,949*	226	42,132	220	45,786

Note: CCGs: Clinical Commissioning Groups; CSUs: Commissioning Support Units; Non-Geographic Central Staff, code AHO. £m: Expenditure in millions of pounds.
* This value was updated when 2019/20 was included. Differential driven by imputation from future values.
** These values were updated when 2020/21 was included. Differential due to some new CCG code formats created in 2019/20 not previously included in the CCG group of providers.

Table 33 reports the number of FTE staff employed by Trusts and other NHS organisations (hereafter non-Trusts) by broad categories for each year from 2018/19 to 2020/21.[85] These figures show that the majority of staff are employed by hospital Trusts and the largest employee group is that of 'Nursing, midwifery and health visiting staff and learners'. The ratios of different staff categories have been stable over the past three years.

Table 33: Count of FTE staff employed by category

NHS Staff type	2018/19		2019/20		2020/21	
	Trust	Non-Trust	Trust	Non-Trust	Trust	Non-Trust
Medical staff	111,896	1,442	115,084	1,446	122,009	1,354
Ambulance staff	29,271	3	33,165	3	35,837	4
Administration and estates staff	228,686	42,471	236,469	42,652	246,786	44,283
Health care assistants and other support staff	139,600	1,201	142,077	433	148,158	431
Nursing, midwifery and health visiting staff and learners	368,418	4,249	374,532	4,430	394,876	4,673
Scientific, therapeutic and technical staff and health care scientists	184,949	5,108	190,177	5,083	201,425	5,170
Unknown and Non-funded staff	4,529	184	2,619	109	1,352	101
Total	**1,067,349**	**54,658**	**1,094,123**	**54,156**	**1,150,443**	**56,016**

Notes: Data are taken from organisational returns of Electronic Staff Records. When there are 5 or fewer people employed in an occupational group, organisations report either 5 or 0 at random; these totals therefore will differ from those derived from national level data.

85 Table A28 in the Online Appendix provides a longer time series of staff employed within Trusts from 2007/08 to 2020/21.

Figure 18 shows the growth in FTE staff by broad staff categories from 2018/19 to 2019/20 and 2019/20 to 2020/21. Positive growth is observed for all categories and is larger between 2019/20 and 2020/21 for all staff groups, except for ambulance staff, than between 2018/19 and 2019/20. Ambulance FTE staff increases by 13% between 2018/19 and 2019/20 and by 8% between 2019/20 and 2020/21. This is also the category with the highest growth rate in both 2018/19-2019/20 and 2019/20-2020/21. A residual group of unknown and unfunded staff (0.12% of the FTE total in 2020/21) is not included in the figure.

Figure 18: Growth in FTE staff by group 2018/19 to 2020/21

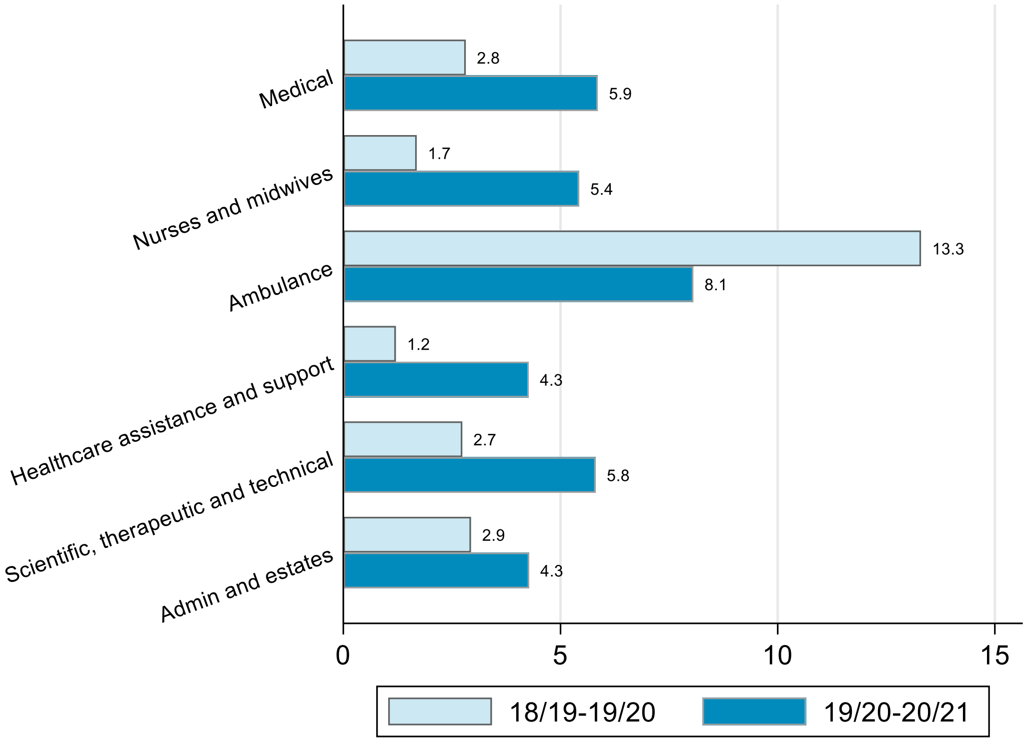


Table 34 presents nominal expenditure growth and Laspeyres volume growth in labour for the NHS overall and for Trusts alone from 2018/19 to 2020/21.[86] Laspeyres volume indices indicate growth of 4.93% overall and 5.06% for the group of Trusts between 2019/20 and 2020/21. These growth rates are larger than those recorded between 2018/19 and 2019/20. Nominal expenditure growth is 3.2 percentage points higher between 2019/20 and 2020/21 than observed between 2018/19 and 2019/20 for both Trusts and all providers. This reflects an increase in the unit cost of staff, supported by a Paasche price growth rate of 3.4% for Trusts and the NHS overall, and an increase in the nominal number of FTEs.

[86] See Table A29 in the Online Appendix for the equivalent series from 2007/08 to 2020/21.

Table 34: Growth in direct labour 2018/19 – 2020/21

Years	Nominal expenditure growth		Laspeyres volume growth	
	All*	Trusts	All*	Trusts
2018/19 – 2019/20	5.35%	5.46%	2.54%	2.68%
2019/20 – 2020/21	8.59%	8.68%	4.93%	5.06%

* All NHS organisations.

7.1.1. Month by month comparisons for NHS Staff

To understand if the increase in staff volume in 2020/21 is strongly related to COVID-19, we compare the month by month count between 2019/20 and 2020/21.

Figure 19 presents month by month comparisons of FTEs, expenditure, mean salary/wages, and the Laspeyres Volume index. The total number of monthly FTEs and expenditure are higher in 2020/21 than in 2019/20. Average salary/wages are stable across months and in 2020/21 are higher than in 2019/20, while Laspeyres index is stable month by month.

Figure 19: Monthly trends in count of staff FTEs, expenditure, average salary/wages and Laspeyres volume index for direct labour

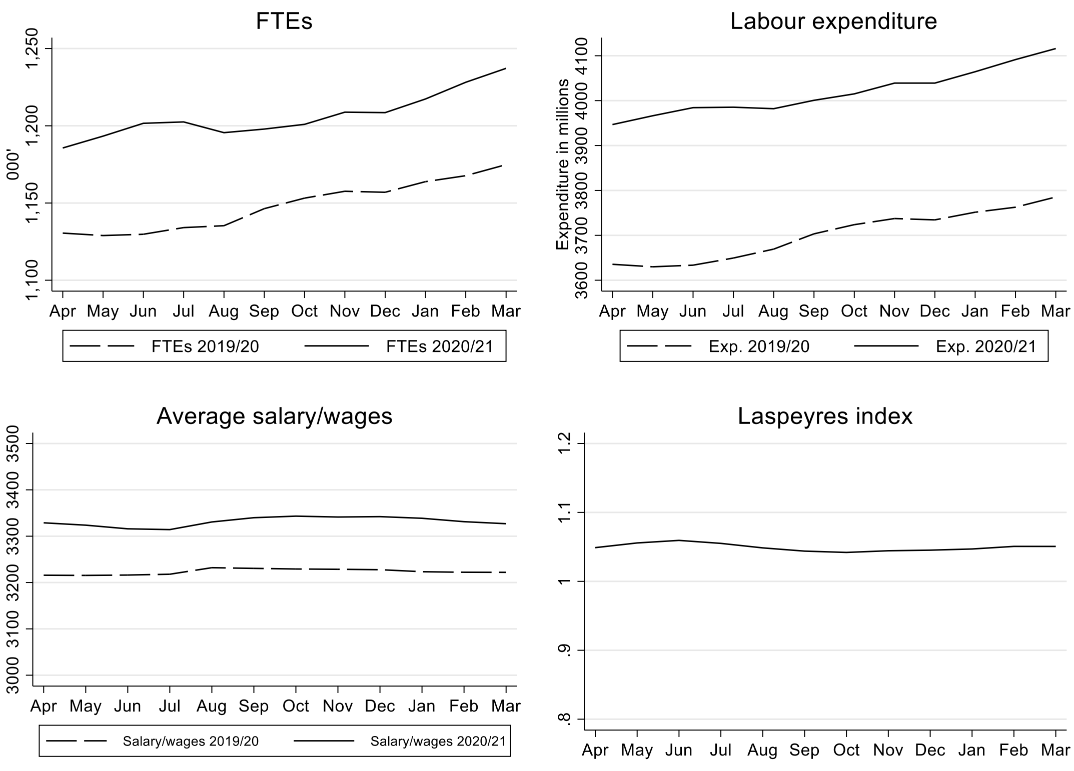
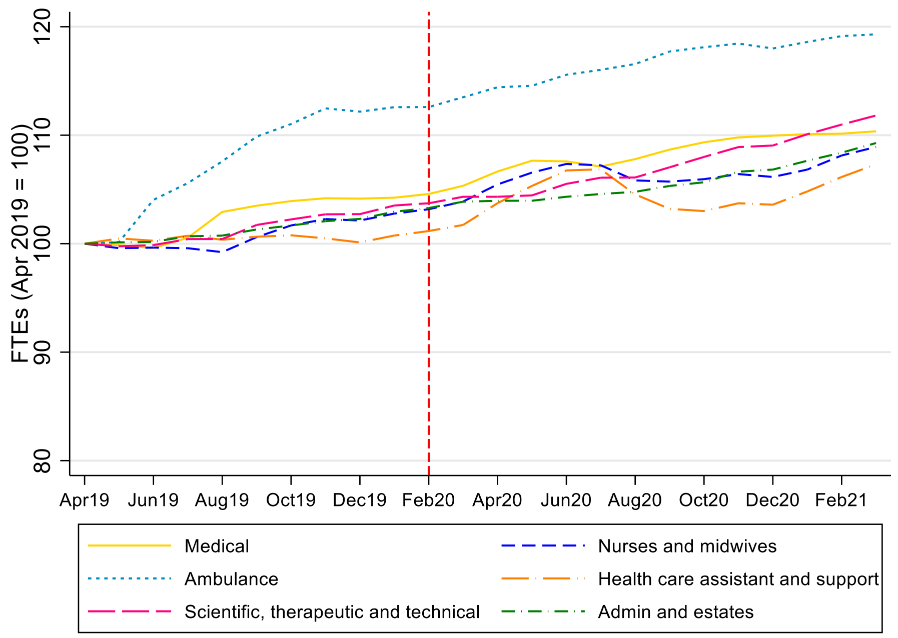


Figure 20 shows the monthly trends in FTEs by staff group. Ambulance staff FTEs increased sharply during 2019/20, before the pandemic started. However, the limited number of staff employed in this category mitigates its impact on overall growth. Between 2019/20 and 2020/21, Ambulance staff continue its increase but at a slower rate, and along with medical and scientific, therapeutic and technical staff are the main drivers of staff increase between these two financial years.

Figure 20: Monthly trends in FTEs by staff group (April 2019 as base), 2019/20 – 2020/21



Note: Vertical line represent start of the pandemic.

Figure 21 provides more detail about staff FTEs by medical specialties. We select the seven largest medical specialties in terms of FTEs with above mean growth, representing about 19% of total FTEs of medical staff.[87] Of these, Intensive care medicine, Acute Internal Medicine, Emergency medicine, Respiratory medicine and Geriatric Medicine are likely to be a response to the COVID-19 pandemic. Endocrinology and diabetes, and Medical oncology also indicate above average growth, but these categories are smaller and growth rates more modest. The remaining 75 specialties (81% of all medical staff) see an increase in FTEs of 4.7%.

Figure 22 depicts the monthly trends of these medical specialties. Staff FTEs in Intensive Care medicine increase the most, followed by Acute Internal Medicine and Emergency Medicine. All of these grow considerably after the pandemic starts (vertical red line). Our data support the hypothesis that an increase in the workforce capacity to deal with the COVID-19 pandemic resulted in an increase in the total number of staff FTEs employed, especially for general and emergency medicine.

[87] The following procedure was applied for selecting these specialties: i) their individual growth is higher than the average, ii) their share in the total count of FTEs as above 1%, iii) we select the minimum number of specialties that fulfil conditions i) and ii) that represent about 20% of total FTEs.

Figure 21: Main medical specialties with higher growth than the average 2019/20 – 2020/21, and their shares in total medical FTEs in 2020/21

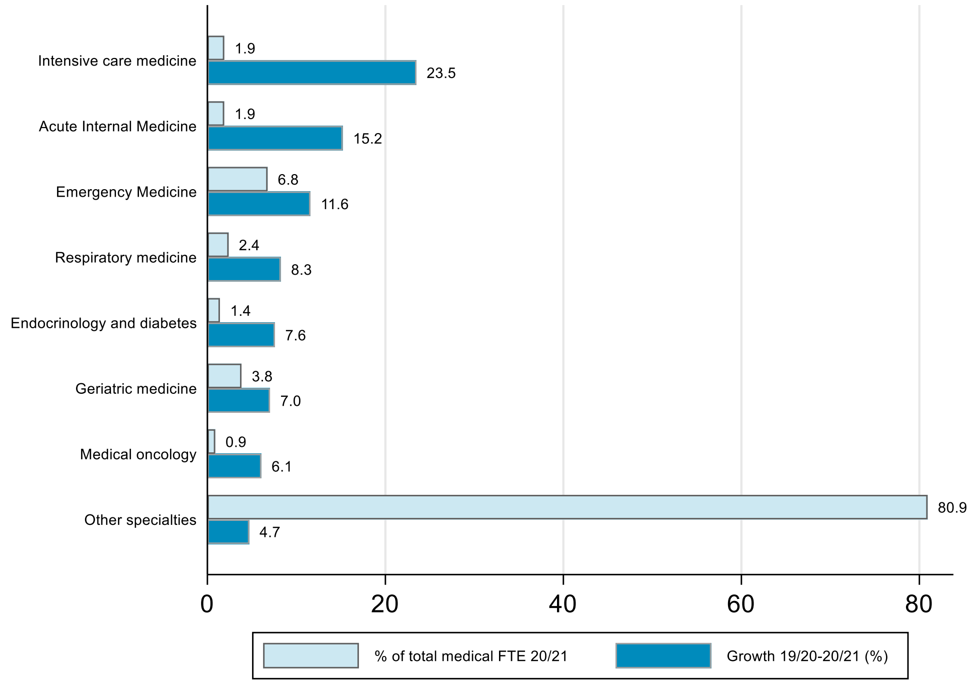
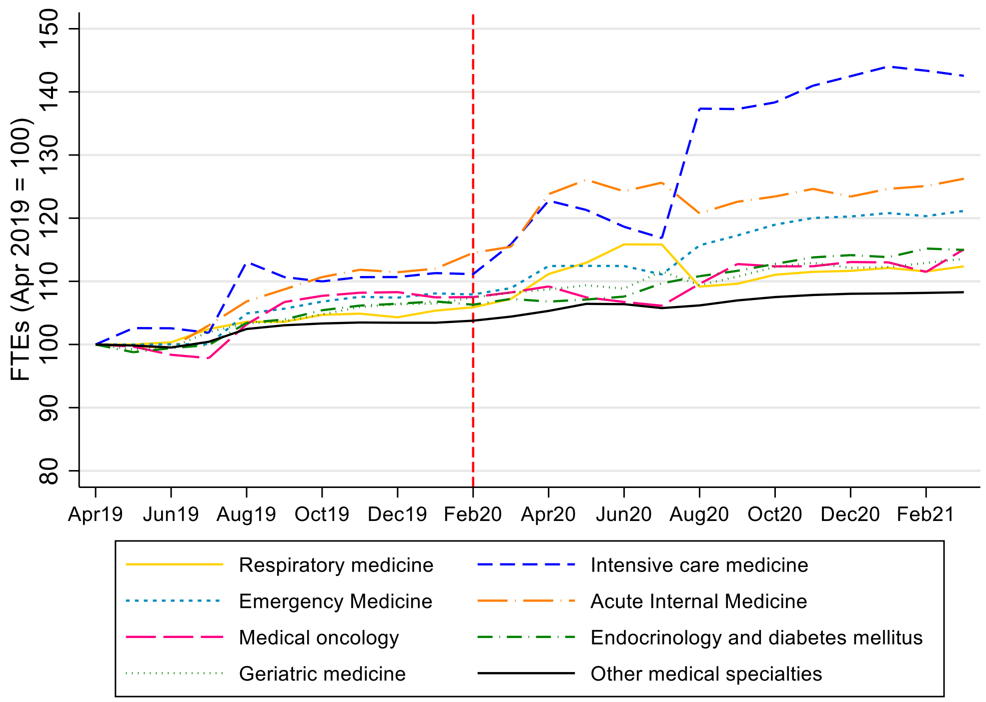


Figure 22: Monthly trends in medical specialties FTEs (April 2019 as base), 2019/20 – 2020/21



Note: The vertical line represents the start of the pandemic.

7.2. Indirect and mixed NHS input growth measures

- **Between 2019/20 and 2020/21, the indirect growth rate for NHS inputs was 13.48% and the mixed NHS input growth rate was 9.87%.**

7.2.1. Expenditure data sources

We employ data from published financial accounts to determine expenditure on inputs by the NHS England Group[88] and NHS Trusts. We aggregate items of expenditure from each account to broad categories of Labour, Materials, and Capital. Labour covers expenditure on staff wages and other payments for work. Materials consist of assets which are expected to be consumed within the financial year they are purchased. Capital consists of expenditure on assets which are expected to be retained and used in multiple years. By using these broad categories, we are able to generate comparable figures over time and across organisations, despite differences in the precise reporting requirements of different organisations and changes in these requirements over time.

Expenditure of the NHS England Group is reported in the annual reports and accounts of the Department of Health and Social Care (DHSC).[89] The items of expenditure used to calculate Labour, Materials, and Capital in the 2019/20 – 2020/21 accounts are presented in Table 35. For the NHS England Group accounts, it was not possible to separate the resources allocated for the COVID-19 response, hence it is not possible for us to estimate the extra (financial) resources raised specifically for the pandemic effort.

Neither DHSC accounts nor the accounts published by NHS Trusts include expenditure on agency staff and bank staff. We obtain agency staff expenditure directly from the DHSC. Bank staff expenditure has been obtained as a result of a Freedom of Information (FOI) request in 2015/16 and 2016/17, whilst expenditure, for more recent financial years, is taken from a report on NHS providers by NHS England and NHS Improvement.[90]

We also use Trust level accounts for all NHS Trusts and Foundation Trusts. Each FT and Non-FT publishes accounts annually, with a specified set of items of expenditure. Since 2017/18, the financial accounts for both FTs and Non-FTS have been harmonised with both types of organisations now publishing the same type of information in TACs. Prior to 2017/18, FTs and non-FTs published accounts with differing expenditure items, though they covered the same types of information in aggregate. Table 36 reports the sources of expenditure data used. In 2020/21, NHS Trust and Foundation Trust accounts include extra items of expenditure, specifically for COVID-10: two expenditure items under Materials and one under Capital (see Table 35). However, these represent a small fraction of total expenditures on either Materials or Capital (4% and 0.4% respectively), and it is not possible to fully disentangle the COVID-19 response resources in other items. Thus, the true impact of COVID-19 on input expenditure cannot be evaluated.

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[88] NHS England Group includes CCGs and NHS England and NHS Improvement.

[89] DHSC Annual Report and Accounts 2020/21 (last accessed 22/02/2023).

[90] Information on NHS bank staff expenditure for 2018/19 is reported here (last accessed 22/02/2023), whilst that for 2019/20 and 2020/21 was based on unpublished management information from NHSEI.

Table 35: Categorisation of operating expenditure items

Organisation	Labour	Materials	Capital
NHS Foundation Trusts and Non-Foundation Trusts Source: TAC	• Staff and executive directors' costs • Non-executive directors	• Purchase of services • Supplies and services – clinical • Supplies and services – clinical: utilisation of consumables donated from DHSC group bodies for COVID response • Supplies and services – general • Supplies and services – general: notional cost of equipment donated from DHSC for COVID response below capitalisation threshold • Drugs costs • Consultancy • Establishment • Transport • Audit services and other remuneration • Clinical negligence costs • Research and development • Education and training • Redundancy costs • Legal fees • Insurance • Early retirement costs • Car parking and security • Hospitality • Other losses and special payments • Other	• Premises • Depreciation • Amortisation • Impairments • Operating lease expenditure • Changes to operating expenditure for on-SoFP and off-SoFP IFRIC 12 schemes • Inventories written down (net including drugs) • Inventories written down (consumables donated from DHSC group bodies for COVID response) • Provisions arising/released in year
NHS England Group Source: DHSC Annual Report and Accounts	• Staff costs	• Consultancy services • Transport • Clinical negligence costs • Establishment • Education, training & conferences • Supplies and services – general • Inventories consumed • Research & development expenditure • Other	• Premises • Impairment of receivables • Rentals under operating leases • Depreciation • Amortisation • Impairments & reversals • Interest charges

Note: Items of expenditure for Foundation Trusts and Non-Foundation Trusts are taken from accounts of 2020/21. The items used in previous years can be found in Table A30 in the Online Appendix.

Table 36: Sources of expenditure information 2013/14 – 2019/20

Years	Foundation Trusts	Non-Foundation Trusts	NHS England Group
2013/14 – 2016/17	Consolidated NHS Financial Trusts Accounts	Financial monitoring and accounts	DHSC Annual Reports and Accounts
2017/18 – 2020/21	Trust accounts consolidation		

7.2.2. Expenditure on inputs

This section describes nominal input data, which is converted to real terms using appropriate deflators, the NHS Cost Inflation Index, and the CHE ESR deflator for NHS Staff. For further details on the deflators used see section 10.1 in Appendix B.

Table 37 presents current expenditure on Labour, Materials, and Capital of the NHS England Group from 2018/19 to 2020/21. Expenditure on Labour grew by 6.78%, Materials by 64.01% -one of the highest increases- and Capital by 14.88% between 2019/20 and 2020/21. These contrast with changes between 2018/19 and 2019/20 when Labour grew by 9.09%, Materials by 2.26% while Capital decreased by 4.11%. Increases in expenditure, especially in Materials and Capital, are likely to be associated with increases in costs linked to treating COVID-19 patients, as well as to inflationary pressures.

Table 37: Current expenditure by NHS England Group (£000)

Year	Labour	Materials*	Capital*
2018/19	1,949,260	1,965,555	564,088
2019/20	2,126,458	2,009,981	540,893
2020/21	2,270,582	3,296,681	621,361

* Interest payments are moved from Material to Capital expenditure, to align with the practice followed with NHS Trusts.

Expenditure on Labour, Materials, and Capital among NHS Trusts is reported in Table 38. It should be noted that expenditure on Labour inputs reported by NHS Trusts in 2019/20 includes additional pension costs, which accrued because of an increase in the NHS employer contribution rate from 14.38% to 20.68%, from 1st April 2019.[91] This additional expenditure, equal to over £2.3 billion, was detracted from total Labour expenditure before calculating the NHS labour input growth rate, as it would otherwise artificially impact its growth rate.

Expenditure on all input categories continued to increase, with the most notable nominal increase in Labour of 20.16% in 2020/21. In nominal terms, also Materials and Capital expenditure had high growth rates of 13.82% and 26.33%, respectively, compared to only 2.71 % and 3.65%, respectively for Materials and Capital, between 2018/19 and 2019/20. These are likely due to both higher use of materials and capital due to COVID-19, and inflation, especially from September 2020 to March 2021 where monthly inflation increased progressively from about 3% to 7% in just over half a year.[92]

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[91] For further information on additional pension costs derived from an increase of the NHS Pension Scheme employer contribution rate, please see here (last accessed 14/03/2022).

[92] Consumer price inflation, UK: September 2022 (last accessed 01/12/2022).

Table 38: Current expenditure by NHS Trusts (£000)

Year	Labour	Materials	Capital
2018/19	54,467,368	24,381,034	8,460,613
2019/20	59,601,842*	25,041,698	8,769,510
2020/21	67,106,390	28,504,921	11,078,757

* Amounts to 57,277,947 if additional pension contributions are excluded.

NHS expenditure on all input items from 2018/29 to 2020/21 is summarised in Table 39. The table includes the sum of Labour (NHS Staff including bank staff and agency staff), Materials and Capital across NHS Trusts and NHS England Group. Expenditure on Primary Care and Community Prescribing (Prescribing) are also included. Details about the source of information of Community Prescribing are given in section 6.7. Expenditure on NHS staff constitutes the largest proportion of total input expenditure and saw an increase of 12.78% in 2020/21 (17.38% if additional pension contributions are excluded). Materials and Capital nominal expenditure increased by 17.56% and 25.67% respectively, while primary care increased by 9.65%.

Table 39: Total NHS current expenditure 2017/18 – 2019/20 (£000)

Year	NHS Staff	Agency**	Materials	Capital	Prescribing	Primary Care	TOTAL
2018/19	54,016,983	2,399,645	26,346,589	9,024,701	8,833,869	13,934,642	114,556,430
2019/20	59,348,146*	-	27,051,679	9,310,403	9,281,577	14,751,852	-
2020/21	66,935,079	-	31,801,602	11,700,118	9,403,486	16,176,029	-

Note: slight discrepancies with previously published figures for Materials and Capital due to the move of NHS England Group interest payments from Material to Capital expenditure, to align with the practice followed with NHS Trusts.
* Amounts to 57,277,947 if additional pension contributions are excluded.
** Agency expenditure figures for 2019/20 and 2020/21 are suppressed as it is unpublished management information. Further to avoid the possibility of reverse engineering these figures from the Total figures in the Table, we have omitted the latter as well for both 2019/20 and 2020/21.

8. Concluding remarks

Between 2019/20 and 2020/21, measured NHS productivity fell by 24.02% using a purely indirect method (22.95% using a mixed input growth method). This result arises from both a substantial fall in outputs (by 16.05%) and increase in inputs (10.49% and 8.95% using indirect and mixed methods respectively). These findings contrast strongly with reported figures for the wider economy. However, in interpreting these results, it is key to recognise both the dramatic effects of the COVID-19 pandemic on healthcare services, over and above those on the wider economy, and on the measurement of productivity growth.

NHS output, input and productivity growth indices used in this report have been developed following the principles embedded in the System of National Accounts (European Commission et al., 2009) and in the European System of Accounts (Eurostat, 2001, Eurostat, 2013). Where possible, it is recommended that healthcare output is measured directly (using volume information, such as surgical operations), with a combination of expenditure and deflators used when volume information is not available(Eurostat, 2001, Eurostat, 2013, European Commission et al., 2009). In order to aggregate the array of healthcare goods and services produced in an overall measure of healthcare output, and in the absence of prices as a measure of consumer value, unit costs of production are used as a proxy. As costs are not expected to fully reflect consumers' valuations, output is adjusted to reflect changes in the quality of care provided.

This approach to measurement has some key interactions with the COVID-19 pandemic.

First, NHS productivity is measured as the ratio of the growth index of healthcare outputs produced and the growth index of healthcare inputs used. Thus, all else being equal, it is assumed that higher volumes of health care provided will translate into higher productivity. However, one of the major responses to the COVID-19 pandemic was to ask hospitals to cancel as much elective care as possible, with the aim of reducing the number of infections, and thus to generate greater overall health. In this instance, at least some inactivity and thus reduced volumes of conventional healthcare was expected to generate greater health overall. However, as a value for inactivity is not available, this is not reflected in our measure of output growth. At the same time, the overall cost of providing healthcare remained, in terms of NHS staff employed and material and capital spend. It even rose with the need to increase the number of healthcare workforce employed, the adoption of additional safety measures, and the introduction of new services, such as testing and contact tracing, and COVID-19 vaccinations.

Second, there are some important misalignments between NHS inputs used and outputs observed, arising due to the pandemic. For example, it is not possible to include vaccinations carried out in settings beside GP practices, or test and trace services, as we did not have access to the full information. So far as these services were delivered by NHS staff as part of their NHS role, the costs of these services would be included in our measure of NHS inputs, but they are not in our measure of NHS outputs.

Third, our NHS output index assumes that treatments have the same relative value between the base and current year. This may be the case in terms of pure health gains. However, in the context of the pandemic, patients may consider healthcare received even more valuable than in normal times. And this is not possible to capture in our output measure.

Given the above, it is important to treat our findings of productivity growth of the English NHS during the COVID-19 pandemic with caution. They reflect a substantial reduction in the number of patients seen and treated during 2020/21 on account of COVID-19. The benefits patients could have received have therefore been delayed, which could have important implications for future healthcare needs and demand. At the same time, measured productivity growth is a much weaker reflection of how effectively the NHS has converted inputs into the ultimate desired output of health, than in the absence of an exogenous shock of such as COVID-19.

9. Appendix A

9.1. Dealing with outliers in the community prescribing data

This appendix sets out the theoretical implications and two related practical solutions for dealing with outliers in the community prescribing data. The focus is on cases where the unit in which a drug is recorded changes over time, which generates specific challenges not addressed by the imputation method employed generally and detailed in the Methods section of the report. The imputation method was developed to address the issue of new healthcare categories (currencies, e.g. new drugs) being introduced in a given financial year, which cannot be matched with healthcare categories reported in the previous financial year. Or equivalently, old categories of healthcare activity which were discontinued in a new financial year. The issue at hand here is that the same drug (category) is reported in both financial years, but the unit that drug is reported in has changed. For example, it has become more granular.

9.2. Theoretical Framework

We ultimately wish to calculate a Laspeyres output growth rate, expressed as

$$X_{(0,t)} = \frac{\sum_{j=1}^{J} x_{jt} c_{j0}}{\sum_{j=1}^{J} x_{j0} c_{j0}} \qquad \text{(A1)}$$

Where x_{jt} is the volume of output type *j*; c_{j0} is the unit cost of output *j*; t indicates time, with 0 indicating the first period of the time series.

Over the last two financial years, in calculating the Laspeyres output growth rate for community prescribing, it has been highlighted that it is sensitive to outliers. One source of outliers is changes in the unit a drug is reported in. The community prescribing dataset includes information on total expenditure (E_j) and total volume (x_j) for each drug prescribed. Unit costs for any drug *j* is calculated as $c_{j0} = E_{j0}/x_{j0}$. So, expression (1) becomes

$$X_{(0,t)} = \frac{\sum_{j=1}^{J} x_{jt} \left(E_{j0}/x_{j0}\right)}{\sum_{j=1}^{J} x_{j0} \left(E_{j0}/x_{j0}\right)} \qquad \text{(A2)}$$

Outliers can be generated if the unit of a given drug changes within or between years.[93] Let's assume that from one year (*t*=0) to the next (*t*=1), the unit of a drug, *j*=1, changed (was reduced) 1000-fold. For example, instead of reporting a drug in litres, it is reported in millilitres. Ceteris paribus, the volume prescribed of this drug will see a 1000-fold increase, and as a consequence, its unit cost will also decrease 1000-fold. Note that the change of the unit in which a drug is reported does not affect its total expenditure. However, it will have an impact on the Laspeyres output growth rate, as this combines information from both years as follows:

$$X_{(0,1)} = \frac{x_{11} * 1000 \left(\frac{E_{10}}{x_{10}}\right) + \sum_{j=2}^{J} x_{j1} \left(\frac{E_{j0}}{x_{j0}}\right)}{\sum_{j=1}^{J} x_{j0} \left(\frac{E_{j0}}{x_{j0}}\right)} \qquad \text{(A3)}$$

Where x_{11} is the volume of drug 1 at time 1, the year in which the unit of measurement changed. Therefore, the total value of this drug, when weighted with unit costs of the previous year, will

[93] The within year change can occur because we have monthly community prescribing data, and the unit in which a drug is reported can change from one month to the next.

increase 1000-fold. Therefore, the total value of all drugs prescribed in year 1 and valued at prices of year 0 would be artificially large if drug 1 was not dropped from the calculations.

In practice, it can be expected that genuine changes in price and volume would occur simultaneously with the change in the unit a drug is reported. So, observed expenditure and volume would come from a mix of these elements. However, in a metric system a unit change represents at least a 10-fold change (1000%) in volume and most genuine changes in volume are within a range of plus or minus 10%. So any genuine change in volume will be swamped by the artificial impact of the change in units in which a drug is reported. We therefore set out the simplified theoretical framework, ignoring the presence of genuine source of volume change, but the key findings would remain the same even if genuine change had been included.
If change in the unit of measurement is retained after period *t*=1, then it no longer poses an issue when calculating the Laspeyres output growth measure for successive years (t=2+).

Therefore, the identification of potential outliers in the community prescribing data needs to be assessed between two adjacent years only. It is not necessary to drop a drug from the analysis across all years.

As the community prescribing dataset records activity on a monthly basis, the issue of potential outliers due to changes in the unit of measurement can occur both within the financial year (i.e. between months) and/or across financial years. In the following sections we set out the theoretical framework for both.

9.2.1. Within year outliers

A change in the unit in which a drug is measured and reported can occur in any month of the financial year. Let's assume that a change in the units for drug *j*=1 occurs in the last *k* months of the year *t*=1, leading to a 1000-fold increase in volume for that drug in these months. The effect of this change can be captured as follows:

$$X_{(0,1)} = \frac{\sum_{m=1}^{k-1} x_{1m1}\left(\frac{E_{10}}{x_{10}}\right)+\sum_{m=\mathrm{k}}^{12} x_{1m1}*1000\left(\frac{E_{10}}{x_{10}}\right)+\sum_{j=2}^{J} x_{j1}\left(\frac{E_{j0}}{x_{j0}}\right)}{\sum_{j=1}^{J} x_{j0}\left(\frac{E_{j0}}{x_{j0}}\right)} \tag{A4}$$

Where x_{1m1} is the volume of drug *j*=1 in month *m* in year *t*=1, and where the exogenous change in the unit of measurement in drug *j*=1 for the last *k* months is expressed as $\sum_{m=\mathrm{k}}^{12} x_{1m1} * 1000(E_{j0}/x_{j0})$. Note that if the change occurs in the first month, *m*=1, of the new financial year and this change is kept for the full year, equation 4 converges to equation 3. A more general version of equation 4 would recognise that units might change multiple times within a year, for example, switching between two alternatives. As the within year method described below compares each month to the median of months in the same year, the distribution of months where the unit differs does not have an impact. The case of a single permanent shift in unit is given both for simplicity of notation and because it is the common case observed in the data.

The effect of removing within year outliers presented in equation 4 solves the problem if we compare years t=1 and t=0. This is because once the expression is dropped from the numerator of equation 4 and removed from the denominator, this converges towards equation 2 while retaining a like for like comparison. However, dropping these terms does not solve the issue for the following year (“t=2”). Let’s assume that this shift in units is permanent. Then the following year, the problem will appear also in the denominator.
The unit cost when the outlier is present is:

$$c_{11} = \frac{E_{11}}{\sum_{m=1}^{k-1} x_{1m1} + \sum_{m=\text{k}}^{12} x_{1m1} * 1000}$$

The unit cost when the *k* months outliers are dropped is:

$$c_{11}^{*} = \frac{\sum_{m=1}^{k-1} E_{1m1}}{\sum_{m=1}^{k-1} x_{1m1}}$$

Without dropping outliers, we can estimate the following Laspeyres output growth measure:

$$X_{(1,2)} = \frac{x_{12}*1000c_{11}+\sum_{j=2}^{J} x_{j2}(\frac{E_{j1}}{x_{j1}})}{\sum_{m=1}^{k-1} x_{1m1}c_{11}+\sum_{m=\text{k}}^{12} x_{1m1}*1000c_{11}+\sum_{j=2}^{J} x_{j1}(\frac{E_{j1}}{x_{j1}})} \tag{A5}$$

And dropping the *k* months outliers, we can estimate the following Laspeyres output growth measure:

$$X_{(1,2)} = \frac{x_{12}*1000c_{11}^{*}+\sum_{j=2}^{J} x_{j2}(\frac{E_{j1}}{x_{j1}})}{\sum_{m=1}^{k-1} x_{1m1}c_{11}^{*}+\sum_{m=\text{k}}^{12} x_{1m1}*1000c_{11}^{*}+\sum_{j=2}^{J} x_{j1}(\frac{E_{j1}}{x_{j1}})} \tag{A6}$$

As $c_{11} < c_{11}^{*}$, the Laspeyres output growth rate calculated with equation 6 is greater than the Laspeyres output growth rate estimated by equation 5. Thus, if there is a permanent change in the unit of measurement of a drug, dropping within year outliers in year *t*=1, reduces the Laspeyres index in *t*=1 but increases artificially the Laspeyres index in *t*=2. Thus, the within-year outlier detection at time *t*=1 is not enough, and in fact, can worsen the effect of this outlier in the following year.

9.2.2. Within year and between year outlier detection

By combining the methodologies, we can take advantage of the benefits of both:

a) Within year outlier detection

Dropping the expression $\sum_{m=\text{k}}^{12} x_{1m1} * 1000\left(\frac{E_{10}}{x_{10}}\right)$ from the numerator and its equivalence expression $\sum_{m=\text{k}}^{12} x_{1m0}\left(\frac{E_{10}}{x_{10}}\right)$ from the denominator of equation 4, we drop the within year outliers, and obtain the following expression for the Laspeyres output growth measure.

$$X_{(0,1)} = \frac{\sum_{m=1}^{k-1} x_{1m1}\left(\frac{E_{10}}{x_{10}}\right)+\sum_{j=2}^{J} x_{j1}(\frac{E_{j0}}{x_{j0}})}{\sum_{m=1}^{k-1} x_{1m0}\left(\frac{E_{10}}{x_{10}}\right)+\sum_{j=2}^{J} x_{j0}(\frac{E_{j0}}{x_{j0}})} \tag{A7}$$

b) Between year outlier detection

On the other hand, if we drop only between year outliers, we should drop the affected drug (in our example, *j*=1) from both numerator and denominator. This is equivalent to excluding the expression $\sum_{m=1}^{k-1} x_{1m1}\left(\frac{E_{10}}{x_{10}}\right)$ from the numerator in (7), as well as drug *j*=1 from the denominator. Expression (8) is equivalent to expression (1), for j= 2, …, *J*, or excluding drug *j*=1 from both numerator and denominator.

$$X_{(0,1)} = \frac{\sum_{j=2}^{J} x_{j1}(\frac{E_{j0}}{x_{j0}})}{\sum_{j=2}^{J} x_{j0}(\frac{E_{j0}}{x_{j0}})} \tag{A8}$$

Note that expression 8 is more restrictive than equation 7 in the sense that in equation 8 we lose more information. Thus, in terms of maximising the use of information, within year detection is preferable.

c) Within year plus between year outlier detection

When comparing years *t*=0 and *t*=1, once we implement the within year outlier detection approach, the between year comparison would not detect any further outliers. However, for comparing years *t*=1 and *t*=2, within year dropping is not enough. Equation 6 shows that within year outlier detection performed in *t*=1 exacerbates the outlier problem in *t*=2. Therefore, in year *t*=2, it is better to drop drugs flagged up by both the between year comparison as well as within year.

9.2.3. Between-year detection methodology

Having established the need to detect and drop between year outliers, we set out two related detection methods. First, a ratio-based method. This employs a cut-off for the ratio of unit costs between years to define outliers. Second, a distribution-based method. This constructs a distribution of unit cost ratios and treats some fixed portion of the tails as outliers. As these two methods have many common elements, it is convenient to present them together. Let's define the ratio of calculated unit costs

$$r\_c_{(0,1)} = \begin{cases} \frac{c_{j1}}{c_{j0}} \;\; if\; c_{j1} \leq c_{j0} \\ -\frac{c_{j0}}{c_{j1}} + 2\; if\; c_{j1} > c_{j0} \end{cases} \qquad \text{(A9)}$$

$r\_c_{(0,1)} \in (0,2)$. This transformation enforces a specified range, where potential outliers are close to the extreme values (0 or 2). More intuitively, the expression $\frac{c_{j1}}{c_{j0}}\; if\; c_{j1} \leq c_{j0} \in (0,1]$ takes value 1 if the cost of drug *j* is the same in both years and converges to zero if the unit cost in the base year (*t*=0) is arbitrarily high compared with the next current year (*t*=1).

Let's assume a v-fold change in the unit of measurement of drug 1 at time *t*=1; in this case, the ratio of unit costs for this drug should be:

$$\frac{c_{j1}}{c_{j0}} = \frac{\frac{E_{j1}}{x_{j1}*v}}{\frac{E_{j0}}{x_{j0}}} = \frac{E_{j1}x_{j0}}{E_{j0}x_{j1}*v} \qquad \text{(A10)}$$

In practice, we observe x_{j1} where $x_{j1} = x_{j1}^{*}v$. So it is not possible to disentangle changes in drug use over time between years, and v, the amplification of change due to unit change or some other issue like substantial data entry error. However, we are ultimately concerned with cases where the factor v is creating so much noise that it would distort more aggregated measures of overall drug use. We can observe this as cases where $\frac{E_{j1}}{x_{j1}} / \frac{E_{j0}}{x_{j0}}$ is very large or very small.

We can employ this observable information in two ways, which represent the two proposed methodologies to identify between year outliers.

9.2.4. Between year outlier identification by ratio

A relatively simple approach to identify outliers between years is to directly use the ratio of unit costs for the given drug in each year. That is, the result from equation 10. As previously noted, a change in the unit a drug is reported in will not in itself change total expenditure for that drug but will change volume by at least one order of magnitude. So, the unit cost E/x will also change by the same order of magnitude and so will the ratio of unit costs between years. For example, if the only change between year 0 and year 1 for a drug is that it is reported in millilitres instead of litres, with expenditure remaining the same, equation 10 becomes $\frac{c_1}{c_0} = \frac{\frac{E_0}{1000x_0}}{\frac{E_0}{x_0}} = \frac{1}{1000}$. While it cannot be expected that expenditure change is purely driven by unit change or that unit cost would not change over time, the scale of genuine volume and expenditure changes is far smaller than what would be observed from a unit change. From past observations, genuine changes would commonly yield a unit cost ratio in the range 0.9 to 1.1. So, it is possible to set a cut off unit cost ratio for outliers of, for instance, 10 and 0.1, to capture unit changes without excluding substantial but genuine changes in volume or unit cost which might also arise between years.

There are several advantages to this method of outlier detection.

1. It is relatively simple to implement, requiring only the unit costs in each year of each drug, which we have already calculated.
2. There is a close link between the issue of concern (changes in units) and the method for identification. That is, if all drugs are reported in the same units in consecutive years, it is likely that none would be identified as outliers by this method.
3. This approach is similar to the use of ratios in the within year method used in the previous productivity update. The primary difference is the numbers being compared (whole year unit costs instead of month by month comparisons).

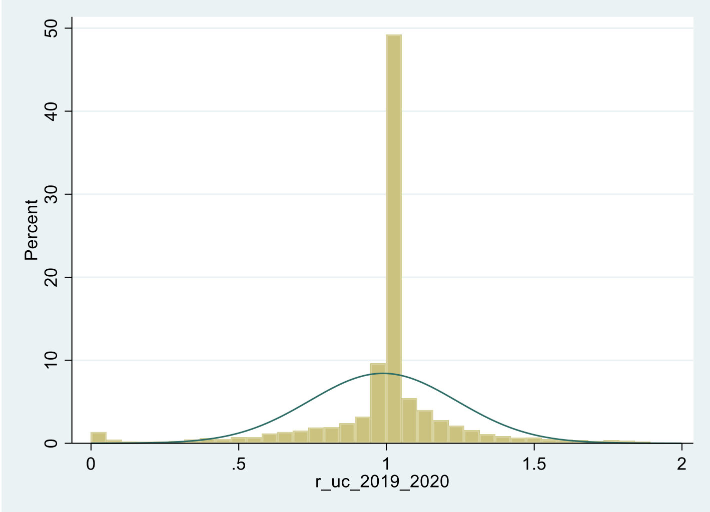
9.2.5. Between-year outlier detection by distribution

An alternative approach is to use the observed ratio in unit costs, transformed as described in equation 9, to construct a distribution of ratios. From equation 10 above, if v→∞ the ratio of unit costs will be equal to zero. Thus, the higher the change in the unit of measurement at time *t*=1, the higher the probability that the ratio of unit costs would be close to zero.

On the other hand, if v→0, from the second expression of Equation 9, $-\frac{c_{j0}}{c_{j1}} + 2 \; if \; c_{j1} > c_{j0} \; \in (1,2)$ the ratio of unit costs will be equal to 2. Thus, the higher the change in the measurement unit of a drug at time *t*= 0, the higher the probability that the ratio of unit costs is close to 2.
So we can identify outliers from how close the ratio $r\_c_{(0,1)}$ is to 0 or to 2.

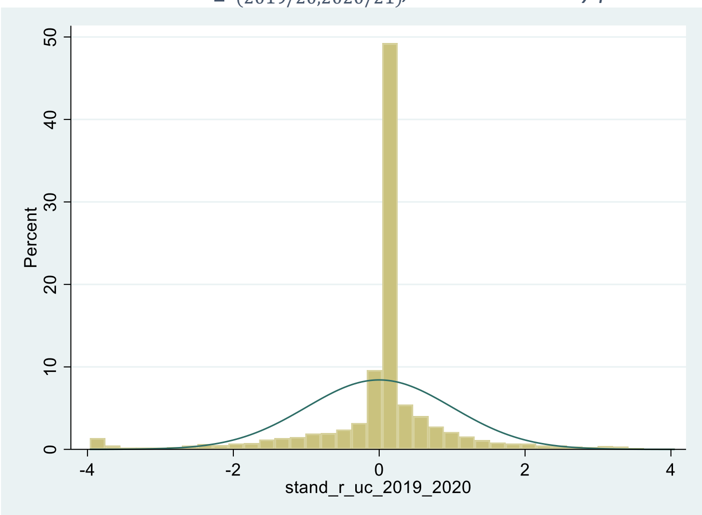
Using community prescribing data for the years 2019/20 and 2020/21, we have plotted in Figure A 1 the distribution of the unit costs ratios for each drug.

Figure A 1: Estimated $r\_c_{(2019/20,2020/21)}$, BNA Community Prescribing data



If we normalise $r\_c_{(2019/20,2020/21)} \sim N(0,1)$, we obtain Figure A 2.

Figure A 2: Standardised $r\_c_{(2019/20,2020/21)}$, BNA Community prescribing data



We can define outliers that are outside of the p% confidence interval distribution in terms of its normal standardised Z value as follows:

$$outlier = 1 \; if \; abs(r\_c_{(0,1)}) > z_p$$

Table A 1 shows the normal distribution standardised values for defining confidence intervals. For the 90% confidence interval, standardised values of ratio of unit costs that are lower than -1.644 and higher than 1.644 will be defined as outliers. At 99.99% confidence interval standardised values lower than -3.89 and higher than 3.89 will be defined as outliers.

Table A 1: Confidence interval and absolute normal Z values

Confidence interval	abs(Z)
90%	1.6448536
95%	1.959964
99%	2.5758293
99.50%	2.8070338
99.90%	3.2905267
99.95%	3.4807564
99.99%	3.8905919

9.3. Results

9.3.1. Results from ratio based approach

In applying a ratio based approach to identifying outliers, the key decision is the point at which a change in unit cost is considered to be implausibly large. In doing this we wish to remove as few drugs as possible, but exclude any drug which would otherwise distort results at a higher level of aggregation of drugs. Similarly to the within year outlier detection approach developed for the previous year, the impact of dropping drugs with unit cost ratios < 0.5 or > 2, < 0.2 or > 5 and < 0.1 or > 10 are considered.

Table A 2 shows the Laspeyres index estimated with this ratio based methodology. The table highlights a few key results. First, the Laspeyres indices calculated for different key ratios of unit costs defined as outliers are generally extremely similar. This holds for applying the within year outlier detection approach as well, with the exception of the year 2019/20-2020/21. This aligns with the theoretical framework described previously, which highlights that the within year detection method is insufficient for comparing the financial years 2019/20 and 2020/21. This arises because changes occurring in 2019/20 (accounted for by the within year outlier detection approach) are retained throughout 2020/21. Similarity across the 2, 5 and 10 ratio approaches indicates that using the higher bar of 10x changes in ratio still excludes drugs which would otherwise distort the overall Laspeyres index, our key statistic.

Table A 2: Laspeyres Index by dropping 10-times, 5-times and 2-times increase/decrease variation in unit cost

Years	Raw estimation	Within-year outlier detection	Unit cost ratio cut-off		
			10	5	2
2016/17 - 2017/18	1.016	1.014	1.014	1.014	1.010
2017/18 - 2018/19	1.026	1.025	1.024	1.023	1.022
2018/19 - 2019/20	1.966	1.051	1.050	1.050	1.050
2019/20 - 2020/21	1.087	2.152	1.027	1.025	1.024

Table A 3 and Table A 4 show the number of drugs identified as outliers and the percentage of drugs identified as outliers, respectively. These tables also highlight some key points. First, the number of drugs identified as outliers when applying the 10 ratio approach is small. Second, that applying this methodology leads to substantially more (though still a small number) of drugs identified as outliers in 2019/20-2020/21. This finding suggests that between year changes were not a major issue in recent previous years.

Table A 3: Number of drugs dropped by dropping 10-times, 5-times and 2-times increase/decrease variation in unit cost

Years	Total drugs	10	5	2
2016/17 - 2017/18	7815	65	118	439
2017/18 - 2018/19	7755	45	117	434
2018/19 - 2019/20	7623	34	79	388
2019/20 - 2020/21	7268	130	189	521

Table A 4: Percentage of drugs dropped by dropping 10-times, 5-times and 2-times increase/decrease variation in unit cost

Years	Total drugs	10	5	2
2016/17 - 2017/18	7815	0.8%	1.5%	5.6%
2017/18 - 2018/19	7755	0.6%	1.5%	5.6%
2018/19 - 2019/20	7623	0.4%	1.0%	5.1%
2019/20 - 2020/21	7268	1.8%	2.6%	7.2%

An alternative way to present the results from the ratio methodology is in terms of the proportion of the overall distribution of unit cost ratios identified as outliers. This is presented in Appendix A.

9.3.2. Results from Between-year outlier detection – distribution approach

Figure A 3 and Figure A 4 show the results of applying the distribution based methodology applied to the Community Prescribing data for the financial years 2016/17 - 2017/18 and 2017/18 - 2018/19 respectively. While in the previous section, we only showed the results of the combined within and between year drop, Figure A 3 and Figure A 4 in this section show the Laspeyres output growth index calculated using the community prescribing data as they are (raw), when applying the estimates: within-year approach only; between-year approach only; and the combined within and between-year outlier detection approach. It can be observed that all four approaches yield very similar results. This suggests that there were very few outliers in these years, and that the three approaches proposed only removed very few observations from the dataset.

Figure A 3: Within-year, between-year, and within-between-year outlier detection 2016/17 - 2017/18

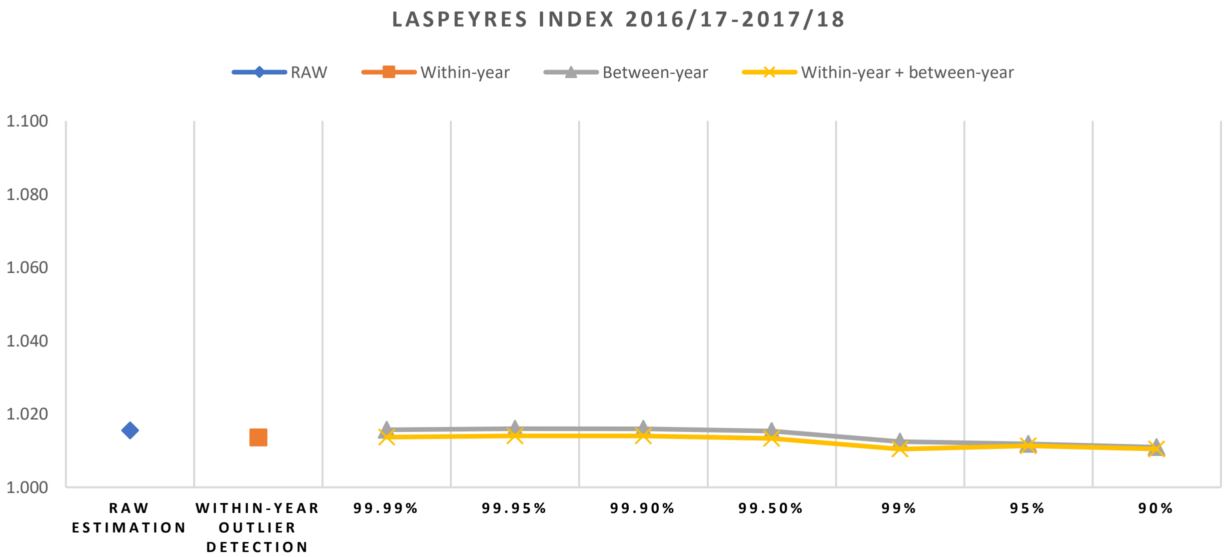


Figure A 4: Within-year, between-year, and within-between-year outlier detection 2017/18 – 2018/19

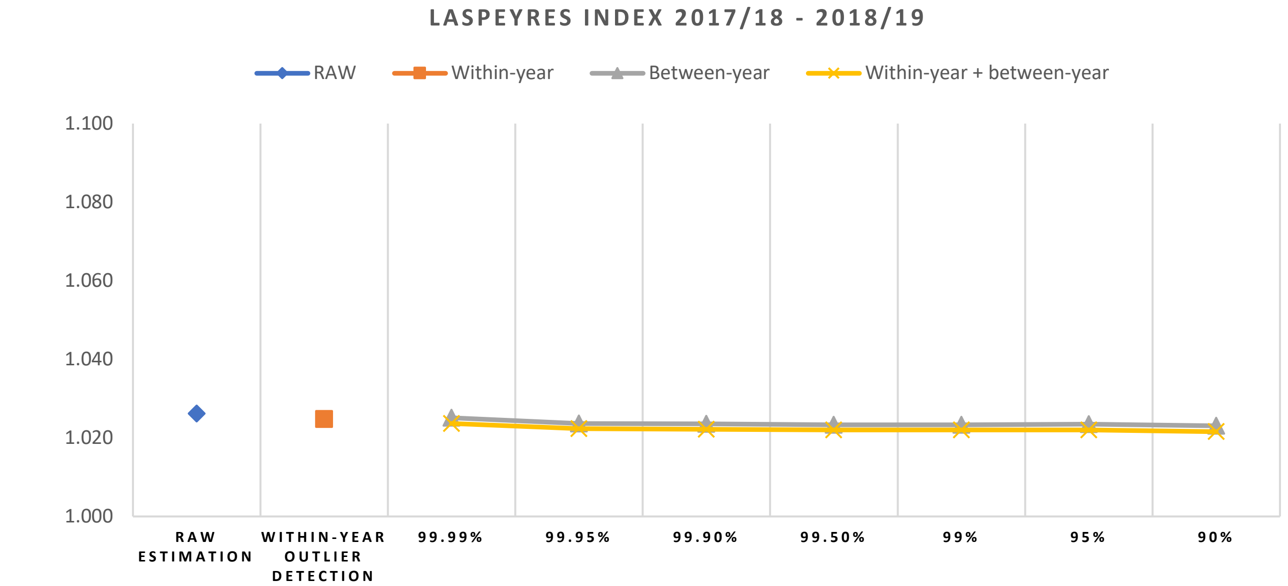
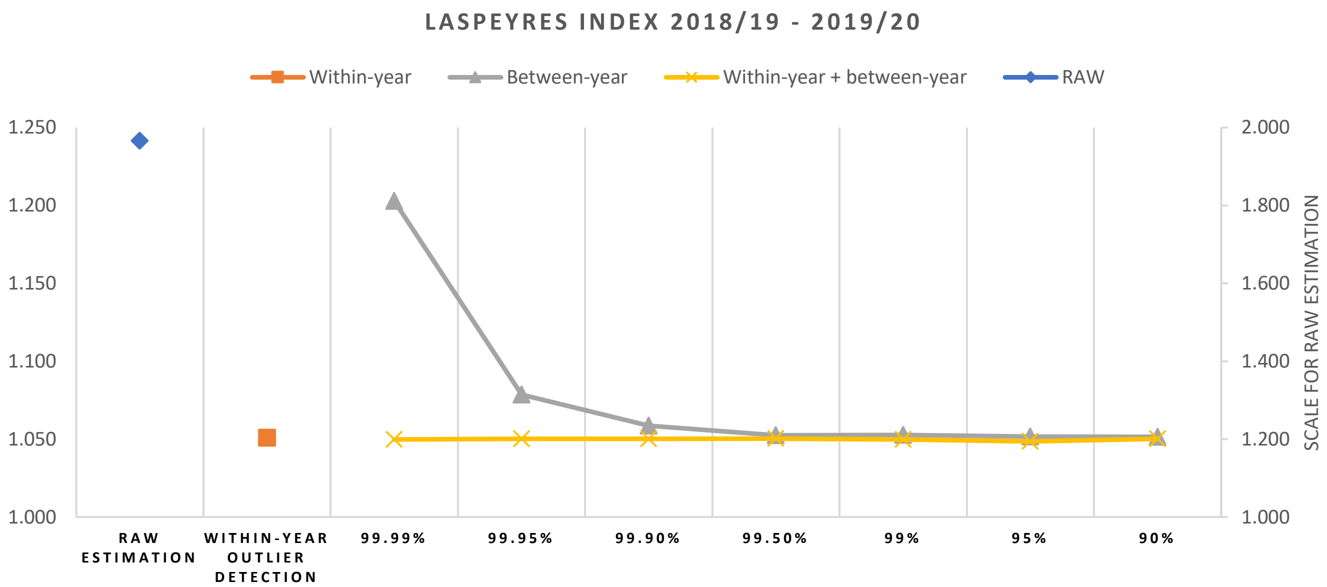


Figure A 5 shows the results of applying the distribution-based methodology to the Community Prescribing data for the financial year link 2018/19 – 2019/20. It should be noted that the Laspeyres output growth index, calculated using the data as they are (raw), is close to 2 (right hand axis scale), suggesting the presence of outliers. The within-year outlier detection reduces the Laspeyres index for all confidence intervals, while the between-year detection series starts at about 1.2 (left hand axis scale) and gradually converges to the within-year estimate as more observations are dropped. On the other hand, the combined within and between-year detection approach yields results very similar to the ones obtained with the within-year detection method.

Figure A 5: Within-year, between-year, and within-between-year outlier detection 2018/19 – 2019/20



Finally, Figure A 6 shows the results of applying the above approaches to the Community Prescribing data for the financial years 2019/20 and 2020/21. The Laspeyres output growth index for the last two financial years, when calculated without correcting for outliers, is close to 1.087. The within-year outlier detection approach increases the Laspeyres index substantially to 2.15 (right hand axis scale), which is due to the outliers identified in 2019/20. However, the between-year outlier detection approach series starts at about 1.088 and then converges to the within-year and between-year estimate slowly. On the other hand, the combined within-year and between-year detection converges rapidly to a value that is stable across the rest of the series from the 99.95% confidence interval onwards.

Figure A 6: Within-year, between-year, and within-between-year outlier detection 2019/20 – 2020/21

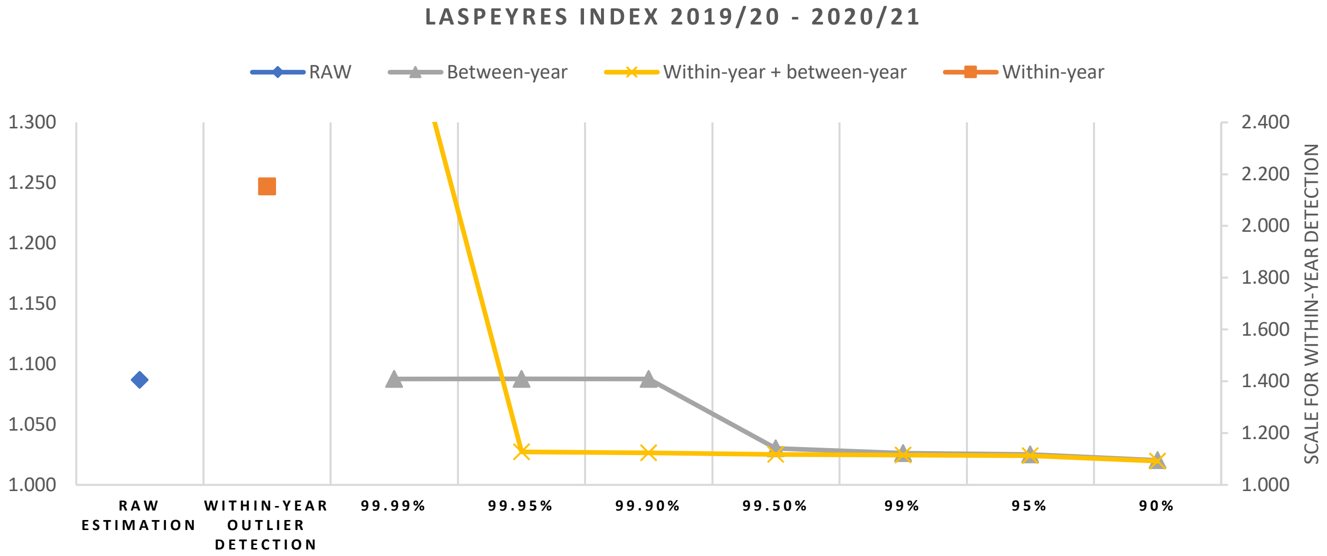


Table A 5 summarises the Laspeyres output growth indices obtained when applying the three outlier detection methodologies, including the raw estimation to the Community Prescribing data, as well as the raw estimation obtained when using the data as they are. For the combined within year and between year approach, we test several confidence intervals, with the 99.95% distribution being our preferred approach. This amounts to excluding about 2% of drugs. Table A 6 shows the absolute number of drugs dropped by each approach, and Table A 7 the number of drugs dropped in percentage terms by each approach. For comparison, the final column of these three tables shows the equivalent results when dropping drugs with a 10-fold change, which was the preferred ratio-based approach. These last two approaches yield very similar results.

The ratio-based approach also drops fewer drugs from the comparison between the financial years 2019/20 and 2020/21: 131 compared to 149 and substantially fewer in previous years, e.g. 34 compared to 112 for the financial years 2018/19 and 2019/20. This suggests that while performing similar functions, applying a 10-fold change in the unit cost rule instead of trimming a distribution of ratios addresses the issue of concern (changes in the units of measurement in which a drug is measured) with greater precision, limiting potential type II errors.

Table A 5: Laspeyres Index for within-year and between-year outlier direction

Years	Raw estimation	Within-year outlier detection	Within-year + Between-year outlier detection							Withinyear + Betweenyear Outlier detection by 10-fold increase
			99.99%	*99.95%*	*99.90%*	*99.50%*	*99%*	*95%*	*90%*	*10x*
2016/17 – 2017/18	1.016	1.014	1.014	1.014	1.014	1.013	1.010	1.011	1.010	1.014
2017/18 – 2018/19	1.026	1.025	1.024	1.022	1.022	1.022	1.022	1.022	1.022	1.024
2018/19 – 2019/20	1.966	1.051	1.050	1.050	1.050	1.050	1.050	1.049	1.050	1.050
2019/20 – 2020/21	1.087	2.152	1.427	1.027	1.026	1.025	1.025	1.024	1.020	1.027

Table A 6: Number of drugs dropped for within-year and between-year outlier direction

Years	Total	99.99%	99.95%	99.90%	99.50%	99%	95%	90%	10x
2016/17 - 2017/18	7815	84	132	161	267	329	561	750	65
2017/18 - 2018/19	7755	82	148	189	298	349	539	711	49
2018/19 - 2019/20	7623	53	112	145	246	306	539	741	34
2019/20 - 2020/21	7268	52	149	179	268	323	543	692	131

Table A 7: Percentage of drugs dropped for within-year and between-year outlier direction

Years	Total	99.99%	99.95%	99.90%	99.50%	99%	95%	90%	10x
2016/17 - 2017/18	7815	1.1%	1.7%	2.1%	3.4%	4.2%	7.2%	9.6%	0.8%
2017/18 - 2018/19	7755	1.1%	1.9%	2.4%	3.8%	4.5%	7.0%	9.2%	0.6%
2018/19 - 2019/20	7623	0.7%	1.5%	1.9%	3.2%	4.0%	7.1%	9.7%	0.4%
2019/20 - 2020/21	7268	0.7%	2.1%	2.5%	3.7%	4.4%	7.5%	9.5%	1.8%

9.3.3. Conclusions

Both methodologies presented for identifying between year outliers (ratio based and distribution based) deal with the same theoretical issue of major outliers in terms of unit costs, especially those driven by changes in the unit a drug is recorded in. As a result, we obtain very similar and overall plausible Laspeyres output growth rates with each approach. Of the two methods presented, we adopt the ratio based approach for two main reasons. First, the relative simplicity of implementation, not requiring transformations to generate a symmetric distribution. Second, it is a more precise way of identifying outliers, as it limits the risk of type II errors whilst retaining maximum information.

10. Appendix B

10.1. Deflators

In order to construct a Laspeyres volume growth measure for NHS inputs, expenditure reported in the most recent year needs to be deflated (see section 2.2 for methodological details). This is to purge any changes in expenditure due to changes in prices. Because inflation rates can vary for different sources of expenditure, we use the most appropriate and disaggregated measures available.

We employed specific deflators for four categories of expenditure (Materials and Capital are considered as a homogenous category) until 2015/16. From 2016/17 and limited to Community Prescribing, we use the direct Laspeyres output growth, instead of deflating its expenditure.[94] In 2018/19 we incorporated a specific deflator for agency staff. The various categories of expenditure and deflators used from 2013/14 onwards are summarised in Table B 1.

Table B 1: Sources of deflator data

Years	Labour	Materials & Capital	Primary Care	Prescribing
2013/14 – 2014/15	ESR deflator	Hospital and Community Health Services (HCHS) deflator	Pay and Price deflator	PCA / NHS BSA
2014/15 – 2015/16				
2015/16 – 2016/17			0.1 + 0.4*ESR deflator + 0.4*HCHS deflator	
2016/17 – 2017/18		NHS Cost Inflation Index: Provider Non-Pay Index (NHSCII-PNPI)	NHS Cost Inflation Index: General Practice Index (NHSCII-GPI)	
2017/18 – 2020/21	ESR deflator and Agency deflator (from NHSCII)			

The deflators applied to Labour and Prescribing expenditure were constructed using the ESR dataset and Prescribing data (PCA, NHS BSA) respectively, and implied calculating the Paasche price index for these two NHS inputs.

The Hospital and Community Health Services deflator and Pay and Price deflator were provided by DHSC. In 2016/17, the Pay and Price deflator was discontinued and we replaced it with a combination of ESR and HCHS deflators. In 2017/18, the DHSC created a set of new deflators – known as the NHS Cost Inflation Index[95] – from which we use specific deflators for Materials and Capital, and Primary Care. We use the Provider Non-Pay Index to deflate expenditure on Materials and Capital, and the General Practice Index to deflate expenditure on primary care. The Provider Non-Pay index (PNPI) is calculated by weighting several sub-components – various expenditure categories in the providers accounts. Each of them is deflated using the most appropriate available deflator: components of Producer Price Index (PPI), Services Producer Price Index (SPPI),[96] Consumer Price Index (CPI), etc. and their combinations are used to construct item-specific deflators. As regards the General Practice Index, it is computed as a weighted average of the staff and non-staff subcomponents. The former is calculated using GP and other staff earnings data provided by NHS Digital, whereas intermediate consumption is deflated using the Consumer Price Index, including the owner occupiers' housing costs (CPIH) published by ONS.

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[94] This approach yields a more precise real input growth rate of the sector. However, we still calculate and report the deflator for Prescribing to give an idea of the price dynamics in this expenditure category in recent years.

[95] Details on the methodology behind the index can be found here (last accessed 30/11/2021). For a comparison of HCSC and NHSCII see p.154 here (last accessed 30/11/2021).

[96] ONS have introduced some changes to the construction of the PPI and SPPI indices, because of these some of the components of the indices used for the NHSCII are not produced anymore. As a consequence, alternative indices were used and the NHSCII back series were updated accordingly. This change does not affect our productivity series.

In addition, starting from 2018/19, a separate deflator for agency staff was produced within the NHSCI index. For the financial year 2020/21 the agency deflator is calculated using data from the Crown Commercial Services/London procurement partnership. This data does not provide full coverage of Agency Expenditure, it is only data on agency supply through the NHS Workforce Alliance framework agreements, and they estimate that this accounts for around 40% of the total market. In previous years, the agency deflator was calculated using data collected by NHS England and NHS Improvement from all NHS Trusts, cover NHS Trusts' agency staff spending and the number of shifts worked, which allowed one to calculate the change in the cost of an agency staff shift, based on the assumption that the length of an agency staff shift was constant, which was deemed to be a reasonable assumption.[97] As agency expenditure normally accounts for a large share of expenditure, it is important to understand more closely how agency staff costs vary over time and reflect this back into our measures of NHS input and NHS productivity growth. This is particularly important when agency staff costs have different growth rates than NHS provider staff costs, as shown in Table B 2.

Table B 2 shows deflation figures for each category of expenditure from 2018/19 – 2019/20 to 2019/20 – 2020/21. These figures indicate that between 2018/19 and 2019/20 all input categories were subject to an increase in costs of a similar magnitude, with the exception of prescribing and agency expenditures.

Table B 2: Deflator values 2018/19 – 2020/21

Years	Labour	Materials and Capital	Primary Care	Prescribing
2018/19 – 2019/20	2.73% (-1.30%)	1.44%	3.18%	-0.08%
2019/20 – 2020/21	3.49% (6.99%)	0.78%	6.04%	1.06%

Note: agency deflator in brackets; the agency deflator for 2019/20 has been suppressed as it is based on management information from NHSEI. The figure for Materials and Capital and Primary Care 2017/18-18/19 deflators are different from that published in the 2018/19 productivity update due to a typo corrected.

[97] As highlighted by ONS (last accessed 27/02/2021), discussions with the NHS experts suggest agency staff shift lengths have been stable in recent years.

10.2. NHS Trust-only productivity measures

While the main body of our research concerns the calculation of productivity growth for the whole NHS, we also produced an NHS Trusts-only productivity growth measure.

Table B 3 reports NHS output, input and productivity growth rates for NHS Trusts only. The NHS output growth measure, adjusted for both quality, and working and total days, where appropriate (see section 2.4 for further details on working and total days adjustment) decreased to -19.37%, from the -0.10% growth recorded between 2018/19 and 2019/20.

Trust specific input growth increased to 9.75% using the mixed method and 11.38% using the indirect method. This was higher than the respective growth rate for the NHS as a whole for both the indirect method and the mixed methods. Given the lower growth in outputs, Trusts-only productivity was also lower for both measures compared to the one for the NHS as a whole (see Table B 3 for full details).

Table B 3: Input, output and productivity growth, Trusts only

Years	Quality and working days adjusted Output growth	Input growth		Productivity growth rate
2018/19 – 2019/20	-0.10%	Mixed	2.34%	-2.39%
		Indirect	2.14%	-2.20%
2019/20 – 2020/21	-19.37%	Mixed	9.75%	-26.54%
		Indirect	11.38%	-27.61%

* Figures for input growth differ from those published in the 2018/19 report due to updating bank and agency expenditure back series and correction of a coding error.

10.3. Working and Total Days

Total days and working days for the last three financial years are reported in Table B 4.

Table B 4: Total days and working days in the last three financial years

Year	Total days	Working days
2018/19	365	253
2019/20	366	254
2020/21	365	253

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