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Productivity of the English National Health Service: 2019/20 Update

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Executive Summary

This report updates the Centre for Health Economics' time-series of National Health Service (NHS) productivity growth for the period 2018/19 to 2019/20.

NHS productivity growth is measured by comparing the growth in outputs produced by the NHS to the growth in inputs used to produce them. NHS outputs include all the activities undertaken for NHS patients wherever they are treated in England. It also accounts for changes in the quality of care provided to those patients. NHS inputs include the number of doctors, nurses, and support staff providing care, the equipment, and clinical supplies used, and the facilities of hospitals and other premises where care is provided.

The measurement of NHS output in 2019/20 is 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 results in non-comparability with previous years' data. NHS England and NHS Improvement have indicated that these issues were due to

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

Therefore, NHS England and NHS Improvement stated that some activity, reported in the NCC dataset for 2019/20, is not comparable with previous years' data. A list of affected activities is included in section 6.4.1.

We address the data quality issues and missing data by carrying out extensive alternative analyses of the National Cost Collection data. In particular, we propose and investigate four different approaches to deal with missing data, and have selected one approach as the preferred baseline estimate for this year's NHS output and productivity growth measures. A description of all approaches can be found in section 3.5, whilst the estimated NHS output growth rates by NHS setting and for the NHS overall using our preferred approach can be found in section 10.3, Appendix B. We implement our own quality checks to ascertain the issue of NCC data comparability in section 6.4.2.

We present two sets of NHS output and productivity growth estimates: one obtained with our preferred approach to deal with missing NHS Trusts activity, and one derived using the 2019/20 NCC data without correcting for missing NHS Trusts activity.

Between 2018/19 and 2019/20, and based on our preferred measure of NHS output growth (Approach 3, see section 3.5), NHS productivity decreased by 2.14% when using the mixed measure of NHS input growth, which includes a direct (volume) growth measure for NHS Staff and an indirect (based on expenditure data) growth measure for materials and capital. The NHS productivity measure was also negative (-2.11%) when relating NHS output growth to a full indirect measure of NHS input growth. The negative growth in NHS productivity registered

[1] https://digital.nhs.uk/data-and-information/data-tools-and-services/data-services/patient-level-information-and-costing-system-plics-data-collections (last accessed 29/11/2021).

in 2019/20 was due to slower growth in NHS output (0.25%), while the concurrent growth in NHS inputs was lower than in the previous year (equal to 2.44% and 2.41% respectively for the mixed and indirect input growth measures).

The COVID-19 pandemic only marginally affected the period covered in this update, as the first positive cases in England were recorded at the end of January 2020, with the UK government introducing lockdown measures at the end of March 2020. Notwithstanding this, we have considered the possibility of an "early" impact of the COVID-19 pandemic on the delivery of healthcare goods and services in some NHS settings (hospital inpatient and outpatient, primary care, and community prescribing). For these settings, we exploit a feature of the data, which allows us to calculate NHS output growth rates on a monthly basis. The sensitivity of findings to potential early COVID-19 effects is explored in section 6.2.7 for hospital inpatient data, section 6.3.2 for hospital outpatient, section 6.6.4 for primary care, and section 6.7.3 for community prescribing. Similarly, but limited to the NHS Staff input (direct measure) as derived from NHS Digital Electronic Staff Records, we also investigate any changes in full-time equivalent staff linked to the COVID-19 pandemic, with results presented in section 7.1.1. In general, our analyses highlighted a dramatic difference in growth rates between the months of April-February and March alone for hospital inpatient, outpatient, primary care, and community prescribing. For all of these NHS settings, except community prescribing, the winding down of activity due to the COVID-19 pandemic seemed to be concentrated within the month of March 2020. For example, the quality-adjusted Laspeyres output growth rate for hospital inpatient activity is equal to 1.96% when comparing the period April 2019-February 2020 with April 2018-February 2019, but it decreases dramatically to -22.56% when comparing March 2020 with March 2019. For community prescribing, the Laspeyres output growth rate is substantially higher when comparing March 2020 with March 2019, than when comparing April 2019-February 2020 with April 2018-February 2019. This might be due to a larger number of prescriptions being issued in anticipation of an imminent lockdown in early March, a shift to increasing the rate of prescriptions made during lockdown, or some combination of these.

In this update, we also implemented the following changes compared to previous years:

- Hospital inpatient activity: we have refined the methods for data cleaning, to construct Continuous Inpatient Spells (CIPS) and impute missing information for Life Expectancy (section 6.2.1);
- Hospital outpatient activity: we refined the methods used to correctly identify outpatient attendances (section 6.3);
- Primary Care: we refined the methods developed to apportion both 'unknown' GP appointment modes and appointment status. We have also introduced a new quality indicator: waiting times (section 6.6.1);
- Community Prescribing: we refined the methods used to identify outliers, compared to different years, in either drugs' quantities or expenditure for a small number of drugs (section 6.7.1)

Finally, a new feature of this report is that we explicitly present and discuss the impact of individual quality measures for both physical and mental health hospital care.

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
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

Table of Contents

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 2018/19 to 2019/20. An analysis of the longer time series is also provided where appropriate.[2]

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. In particular, 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, whilst activity delivered in the primary care setting is adjusted based on the changes regarding blood pressure monitoring. Where possible, we use a direct measure of growth, which is feasible when both unit costs and volumes of each unit of input or output are available. When only expenditure data are available, we disentangle changes in terms of volume and inflation by using appropriate deflators. We use direct measures for all sources of output and for NHS staff. We use indirect measures for bank staff, agency staff, materials, and capital. We also consider a purely indirect measure for inputs, where all labour inputs are considered in terms of expenditure. These methodological approaches are in line with national and international accounts recommendations (Eurostat, 2001).

Since we are concerned with the financial year ending March 2020, this NHS productivity update has been only marginally affected by the SARS-CoV-2 pandemic. The first two positive cases were recorded on January 31 2020, and the UK entered a national lockdown only on March 23 2020. However, we have investigated an “early” impact of the COVID-19 pandemic on the delivery of healthcare goods and services in some NHS settings (hospital inpatient and outpatient, primary care, and community prescribing), following the introduction of national guidelines to deal with the pandemic. We also explored whether any changes occurred in NHS Staffing.

National guidelines introduced by NHS England to reorganise modes of delivery and to free-up capacity to deal with the pandemic are summarised in section 2.

Methods used in calculating the productivity of the English health care system are presented in this report in section 3, including the four approaches to deal with missing NHS Trust activity in the National Cost Collection data. Findings are presented for the two most recent financial years, i.e. between 2018/19 and 2019/20. Finally, since 2017/18 the NHS output and productivity measures are adjusted for the total number of days and working days in each

[2] For a longer time series, since 1998/99, see Bojke et al. (2017).

financial year, where appropriate; and labour expenditure figures include separate expenditure information on both bank and agency staff.

The remainder of the report is organised as follows: first, we present our findings for productivity growth; we then consider increasingly small constituent parts of this overall result, beginning with NHS outputs and inputs overall. 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 Appendix A.

In Appendix B, we include the formal derivations for the sensitivity analyses performed in dealing with missing Trust information, as well as the estimated NHS output growth rates (by setting and for the NHS as a whole) and related NHS productivity growth rates.

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 C.

2. The COVID-19 pandemic

In the early phases of the SARS-COV-2 epidemic, the science and international guidance issued by the WHO (World Health Organization, 2020a, 2020b) indicated the importance of avoiding any unnecessary contact (containment) and of introducing a system to allow for contact-tracing in an effort to reduce the spread of the virus. This included the introduction of guidelines issued by NHS England on safe working. The first step towards minimising the negative impact of the coronavirus on GP practices was taken on February 18 2020, when individuals with specific travel history and symptoms were advised to avoid going to a GP practice.[3] The initial advice to single individuals was followed by two further sets of guidance issued by NHS England, respectively on March 5[4] and March 19,[5] directly to GP practices to move previously booked face-to-face appointments to telephone or video appointments. Further, GP practices were advised to adopt a total triage system, with all appointments needing to be assessed by either a telephone or online triage procedure with a view to carrying out as much care as possible remotely. Finally, GP practices were advised to prepare for an increase in home visits. Importantly, the changes 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.

With the rapidity with which the virus spread and the high number of seriously sick patients requiring hospitalisation, the UK government followed other European countries by introducing more substantial actions, with a national lockdown starting on March 23 2020. All

[3] https://www.england.nhs.uk/coronavirus/wp-content/uploads/sites/52/2020/03/coronavirus-primary-care-briefing.pdf (last accessed 10/03/2022).
[4] https://www.birminghamandsolihullccg.nhs.uk/about-us/publications/your-health/coronavirus-advice-for-professionals/3566-covid-19-letter-to-primary-care/file (last accessed 10/03/2022).
[5] https://www.birminghamandsolihullccg.nhs.uk/about-us/publications/your-health/coronavirus-advice-for-professionals/3639-preparedness-letter-for-primary-care/file (last accessed 10/03/2022).

citizens were asked to shelter in place and to socially distance themselves when outside. At the same time, NHS England announced that all NHS Trusts needed to free up the maximum possible inpatient and critical care capacity (March 17), and NHS Trusts chief executives were requested to implement a series of responses to the pandemic either immediately or in the very short term.[6] These 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.

Therefore, while the full changes were not implemented during March 2020, it is plausible that substantial resources were committed to this work, and activities that could be postponed, such as outpatient appointments and elective inpatient care, may have been reduced before the end of March. In the report, and limited to hospital inpatient, outpatient, primary care activity, and community prescribing, we calculate NHS output growth in the above settings for two separate sub-periods for the financial years 2018/19 and 2019/20:

- April – February, and March alone
- April – December, and January – March.

3. Methods

Total Factor Productivity growth, ΔTFP, of the healthcare system 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.

3.1. 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

[6] https://www.england.nhs.uk/coronavirus/wp-content/uploads/sites/52/2020/03/urgent-next-steps-on-nhs-response-to-covid-19-letter-simon-stevens.pdf (last accessed 10.03.2022).

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:

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

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.

3.2. 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:

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

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:

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

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

3.3. 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:

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

This can be simplified to:

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

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

3.4. 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.

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

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

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.[7]

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	

3.5. Alternative approaches to deal with missing NHS Trusts in the 2019/20 National Cost Collection data

The measurement of NHS output in 2019/20 is affected by data quality issues and missing data in the National Cost Collection (NCC) data series (previously known as the National

[7] A table reporting working and total days for the financial years 2016/17, 2017/18 and 2018/19 is presented in Appendix C, section 11.3.

Reference Costs data), which leads to non-comparability with previous years data. NHS England and NHS Improvement have indicated that this is due to:

1. the move to the Patient Level Information and Costing System (PLICS), started in 2016;[8]
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.[9]

We have developed four alternative approaches to dealing with missing Trusts data in the 2019/20 National Cost Collection. All approaches make use of the organisational (Trust) level NCC data. However, these data have the added issue of missing activity (and therefore, unit cost) information because of the suppression of small numbers by NHS Digital. In particular, NHS Digital suppresses any activity information if it amounts to less than eight units.

The first two approaches make the most use of data available at the national level in both financial years; thus avoiding the need for artificially imputing missing activity information when using Trust level NCC data.

The remaining approaches 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 2018/19), 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.

In the remainder of this section, we explain each approach in greater detail. The Laspeyres NHS output growth estimates by NHS setting and for the NHS as a whole, obtained with three of the four approaches can be found in Appendix B, section 10.3. We have chosen as our baseline the NHS output growth measure that was obtained with Approach 3, with missing activity information set to equal 4.

3.5.1. Approach 1

NHSEI indicated that expenditure for health care activity, measured at the level of single currencies and captured by the variable 'total cost' (TC_{jht} for activity type *j*, Trust *h,* and time *t*) in the NCC schedule at the Trust level, should be comparable between 2019/20 and 2018/19 for most of the services. We consider using these cost data via the indirect approach to determine the NHS output growth measure for each NHS setting (see Box 1).

[8] https://digital.nhs.uk/data-and-information/data-tools-and-services/data-services/patient-level-information-and-costing-system-plics-data-collections (last accessed 10/03/2022).

[9] In addition, four Trusts present in the 2019/20 NCC were absent in the 2018/19 collection.

Box 1. NHS settings with comparable NCC data in 2018/19 and 2019/20

- A&E (excl, Ambulance services);
- Community Care;
- Chemo-/Radiotherapy/High Cost Drugs;
- Radiology;
- Rehabilitation;
- Diagnostic Tests;
- Renal Dialysis;
- Specialist services (excl. Cystic Fibrosis);
- Other NHS activity.

Since we need to disentangle price (as measured by the NHS unit costs) changes from volume changes, we need to deflate the expenditure data. To this end, we use the NHS Provider non-pay deflator (π_0).[10] If expenditure data and deflators are available, the Laspeyres output growth index (in this instance using national level data) can be specified as:

$$X_{(0,t)}^{IND} = \frac{\sum_{j=1}^{J} TC_{jt}/\pi_0}{\sum_{j=1}^{J} TC_{j0}} = \frac{\sum_{j=1}^{J} x_{jt}c_{jt}/\pi_0}{\sum_{j=1}^{J} x_{j0}c_{j0}} \approx \frac{\sum_{j=1}^{J} x_{jt}c_{j0}}{\sum_{j=1}^{J} x_{j0}c_{j0}} = X_{(0,t)}^{D} \quad \text{(E9)}$$

where $c_{j0} = c_{jt}/\pi_0$.

The indirect approach should provide equivalent estimates to that obtained using volume data (direct approach), as long as deflators correctly capture the trend in unit costs for each output in question.

First, using NCC Trust level data, for each setting *s* we calculate NHS setting specific Laspeyres output growth indices ($X_{(0,t)}^{IND\_unrest,s}$) using the indirect approach and ignoring in a first instance the issue of missingness of NHS Trusts (unrestricted sample, 'unrest'), as in (E9a).

$$X_{(0,t)}^{IND\_unrest,s} = \frac{\sum_{h=1}^{H}\sum_{j=1}^{J} TC_{jht}/\pi_0}{\sum_{h=1}^{H}\sum_{j=1}^{J} TC_{jh0}} \quad \text{(E9a)}$$

The total number of Trusts (*H*) included in the numerator (financial year 2019/20) and denominator (financial year 2018/19) differs and is equal to 209 and 223 NHS Trusts, respectively.[11]

[10] The provider non-pay deflator is derived from the NHS Cost Inflation Index, which is published as part of the PSSRU Unit Costs of Health and Social Care publication. However, the value used here was taken from a document shared by the Department of Health and Social Care.

[11] Note that the total number of Trusts in the NHS was 227 in 2018/19 and 223 in 2019/20. The decrease is due to one merger and three acquisitions among the Trusts, which were included in the NCC in both years. Therefore, the 14 Trusts missing from the NCC in 2019/20 and the 4 Trusts missing in 2018/19 did not disappear due to mergers or acquisitions, but were excluded from the NCC schedule due to low quality of data provided.

Next, we calculate the setting specific output growth indices for a sub-sample of NHS Trusts ($X_{(0,t)}^{IND\_rest,s}$), namely for those 205[12] NHS Trusts for which we have organisational level NCC data for both 2019/20 and 2018/19 (restricted sample, 'rest'). Hence, the setting specific Laspeyres index calculated via the indirect approach for the restricted sample can be expressed as:

$$X_{(0,t)}^{IND\_rest,s} = \frac{\sum_{h=1}^{H}\sum_{j=1}^{J} TC_{jht}/\pi_0}{\sum_{h=1}^{H}\sum_{j=1}^{J} TC_{jh0}} \quad \text{(E9b)}$$

where H =205.

Finally, for each setting *s*, we calculate the ratio of the indirect Laspeyres output growth indices as the ratio of the indirect Laspeyres output growth index for the restricted sample and the unrestricted sample, as follows:

$$r_s = \frac{X_{(0,t)}^{IND\_rest,s}}{X_{(0,t)}^{IND\_unrest,s}} \quad \text{(E10)}$$

We use this ratio to rescale the Laspeyres output growth index $X_{(0,t)}^{D,s}$, determined with the direct approach using national level NCC data, to obtain an estimated "direct" output growth measure ($X_{(0,t)}^{D\_1,s}$) for NHS Trusts *present in both financial years*:

$$X_{(0,t)}^{D\_1,s} = X_{(0,t)}^{D,s} \times r_s \quad \text{(E11)}$$

3.5.2. Approach 2

This method assumes that the shares (γ_s) in the total value of activity (by NHS setting *s*) of missing NHS Trusts for 2019/20 are equal to their respective shares in the total value of activity for 2018/19. In 2019/20, there were 14 NHS Trusts that were excluded from the NCC schedule due to low quality of data submitted. Using NCC organisational level data, we calculate the shares in the total value of activity for 2018/19 for the 14 missing Trusts and for each setting *s*, using the 'total cost' (TC_{jht}) variable provided in the data, as follows:

$$\gamma_s = \frac{\sum_{h=1}^{14}\sum_{j=1}^{J} TC_{jh0}}{\sum_{h=1}^{H}\sum_{j=1}^{J} TC_{jh0}} \quad \text{(E12)}$$

Here *H* is the total number of Trusts included in the NCC data at time *t* = 0, i.e. 2018/19.

For each setting, we then deduct the setting specific share of the missing Trusts from the total value of activity produced in *t* = 0 as follows:

[12] The restricted sample comprises a total of 205 NHS Trusts, having excluded four NHS Trusts for which we do not have data in 2018/19 and 14 NHS Trusts for which we do not have data in 2019/20.

$$X_{(0,t)}^{D\_2,S} = \frac{\sum_{j=1}^{J} x_{jt} c_{j0}}{(1-\gamma_S)\sum_{j=1}^{J} x_{j0} c_{j0}} = X_{(0,t)}^{D,S} \times \frac{1}{(1-\gamma_S)} \quad \text{(E13)}$$

Similarly, to NHS output growth estimates obtained with Approach 1, Approach 2 will give an estimate of the NHS setting specific and overall output growth indices for NHS Trusts *present in both financial years*. Importantly, Approach 2 does not take into account that four Trusts present in the 2019/20 cost collection are missing from the 2018/19 dataset, and therefore the obtained growth rate is likely to be upward biased. However, the magnitude of the bias may not be substantial as the contribution of the four Trusts missing in 2018/19 to the total value of NHS output is relatively small.

3.5.3. Approach 3 – the preferred method

Similarly, to Approaches 1 and 2, Approach 3 relies on the assumption that the growth for Trusts observed in both years is representative of the NHS as a whole. But instead of making an additional assumption of constant shares of the total value produced, as in Approach 2, we use Trust level NCC data for both 2018/19 and 2019/20 and restrict our analysis to only Trusts present in both years.

However, the NCC Trust level data have activity (and consequently also unit cost) information missing because of the suppression of small numbers by NHS Digital; this means that we will need to impute missing quantities in the Trust-level data. We explore three different values: 1, 4, and 7.[13] In Appendix B, section 10.2, we describe the steps followed to implement this approach and provide the growth estimates by NHS settings obtained using the three values. The choice of value to use to impute missing quantities was based on how well they approximated the total volume of activity reported in the national-level NCC data, and this was equal to 4.

To ensure comparability with the Laspeyres NHS output growth indices estimated using national level data, we use the restricted sample of Trusts and Trust level data, and aggregate it up so that $x'_{jt} = \sum_{h=1}^{H} x_{jht}$ and $c'_{jt} = \frac{\sum_{h=1}^{H} x_{jht} c_{jht}}{\sum_{h=1}^{H} x_{jht}}$. Here *H* = 205 (the total number of NHS Trusts included), for each NHS setting.

The setting specific Laspeyres output growth index then takes the form:

$$X_{(0,t)}^{D\_3,S} = \frac{\sum_{j=1}^{J} x'_{jt} c_{j0}}{\sum_{j=1}^{J} x'_{jt} c_{j0}} \quad \text{(E14)}$$

Here (E14) is our usual NHS output growth index, but limited to the subsample of Trusts *present in both financial years*.

[13] Note that there is no need to impute the missing unit costs for each activity *j* at the Trust level (c_{jht}). After imputing missing quantities x_{jht} , we aggregate the volumes and total costs across Trusts, and derive the unit cost for each *j* dividing overall cost by total volume.

3.5.4. Approach 4

This approach is based on the assumption that the growth in *activity* of Trusts observed in both years is the same as that of the missing Trusts and yields an approximation for the growth rate of *all Trusts*. The Laspeyres output growth index, for each setting *s*, then takes the form (see Appendix B for the full derivation):

$$X_{(0,t)}^{D\_4,s} = \sum_j \frac{x_{jt}^A}{x_{j0}^A} \times \theta_{j0} \qquad \text{(E15)}$$

Here x_j^A is the volume of activity *j* produced by Trusts present in the NCC in respective years, and θ_{j0} is the share of the value of the category *j* in the total value of the services produced in a given setting at time *t* = 0 (base year), in this case, 2018/19.

This method has the main advantage of approximating the setting specific growth index for the whole NHS, rather than for a subsample of Trusts. However, similarly to Approach 3, as it relies on Trust-level NCC data, we need to impute missing quantities in the Trust-level data, and similarly to Approach 2, it does not take into account that four Trusts are missing in 2018/19 NCC.

3.5.5. Choosing the best approach for missing NHS Trusts data

We consider Approaches 2 and 4 to be inferior to both Approaches 1 and 3. Approach 2 is the crudest and does not take into account that four Trusts are missing in 2018/19 and so overestimates the growth rates; but it can still be useful as an upper bound. Approach 4, in addition to that, adds a further assumption that volume growth for each activity type *j* is the same for missing and non-missing Trusts, which has proved not to hold, yielding implausible results for some NHS settings. Approach 1 provides a reasonable estimate, but it uses indirect growth rates to approximate the growth rates for the restricted sample, making an additional assumption that the differences between growth rates for the restricted and unrestricted samples should be the same for indirectly and directly measured output growth.

Therefore, Approach 3 is preferred because it is methodologically the closest to our traditional measure (that is directly measured growth rate with the minimum additional assumptions), with the only caveat of imputing missing values. Further, Approach 3 makes maximum use of the comparable and high-quality data available, i.e. from Trusts with published NCC data for both 2018/19 and 2019/20. We are reassured of the quality of the data submitted by these Trusts, as they have met the rigorous data quality standard set by NHS England and NHS Improvement. Trusts submitting data of insufficient quality are not published as part of the NCC dataset. 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 (> 90%), as reported in section 10.2, in Appendix B.

The NHS setting-specific and the overall NHS growth rates obtained with Approaches 1, 2, and 3 are reported in section 10.3, in Appendix B.

3.5.6. Expected impact of correcting for missing NHS Trusts

In this subsection, we report the expected impact that correcting for missing NHS Trusts in the NCC data has on the uncorrected NHS output growth rates by NHS settings. The issue with missing NHS Trusts data arises mainly for the 2019/20 NCC data, with 14 NHS Trusts excluded from the collection (see section 3.5). However, the 2019/20 NCC data included 4 NHS Trusts which were excluded, for similar reasons, from the 2018/19 collection.

We expect these exclusions to result, on average, in the uncorrected Laspeyres output growth rates being downward-biased. However, the exact distribution of output across Trusts may vary by NHS settings. To gauge the direction of the impact Approach 3 will have on the NHS setting-specific growth rates, we compare the value of output of the 14 NHS Trusts missing in 2019/20 in the total value of NHS output delivered in 2018/19, and the value of output of the four NHS Trusts missing in 2018/19 in the total value of NHS output delivered in 2019/20. In the absence of significant changes in average unit costs, this will provide a reasonable expectation of the direction of change in the growth rates of setting-specific NHS output after implementing our preferred approach for dealing with missing Trust information. Table 2 below shows that corrected growth rates are expected to be higher than the uncorrected ones[14] for all NHS settings, except for Rehabilitation. The magnitude of the difference in shares presented in the table can also be indicative of the absolute difference between corrected and uncorrected growth rates. For example, applying Approach 3 is likely to make the biggest impact on Chemo-/ Radiotherapy and High Cost Drugs setting and the smallest on Rehabilitation.

Table 2: Expected impact of Approach 3 correction of growth rates by NHS setting

NHS Setting	Share of 14 Trusts missing from 2019/20 NCC in 2018/19 total output value	Share of 4 Trusts missing from 2018/19 NCC in 2019/20 total output value	Difference (percentage points)	Expected relationship between corrected and uncorrected growth rate
Community care	6.75%	2.52%	4.23	$X_{(0,t)}^{D\_3,s} > X_{(0,t)}^{D,s}$
Chemo-/Radiotherapy/High Cost Drugs	7.38%	1.62%	5.76	$X_{(0,t)}^{D\_3,s} > X_{(0,t)}^{D,s}$
A&E	6.54%	1.62%	4.92	$X_{(0,t)}^{D\_3,s} > X_{(0,t)}^{D,s}$
Specialist Services	4.58%	1.12%	3.46	$X_{(0,t)}^{D\_3,s} > X_{(0,t)}^{D,s}$
Radiology	6.28%	1.60%	4.68	$X_{(0,t)}^{D\_3,s} > X_{(0,t)}^{D,s}$
Diagnostic Tests	5.78%	2.25%	3.53	$X_{(0,t)}^{D\_3,s} > X_{(0,t)}^{D,s}$
Rehabilitation	1.58%	2.70%	-1.12	$X_{(0,t)}^{D\_3,s} < X_{(0,t)}^{D,s}$
Renal Dialysis	3.79%	1.38%	2.41	$X_{(0,t)}^{D\_3,s} > X_{(0,t)}^{D,s}$
Other	3.45%	1.25%	2.20	$X_{(0,t)}^{D\_3,s} > X_{(0,t)}^{D,s}$

[14] This may imply that after correction the growth rates can change sign from negative to positive.

4. Productivity Growth

Overall NHS productivity growth between 2018/19 and 2019/20, adopting Approach 3 above, was -2.14% when using the mixed measure and -2.11% using the indirect measure.

In Table 3 we present the productivity growth measures, both mixed and indirect, for 2017/18 – 2018/19 and 2018/19 – 2019/20, 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 Appendix A.

Table 3: NHS Productivity Growth[15]

Years	**Mixed**		**Indirect**	
	Baseline (Approach 3)	Not corrected for missing Trusts	Baseline (Approach 3)	Not corrected for missing Trusts
2017/18 – 2018/19	-	-0.80%	-	-0.71%
2018/19 – 2019/20	-2.14%	-3.08%	-2.11%	-3.05%

Based on NHS output growth rates derived using Approach 3, the negative growth in NHS productivity registered in 2019/20 is due to both slower (negative) growth in NHS outputs and a concurrent increase in NHS input growth. The details of changes in both NHS outputs and inputs are shown in Figure 1, indexed to 2004/05 – 2005/06.

Figure 2 presents the cumulative NHS outputs, inputs, and productivity indices over time, using 2004/05 as the index year (year 0). It can be seen from this figure that outputs grew by over 68% between 2004/05 and 2019/20, while inputs grew by about 47%. Productivity growth increased by just over 17% by 2017/18, followed by a decrease in 2018/19, which continued in 2019/20. The figure also shows productivity growth has been relatively stable over time, with an average growth rate of 0.93% per annum (mixed method).

[15] 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.

Figure 1: NHS Output and Input Indices (Mixed Method) 2004/05-05/06 to 2018/19-2019/20

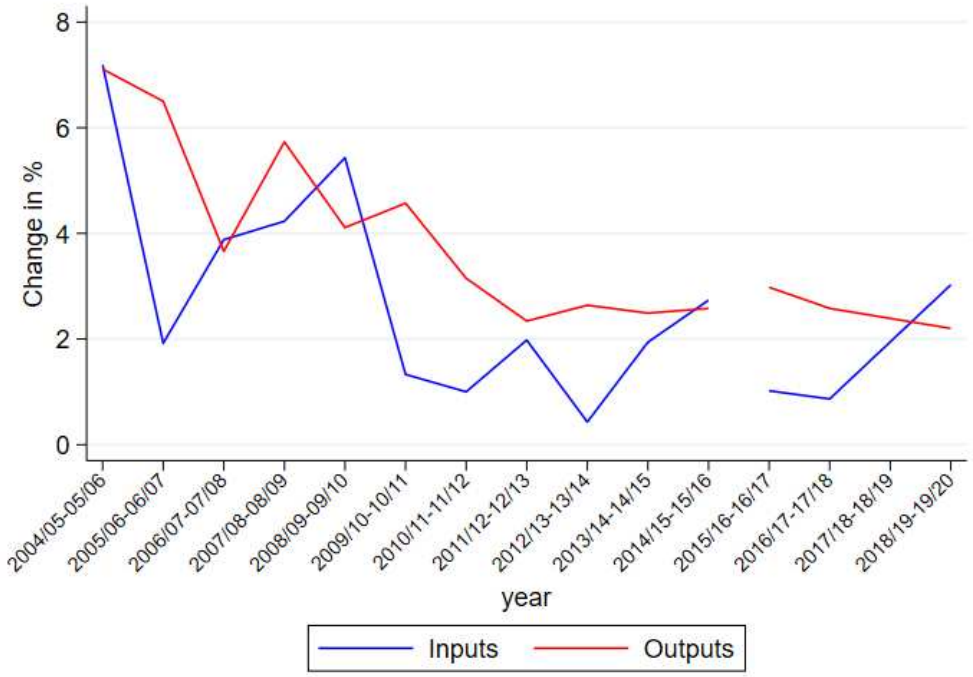
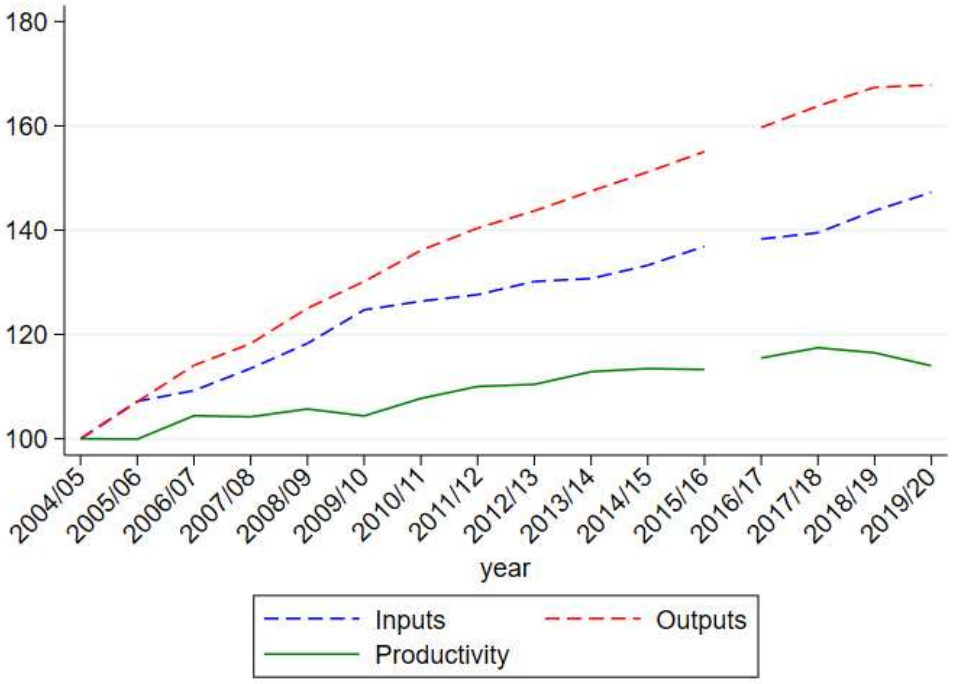


Figure 2: Cumulative NHS Output, Input and Productivity Indices Over Time

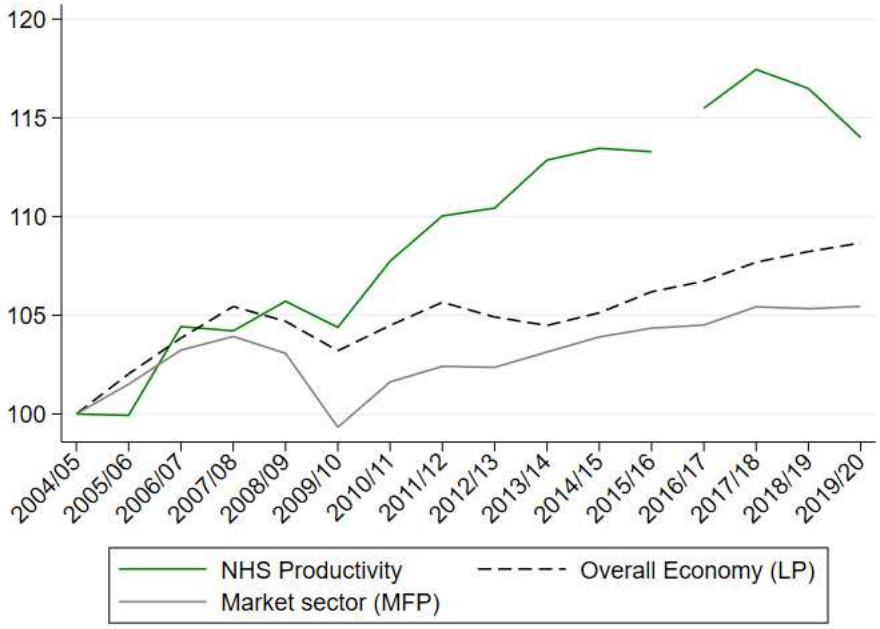


A further and final comparison is that between productivity growth of the NHS and growth of the UK economy as a whole. To measure productivity growth in the wider economy, we employ the Gross Value Added per Hour (LP) measure, a measure of Labour Productivity of the whole economy, and the Multi-Factor 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.[16,17,18]

Figure 3 indicates that NHS productivity growth since 2004/05 is higher than that of the overall economy, as measured by both the LP and MFP indices; however, and unlike both the ONS labour and multi-factor productivity indices, it has been negative since 2018/19.

Figure 3: Cumulative NHS and Whole Economy (LP and MFP) Indices over time



[16] https://webarchive.nationalarchives.gov.uk/20160128204104/http://www.ons.gov.uk/ons/guide-method/method-quality/specific/economy/national-accounts/gva/relationship-gva-and-gdp/gross-value-added-and-gross-domestic-product.html (last accessed 9/03/2022).
[17] https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/labourproductivity/datasets/labourproductivitytables110andr1 (last accessed 9/03/2022).
[18] https://www.ons.gov.uk/economy/economicoutputandproductivity/productivitymeasures/datasets/multifactorproductivityexperimentalestimatesreferencetables (last accessed 9/03/2022).

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 4, the cost-weighted and quality-adjusted output growth measures, both also adjusted for the number of total and working days, for both the direct approach figures, which include the National Cost Collection data as reported by NHS England and NHS Improvement, and the figures obtained with Approach 3.

Our baseline (Approach 3) figures indicate a cost-weighted NHS output growth of 0.38% between 2018/19 and 2019/20. When re-scaling each type of cost-weighted output, where appropriate and feasible, according to changes in survival, health improvements, waiting times, and blood pressure monitoring, we obtain an NHS output growth of 0.25%.

Their respective values, using the NCC data without adjusting for missing Trusts activity, are equal to -0.59% and -0.72% respectively for the cost-weighted and quality-adjusted measures.

Quality adjusting NHS output impacts negatively the overall NHS output growth, which is mainly driven by a decrease in average life expectancy and an increase in long waiting times, which more than outweigh the recorded, albeit small, improvement in survival rate and in patient reported outcome measures (PROMs).

Table 4: Output growth

Years	Cost-weighted Growth (CW)		Quality-adjusted CW growth	
	Baseline (Approach 3)	Not corrected for missing Trusts	Baseline (Approach 3)	Not corrected for missing Trusts
2017/18 – 2018/19	-	1.65%	-	2.20%
2018/19 – 2019/20	0.38%	-0.59%	0.25%	-0.72%

5.1.1. Contribution by settings

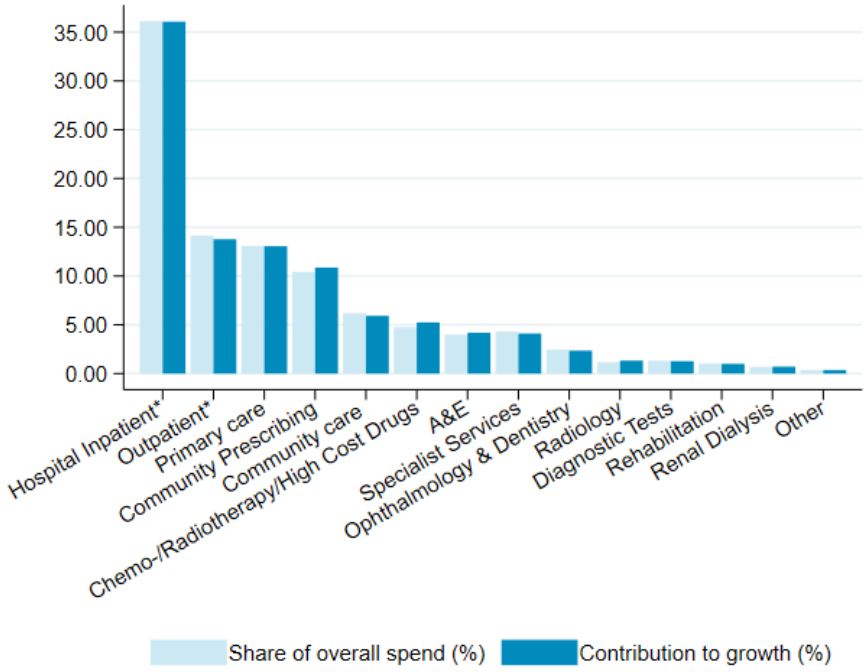
Not all settings contribute equally to the output index. Figure 4 shows the share of overall spend for each of the settings as well as their contribution to growth, calculated as a share of overall spend multiplied by the output growth of the setting, using growth rates obtained when estimating missing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

Table 5 includes more information on the contribution to overall NHS growth by setting, for both the uncorrected growth figures, which include the National Cost Collection data as reported by NHS England and NHS Improvement, and the figures obtained when accounting for missing Trust activity (Approach 3). 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, with the actual direction of impact (and magnitude, see section 3.5.6) depending on the shares of the value of output produced by missing Trusts, in each year. As

previously indicated, we expect that applying Approach 3 is likely to make the biggest positive impact on the Chemo-/Radiotherapy and High Cost Drugs NHS setting and a small and negative impact for Rehabilitation.

Overall, the largest contributor to the output index is Hospital Inpatient activity, with a share of about 36% of both total spend and overall output growth. Other sizeable contributors (in order of overall contribution to output growth) are Outpatient activity, Primary care, 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.

Figure 4: Contribution to output growth by setting, 2019/20



* Hospital Inpatient and Outpatient activity are quality-adjusted.

Table 5: Contribution to overall NHS output growth by NHS setting, 2019/20

Setting	Quality-adjusted CW growth		Setting specific growth index	Value of Activity in 2018/19	Share of overall spend	Contribution to overall growth rate**	
	Baseline (Approach 3)	Not corrected for missing Trusts				Baseline (Approach 3)	Not corrected for missing Trusts
Hospital Inpatient*	-0.15%		99.85%	30,603,153,300	36.13%	36.08%	
Outpatient*	-2.61%		97.39%	11,978,397,000	14.14%	13.77%	
Primary care	-0.05%		99.95%	11,065,429,947	13.06%	13.06%	
Community Prescribing	4.25%		104.25%	8,831,046,458	10.43%	10.87%	
Community care	-4.33%	-8.30%	91.70%	5,241,584,568	6.19%	5.92%	5.67%
Chemo-/Radiotherapy/High Cost Drugs	10.62%	4.56%	104.56%	4,015,115,706	4.74%	5.24%	4.96%
A&E	4.59%	-0.05%	99.95%	3,385,777,357	4.00%	4.18%	4.00%
Specialist Services	- 4.63%	-8.14%	91.86%	3,647,761,230	4.31%	4.11%	3.96%
Ophthalmology & Dentistry	-4.35%		95.65%	2,082,864,679	2.46%	2.35%	
Radiology	14.94%	11.11%	111.11%	978,834,558	1.16%	1.33%	1.28%
Diagnostic Tests	-3.20%	-6.28%	93.72%	1,111,674,647	1.31%	1.27%	1.23%
Rehabilitation	-2.47%	-1.83%	98.17%	869,116,195	1.03%	1.00%	1.01%
Renal Dialysis	3.82%	1.57%	101.57%	578,867,117	0.68%	0.71%	0.69%
Other	-1.07%	-3.41%	96.59%	313,768,464	0.37%	0.37%	0.36%
Total/NHS output growth rate				**84,702,391,225**		**0.25%**	**-0.72%**

* Hospital Inpatient and Outpatient activity are quality-adjusted. ** The contribution of each setting to growth in 2019/20 is expressed as a percentage of the total output in 2018/19. 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 6 presents the growth in inputs for the last two links, 2017/18 – 2018/19 and 2018/19 – 2019/20 using the mixed and indirect methods. The mixed method, our preferred approach, 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 C for more details on the agency deflator). In our baseline input growth figures, we employed the agency deflator.

As appears from Table 6, the mixed and the indirect input growth rates are very similar for the 2018/19 – 2019/20 link.

Table 6: Input growth[19]

Years	All NHS	
	Mixed	**Indirect**
2017/18 – 2018/19	3.03%	2.93%
2018/19 – 2019/20*	2.44%	2.41%

*Indirect growth rate calculated excluding additional employer NHS pension contributions (see section 7.2.2 for details).

A breakdown of contributions to the growth in inputs is presented in Table 7. Similarly, to last year, the growth in inputs was mainly driven by both labour and materials, with primary care also a close contributor.

[19] 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.

Table 7: Contribution to input growth, 2019/20

Input type	Growth rate	Setting specific growth index	Value of Activity in 2018/19	Share of overall spend	Contribution to overall growth rate
Labour (Direct) (Labour - Indirect, excl. agency and bank staff)*	2.54% (2.48%)	102.54% (102.48%)	50,571,789	44.15%	45.27% (45.24%)
Agency**	-	-	-	-	2.11%
Bank**	-	-	-	-	3.22%
Materials	1.22%	101.22%	26,346,637	23.00%	23.28%
Capital	1.96%	101.96%	9,024,653	7.88%	8.03%
Primary care	2.61%	102.61%	13,934,642	12.16%	12.48%
Prescribing	4.50%	104.50%	8,833,869	7.71%	8.06%
Total/NHS input growth rate			**114,556,430**		**2.44% (2.41%)**

* Direct: Labour input measured by FTE counts and national average wages provided in the Electronic Staff Record; Indirect: Labour input measured by expenditure on staff, provided in published Trust financial accounts. Additional employer NHS pension contributions occurring in 2019/20 are excluded (see section 7.2.2 for details). Figures reported use the new NHS Cost Inflation Index agency deflator.

** Information on Agency and Bank staff growth rates and expenditures has been as it is unpublished management information.

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.[20] Table 8 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 8: 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
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.

[20] 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 0.18% between 2018/19 and 2019/20.**
- **Including adjustments for quality leads to a reduction in measured growth to -0.15%.**

Day-case, elective and non-elective hospital inpatient care is calculated from the HES Admitted Patient Care (APC) dataset. Records are at the Finished Consultant Episode (FCE) level, periods of treatment under the same hospital consultant. It includes both physical and mental health inpatient care.[21] In 2019/20, 22.4 million inpatient FCEs are recorded, an increase of 0.6% from 2018/19, similar to the increase reported by NHS Digital.[22] Table 9 presents activity in terms of FCEs across different provider types. In 2019/20, just over 97% of FCEs occurred within Trusts, a very similar rate to 2018/19. Details of a longer time trend can be found in Appendix A.

Table 9: Organisational coverage of HES activity, FCEs

Year	NHS Trusts	Private providers	Other	Total
2017/18	20,826,151	611,745	192	21,438,088
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

Notes: 2018/19* presents figures for this financial year following the translation of code from SAS 9.2 to STATA 17 and minor refinements detailed in section 6.2.1.

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.[23, 24]

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 different activities, we take the cost of elective care also for day-case care in the same HRG. This approach reflects the expectation that appropriately employed day-case care provides the same health benefit as elective care (Bojke et al.,

[21] 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').

[22] https://digital.nhs.uk/data-and-information/publications/statistical/hospital-admitted-patient-care-activity/2018-19 (last accessed 18/01/2021).

[23] https://webarchive.nationalarchives.gov.uk/20180328130852tf_/http:/content.digital.nhs.uk/media/11859/Provider-Spells-Methodology/pdf/Spells_Methodology.pdf (last accessed 26/10/2021).

[24] 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).

2016).[25] 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). In such cases we deflate (inflate) costs in order to impute missing values (Castelli et al., 2011). In 2019/20, there were no changes to the set of HRGs.

As part of the update to growth in the inpatient setting, data cleaning and growth calculation was translated from SAS 9.2 to STATA 17. The process of quality assurance undertaken during the translation and reconsideration of the general approach, lead to some minor refinements, listed below:

1. Observations with an admission method (admimeth) code of 25 "admission via mental health crisis resolution team" were previously dropped as not allocated to elective or non-elective care. In this update, we have treated these observations as non-elective. This change impacts 31,496 observations.
2. At the FCE level, duplicate observations are dropped from the data. A duplicate is an observation where the patient identifier, episode start and end date, episode order identifier and identifier for whether a patient is transferred in from or out to another provider are all the same. In previous updates, a single observation was kept at random. In this update, we refine this approach to keep the single observation which has the highest data quality. Data quality is determined in terms of observations reporting valid values for the main specialty a consultant works in (mainspef), the treatment specialty of the episode (tretspef), the primary procedure (opertn_1), and episode order identifier (epiorder).
3. A bug was observed in the construction of the provider identifier, which had the effect of assuming all care took place within the same provider. While this is unlikely to have a substantive impact on the unit of analysis (CIPS), which includes transfers between providers if they represent continuation of care, this error has been corrected in the STATA code.
4. The approach for imputing life expectancy values when otherwise missing has been refined. In previous updates, when patient age was unknown, life expectancy was calculated from the activity weighted mean age of patients of the same sex, treated within the same HRG with the same activity type (elective/non-elective), and rounded to the year. Where sex was unobserved (11,877 observations between 2018/19 and 2019/20), the observation was dropped. In the present update, for each HRG, where age is observed but sex is not, patients are assumed to have a life expectancy equal to the activity weighted average of male and female patients of the same age for each type of activity (elective and non-elective). Further, where age and sex are both unobserved, the activity weighted life expectancy of all elective (non-elective) patients within the HRG is used.

[25] 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.

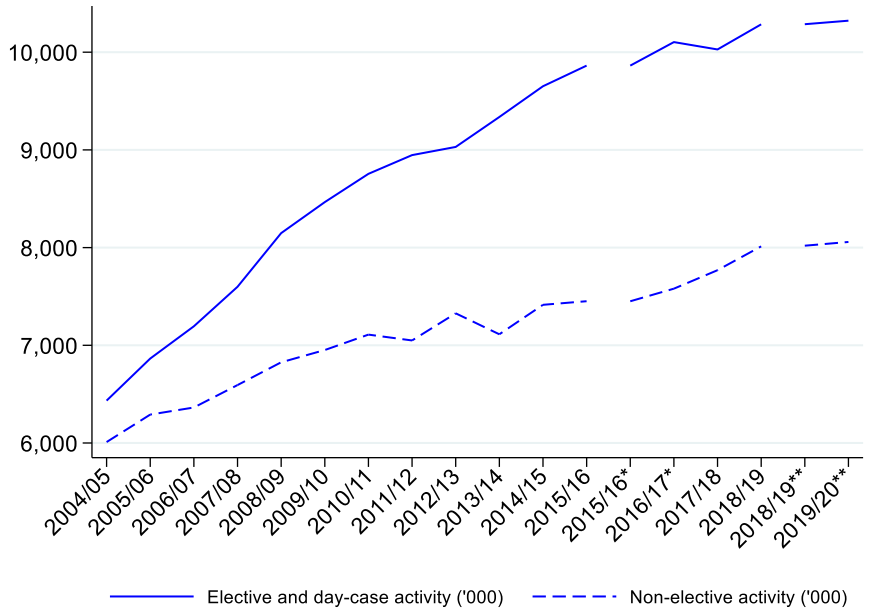
Due to these changes, the hospital inpatient figures presented in Arabadzhyan et al. (2021) for the financial year 2018/19 are not comparable with those included in this report. Therefore, updated figures for 2018/19 are presented throughout the following subsections, wherever they change.

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 -1.57% between 2018/19 and 2019/20. Non-elective physical care Laspeyres output growth was 2.37% over the same period, leading to overall NHS cost-weighted and working days adjusted activity output growth of 0.19%.**
- **Including adjustments for quality leads to a reduction in elective and day-case physical care output growth, equal to -2.30%, but a slight increase in non-elective physical care output growth, equal to 2.55%. Overall, changes in quality indicate a reduction of Laspeyres growth by 0.32 percentage points to -0.13%.**

Between 2018/19 and 2019/20, the volume of day-case, elective and non-elective physical healthcare was essentially flat. Elective and day-case care grew by 0.35% and non-elective care by 0.48%. This contrasts with generally substantial growth between 2004/05 and 2018/19, as shown in Figure 5. Between 2004/05 and 2018/19, day-case and elective care grew by 60% and non-elective care by 33%. Activity information is also presented in Table 10 along with mean costs. It can be seen from this table that the mean cost of elective and non-elective care rose substantially between 2018/19 and 2019/20. From £1,632 to £1,901 (equivalent to a 16.48% growth) for elective care and from £1,693 to £1,852 (equivalent to a 9.39% growth) for non-elective care.

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 section 6.2.1 for details.

Table 10: 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 (£)
2017/18	10,028,398	1,641	7,769,004	1,599
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

* 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 section 6.2.1 for details.

Cost-weighted and working days adjusted Laspeyres output growth for elective and day-case physical care output was -1.57% between 2018/19 and 2019/20. Non-elective output grew by 2.37% over the same period, leading to an overall NHS cost-weighted and working days adjusted activity output growth of 0.19% for inpatient physical care.[26] This represents a very sharp fall in output growth, especially in elective care, compared to previous years. This is likely to be due, at least in part, to the requirement to wind down as much care as possible in March 2020 to prepare for expected demand from patients with COVID-19. In section 6.2.7, we shall explore the impact of the COVID-19 pandemic on inpatient activity in greater detail.

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

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 life tables published annually by ONS.[27]
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:

[26] The cost-weighted output growth for elective and day-cases without the working days adjustment was equal to -1.18% and for non-elective care equal to 2.65%. This gives an overall cost-weighted output growth of 0.53% 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 2018/19 with 2019/20 due to 2020 being a leap year with an extra day.

[27] https://www.ons.gov.uk/releases/nationallifetablesuk2017to2019 (last accessed 26/10/2021).

i. Patient Reported Outcome Measures (PROMs) for all patients undergoing unilateral hip and knee replacement.[28] 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 where no such information is available, 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 11 and Table 12 present average values of the measures for the quality elements for the years 2017/18, 2018/19, and 2019/20. Table 11 highlights that life expectancy has fallen, on average, between 2018/19 and 2019/20 by 0.5 years for day-case and elective care and 0.7 years for non-elective care. This implies treatment of slightly older patients on average but also reflects a slight reduction in life expectancy in the general population between 2018 and 2019 shown in ONS life tables. Survival rates have also fallen slightly, from 97.52% to 97.46% for non-elective care. In contrast, waiting times have fallen slightly from 86 days to 85 days at the 80th percentile. It is important to stress that these values are averages and mask considerable variation in the value of survival rates and waiting times 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 12 indicates an increase in the ratio of pre to post health from hip replacement by 0.05 and knee replacement by 0.04. These are substantive increases, representing reductions in health gain, compared to the value of these measures seen between 2017/18 and 2018/19. However, the impact on overall inpatient growth is limited, as these measures are applied only to elective care for two narrow procedure groups.

Table 11: 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
2017/18	99.94%	22.7	85	97.27%	32.8
2018/19	99.94%	22.7	86	97.52%	32.7
2019/20	99.94%	22.2	85	97.46%	32.0

[28] From 2018/19, PROMs for varicose vein surgery and groin hernia repair were discontinued.

Table 12: Ratio of pre to post health status, based on EQ-5D

Year	Groin hernia repair	Hip replacement	Knee replacement	Varicose vein removal
2017/18	0.74	0.33	0.41	0.88
2018/19	n/a*	0.34	0.40	n/a*
2019/20	n/a*	0.39	0.44	n/a*

* Groin hernia repair and varicose vein removal were discontinued from the PROMs survey in 2018/19.

Including adjustments for quality leads to a further reduction in elective and day-case output growth to -2.30%, but a slight increase in non-elective care growth to 2.55%. Overall, changes in quality indicate a reduction in Laspeyres growth by 0.32% to -0.13% for physical health.[29]

6.2.4. Inpatient mental health

- **The cost-weighted and working days adjusted Laspeyres mental health inpatient output growth measure between 2018/19 and 2019/20 was -1.29%.**
- **After accounting for changes in quality, the total Laspeyres output growth of NHS mental health activity becomes -2.67%.**

Table 13 shows the number of CIPS and average costs for equivalent activity in the years 2017/18 to 2019/20. This highlights that while the absolute change in elective mental health care is small, it is proportionally large at -12.4%. This is less apparent from Figure 6, due to the scale needed to accommodate non-elective care figures. Scale is also key in recognising that the impact of elective mental health care on overall inpatient growth is minimal, due to its much smaller number compared to physical health care or even non-elective mental health care. The higher non-elective mental health care activity reported in the updated 2018/19 figure comes largely from including patients admitted to hospital from a secure mental health unit (admimeth 25, see section 6.2.1 for further details). These observations had previously been dropped.

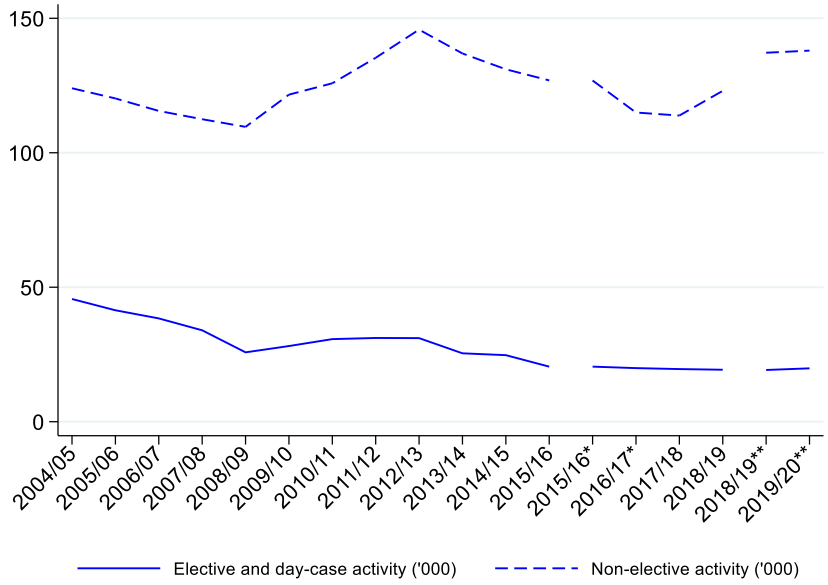
Table 13: CIPS and average cost for inpatient mental health patients

Year	Elective and day-case activity		Non-elective activity	
	# CIPS	Average cost (£)	# CIPS	Average cost (£)
2017/18	19,573	1,440	113,834	1,461
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

* 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 section 6.2.1 for details.

[29] The quality-adjusted Laspeyres output growth measure for hospital inpatient output is equal to 0.21% without the working days adjustment.

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



The cost-weighted and working days adjusted Laspeyres mental health inpatient output growth measure between 2018/19 and 2019/20 was -1.29%.[30] This indicates a larger reduction in activity than for physical health, though the impact on overall inpatient activity is limited by the relative size of physical compared to mental health output. The greater reduction recorded for mental health activity may be due to MH Trusts no longer being mandated to submit data to the HES APC collection.

6.2.5. Inpatient mental health: quality adjustment

Table 14 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 2018/19, survival rates and life expectancy were both lower in 2019/20, though the 80th percentile waiting time was substantially shorter (by 8 days). 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 14: 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
2016/17	98.91%	30.3	59	98.04%	25.1
2017/18	99.29%	30.7	54	98.00%	24.6
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

* 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 section 6.2.1 for details.

[30] The cost-weighted growth in mental health output is equal to -1.00% when not adjusted for working days.

After accounting for changes in quality, the total Laspeyres output growth of NHS mental health activity becomes -2.67%.[31] This represents a substantial impact from quality adjustment at over 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 15 presents growth rates when adjusting solely for cost (cost-adjusted column) and for different combinations of these quality measures.

Overall and/or when considering all physical care, this table shows a strong improvement in growth when considering survival alone or survival and PROMs measures of quality. The impact of survival is particularly strong when considering non-elective physical care. In contrast, output growth is slightly lower for the group of patients treated for mental health conditions when adjusting for survival alone or survival and PROMs.[32] These findings indicate that the small reduction in survival rate on average for day-case, elective and non-elective patients treated for physical conditions, reflects a higher risk case-mix in 2019/20 than in 2018/19.

For all patient groups, quality adjusting for life expectancy indicates lower output growth and this falls further when considering waiting times as well. These are the main drivers of the overall negative quality adjustment, overhauling the improvement seen in survival and PROMs. This reflects, in part, the shorter mean life expectancy observed in Table 11 and Table 14, from a combination of slight reductions in life expectancy in the general population and the treatment of older patients on average in 2019/20. However, these tables also indicate shorter waiting times in 2019/20 than in 2018/19. The further reduction in quality-adjusted output growth after adjusting for waiting times may reflect a concentration of the most urgent cases in HRGs with shorter waiting times in 2019/20.

Taken together, Table 11, Table 14, and Table 15 indicate patient case-mix in 2019/20 was more severe on average than in 2018/19. This might be expected from the need to wind down care as much as possible in March of 2020 in preparation for demand from COVID-19 patients since less severe and urgent cases can be expected to be easier to postpone while minimising the impact on patient welfare. The early impact of COVID-19 is considered in greater detail in section 6.2.7.

[31] The quality-adjusted mental health Laspeyres output growth rate is equal to -2.39%, when not adjusted for the number of working days.

[32] A positive survival ratio is magnified when also adjusting for PROMs even when the PROMs adjustment itself does not change over time, as in the case of non-elective care where the change in health status before and after treatment is fixed at 0.4. This arises because the PROMs adjustment deducts the ratio of pre and post procedure health from the survival rate. For example, a survival rate increasing from 0.45 to 0.5 (survival ratio = 1.11) becomes a PROMs adjusted survival rate growing from 0.05 to 0.1 (survival + PROMs ratio = 2).

Table 15: Quality adjustment breakdown with working day/total day adjustment 2018/19 – 2019/20

	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)	0.182%	-0.151%	0.374%	0.583%	-0.485%	-0.523%
Physical Inpatient (all)	0.193%	-0.131%	0.387%	0.598%	-0.469%	-0.507%
Physical Inpatient (Elective)	-1.567%	-2.296%	-1.454%	-1.329%	-2.408%	-2.477%
Physical Inpatient (Non-Elective)	2.369%	2.546%	2.665%	2.981%	1.928%	1.928%
Mental Health Inpatient (all)	-1.286%	-2.665%	-1.326%	-1.390%	-2.564%	-2.567%

6.2.7. Impact of the COVID-19 pandemic on hospital inpatient activity

As noted in section 2, the response to expectations of COVID-19 increasing demand for hospital care in England had a major impact on care provision in March of 2020, when hospitals were asked to wind down as much care as possible, especially elective care. It is also possible that some winding down had already begun before March, in anticipation of a later need for capacity. We measure productivity growth for a series of sub-year periods in order to provide a tentative estimate of the impact of COVID-19 on measured output growth in the inpatient setting. Specifically, comparing April 2018 – February 2019 with April 2019 – February 2020, March 2019 with March 2020, April – December 2018 with April – December 2019 and January – March 2019 with January – March 2020.

In calculating output levels and so growth in the inpatient setting for periods of time within a financial year, only observations within the period concerned were used. An observation was allocated to a period of time based on the date of admission, so that periods of time are mutually exclusive. The key advantage of this approach is that activity occurring outside of the period of time concerned does not indirectly contaminate the calculation of output within them. Within the methodology for calculating productivity growth, this impacts

1. **Imputation of missing values:** When activity occurs with no associated cost in either year being considered, a weighted average unit cost is calculated with observed activity and their associated unit costs to impute missing values. When applied to a sub-year period such as April – February, only activity occurring in the specific period is considered. That is, activity from March is not included in calculating the imputed value for the April – February period, and vice versa.
2. **Quality adjustment:** When calculating quality in terms of survival and other measures, only activity occurring within the specific period is included.
3. **Total and working days adjustment:** When adjusting output for working days, only days falling in the specific period are used instead of the full year.

Points one and two are most impactful when activity is relatively rare or strongly seasonal, and so may not occur in all months. Point three impacts all elective activity as differences in working days centre around Easter in March/April. Total day adjustment also has an impact when considering April – December and January – March, as the additional leap year day occurs in February.

Table 16 presents cost-weighted and working day adjusted and cost-weighted, quality and working days adjusted growth in inpatient care overall for the four sub-year periods described above, plus growth for the full year (April – March) for comparison. It highlights a dramatic difference in growth rates between April – February and March alone. From +1.96% to -22.56% for cost-weighted, quality and working day adjusted growth. This coincides with the winding down of activity, especially elective and day care, in March of 2020. The difference when considering the periods April – December and January-March is much smaller but still substantial (+2.14% compared to -6.04%). This suggests winding down was concentrated within the month of March.

Table 16: Inpatient growth by time period 2018/19 – 2019/20

	Time period				
	April-Feb 2018/19 – 2019/20	March 2018/19 – 2019/20	April-Dec 2018/19 – 2019/20	Jan-March 2018/19 – 2019/20	April-March 2018/19 – 2019/20
Cost-weighted & working days adjusted	2.10%	-20.58%	2.14%	-4.75%	0.19%
Cost-weighted, quality & working days adjusted	1.96%	-22.56%	2.14%	-6.04%	-0.15

6.3. HES outpatient data

- **The cost-weighted and working days adjusted Laspeyres output growth measure for outpatient activity between 2018/19 and 2019/20 was -2.59%.**
- **After adjusting for waiting times, the Laspeyres output growth measure between 2018/19 and 2019/20 was -2.61%.**

Outpatient activity can be derived from two sources. The HES Outpatient (OP) dataset and the National Cost Collection (NCC) data (previously known as the National Reference Cost data). In this section, we present information from the HES OP dataset, our preferred source. Specifically, we combine activity data from the HES OP dataset with unit costs from the NCC dataset. Activity in HES and NCC data are not directly comparable due to different recording methods. We have summarised the main differences between the two sources of outpatient data, as well as the costing method applied, in Castelli et al. (2019), Castelli et al. (2018).

In this report, we have refined the methodology in identifying outpatient attendances, and corrected for a coding bug, which resulted in retaining some non-attended appointments as activity. Therefore, activity is not comparable with that of earlier years. Table 17 includes two figures for 2018/19, calculated with the old (first row) and new (second row) methodology. As this change impacts the observations included, observed mean and 80th percentile waiting times, used in quality adjustment have also changed equivalently.

Table 17 shows outpatient activity increased modestly, by 0.03%, between 2018/19 and 2019/20. The mean cost of care also increased, by 4.1%, between 2018/19 and 2019/20. Figure 7 highlights that growth in activity between 2018/19 and 2019/20 was slower than in most previous years from 2012/13. This may reflect, in part, a reduction in outpatient activity in response to the COVID-19 pandemic during March 2020. Therefore, in section 6.3.2, we shall explore the impact of the COVID-19 pandemic on outpatient activity in greater detail.

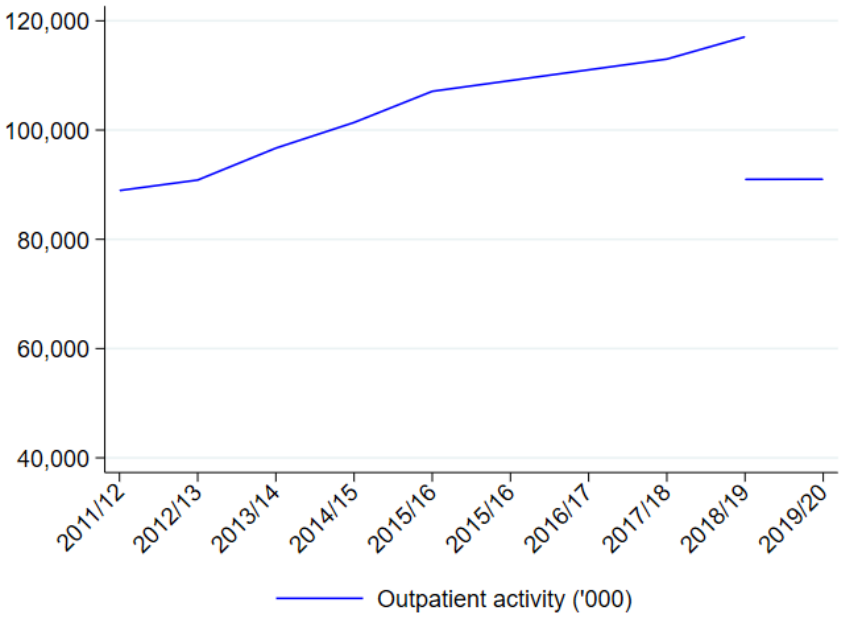
Despite the upward trending growth in absolute volumes of outpatient activity, the cost-weighted Laspeyres growth in outpatient activity amounted to -2.20% before working day adjustment and -2.59% after this adjustment. This implies a shift in the distribution of outpatient activity towards relatively less costly categories in 2019/20 compared to 2018/19.

Table 17: HES outpatient volume and average cost over time

Year	HES Outpatient Activity	
	Volume	Average cost (£)
2017/18	112,986,081	127.27
2018/19	117,066,614	132.67
2018/19*	90,972,391	131.67
2019/20*	91,004,047	137.11

* 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.

Figure 7: Trends in HES outpatient activity, 2011/12 – 2019/20



6.3.1. HES outpatient: quality adjustment

Similarly to the hospital inpatient setting, we adjust outpatient activity for the 80th percentile of waiting times. As waiting time is calculated from observed outpatient activity and the methodology used to obtain this information changed in the current update, summary statistics for waiting times in 2018/19 have been recalculated equivalently to 2019/20.[33] Between 2018/19 and 2019/20, mean waits increased by 3 days (from 45 to 48) and 80th percentile waiting time by 5 days (from 63 to 68). Mean and 80th percentile waiting times are presented in Table 18. These descriptive statistics are an activity weighted average of waiting times among all forms of outpatient activity. As such, the considerable variation in waits for different outpatient activity is better represented in calculating quality adjustment. After adjusting for waiting times, growth in outpatient activity was lower (by 0.02 percentage points) at -2.61%.[34,35] The relatively small impact of the observed change in waiting time is due to the fact that waiting times were discounted and already at a relatively high level in 2018/19.

Table 18: Mean and 80th percentile outpatient waiting times

Year	Mean	80th Percentile
2017/18	48	68
2018/19	50	71
2018/19*	45	63
2019/20*	48	68

* 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 section 6.3 paragraph 2 for details.

[33] Using the updated code, mean waiting times in 2017/18 are 44 and the 80th percentile is 62 days.
[34] The quality-adjusted growth of outpatient activity is equal to -2.22% when not adjusted for working days.
[35] Using the updated code described earlier in this section, cost-weighted quality and working day adjusted growth in the outpatient setting between 2017/18 and 2018/19 is 3.81%, compared to 4.10% reported in Arabadzhyan et al (2021).

6.3.2. Impact of the COVID-19 pandemic on hospital outpatient activity

In order to provide a tentative indication of the impact of the COVID-19 pandemic, Table 19 presents a breakdown of growth rates between April 2018 – February 2019 and April 2019-February 2020; March 2019 and March 2020; and April – December 2018 and April – December 2019; January – March 2019 and January – March 2022. This highlights a dramatic drop in cost-weighted outpatient output growth when comparing March 2019 with March 2020 and a still substantial but smaller impact when considering comparing January – March 2019 with January – March 2022. This is what might be expected, as output growth is based on volumes of activity, and hospitals were asked to postpone care as much as possible for at least three months in the latter part of March 2020.

In calculating this breakdown, only observations in the relevant periods were included. Therefore, as well as volumes being taken from specific periods of the year, waiting times adjustment is based on observations in the same sub-year period and working day adjustment is based on a count of working days in the sub-year periods considered. As such, it is not possible to reconstruct precisely the overall growth rate from combining sub-year periods.

Table 19: Breakdown of growth rates over time 2018/19 – 2019/20

	Time period				
	April-Feb 2018/19 – 2019/20	March 2018/19 – 2019/20	April-Dec 2018/19 – 2019/20	Jan-March 2018/19 – 2019/20	April-March 2018/19 – 2019/20
Cost-weighted & working days adjusted	-0.82%	-21.13%	-2.47%	-6.00%	-2.59%
Cost-weighted, quality & working days adjusted	-0.84%	-21..14%	-2.49%	-6.02%	-2.61%

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 and outpatient departments. NCC data are checked for both accuracy and activity coverage.

As mentioned in section 3.5, the NCC data for 2019/20 present a number of issues of comparability with previous years data, which resulted in the recommendation by NHS England and NHS Improvement that the following healthcare services should ideally not be compared:

- High Cost Drugs;
- (Community) Mental Health;
- Audiology;
- Community Health Services (captured in the 'Community Care' setting);
- Ambulance services;
- Cystic Fibrosis.[36]

In the remainder of this section, first we summarise the main issues with the 2019/20 NCC data, which were either flagged up by NHSEI or detected in our data manipulation stage. In section 6.4.2, we present the results of our internal data quality checks. In section 6.4.3, we report 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 missing Trusts

6.4.1. Summary of issues with the 2019/20 NCC data

<u>High Cost Drugs</u>

Up until 2018/19, the main schedule for High Cost Drugs reported volumes and total costs for each high cost drug (currency code) by service type (Admitted Patient Care, Outpatient, Other); in the 2019/20 NCC data the split by service type is no longer provided. This is not, however, an issue as we are able to aggregate high cost drugs across service types for each currency code for the 2018/19 NCC data, thus matching the level of aggregation of the data in 2019/20. A further change present in the 2019/20 NCC data was a re-coding for a great number of high cost drugs, whilst the actual type of drugs, as appeared from their currency description, was the same. We, therefore, decided to match the high cost drugs affected through their currency descriptions and assigned new codes (from the 2019/20 NCC data) to

[36] Although High Cost Drugs and Community Health Services were flagged up as not comparable between 2018/19 and 2019/20 by NHSEI, our data analysis and quality assurance process do not flag these up as a group of services with substantial differences in volumes and values of activity between 2019/20 and 2018/19. Therefore, we have decided to keep these two settings in our calculations of the overall NHS output growth measure.

the affected high costs drugs in 2018/19. Both solutions have allowed us to keep High Cost Drugs in this year's NHS output growth measure.

Community Mental Health

Community Mental Health data have been completely overhauled in 2019/20, with the most recent NCC mental health data largely based on PLICS (Patient Level Information and Costing System), although some providers submitted the data in the old format (see p.10 in NHS England & NHS Improvement (2021)). Since PLICS is not costing activity in the same way, direct year-to-year comparisons are not possible even for total quanta. For this reason, the Mental Health setting is omitted from our 2019/20 growth estimates.

Audiology ('Other NHS' setting)

In 2019/20, some audiological services, captured by HRG codes 'CA37* – CA43*',[37] are recorded in a dedicated schedule; the same HRGs were included in previous years in the elective inpatient, day-case, and outpatient procedures schedules, respectively.[38] Since our productivity measure relies on HES (APC and OP) data when evaluating inpatient and outpatient output growth, we exclude the above audiological services from our analysis.[39] All remaining audiological services reported in the NCC dataset are not affected, and continue to be included in the Audiology group within the 'Other NHS' setting of our NHS output growth measure.

Ambulance services (A&E setting)

NHSEI reports that ambulance activity previously reported under the 'Calls' category is no longer collected. It has been replaced by the 'Other' category, and these two categories capture different types of activity and are therefore not comparable (see p.11 in NHS England & NHS Improvement (2021)). In addition, NHSEI suggested that all the other categories, although reported, are not directly comparable anymore. Thus, when calculating both the A&E setting output and overall NHS output growth measures, we exclude all ambulance activity for 2018/19 and 2019/20.

A&E services (A&E setting)

A&E activity delivered in 24-h Emergency departments and Other A&E departments has also been recorded differently in 2019/20, with activity being now split into three types: 'leading to admitted (AD)', 'not leading to admitted (NAD)', and 'unknown'. This is due to a change in the data source (HES), rather than in the type and total volumes of activity reported, which up to 2018/19 were provided directly by NHS Trusts to NHSEI for the NCC data collection purposes. It is our understanding that the 'unknown' activity was previously reported under both A&E activity 'leading to admitted (AD)' and 'not leading to admitted (NAD)'; therefore, the total volume of A&E activity by Emergency departments should still be comparable to those reported in previous years, whilst totals by activity type are no longer comparable to those reported in previous years. Therefore, we keep the 'unknown' A&E activity in the A&E

[37] For details on activity recorded under excluded codes see the National schedule of NHS costs (last accessed 14/03/2022).
[38] Directly Accessed Diagnostic Services also included activity under these codes in the years prior to 2019/20, and were possibly re-categorised as well. For this reason, we exclude these codes from DADS activity for 2018/19 too when calculating the Diagnostic Tests setting growth estimates.
[39] Please note that excluding audiological services, captured by HRG codes CA37* – CA43*, affects the outpatient growth rate as presented in section 6.4.3.1.

setting output growth measure, by imputing missing unit costs (for 2018/19) information through the imputation method (Castelli et al., 2011).

Cystic Fibrosis (Specialist services setting)

In 2019/20, Cystic Fibrosis activity, which is captured in our 'Specialist services' setting, is no longer reported as a separate activity within the NCC data, but is now accounted for under HRG codes PD13* and DZ13* across both inpatient and RDNA (Regular Day and Night Attendances) healthcare settings. We, therefore, excluded activity recorded under Cystic Fibrosis and PD13* and DZ13* currency codes[40] when calculating setting specific and overall NHS output growth rates.

All remaining activity have been recorded consistently or with reconcilable re-categorisations across the last two financial years and as such can be considered comparable.

6.4.2. 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).

We also implement 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 2019/20 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 cost guidance publication.[41]

[40] For details on activity recorded under excluded codes see the National schedule of NHS costs (last accessed 14/03/2022).
[41] The most recent HRG4+ Reference Cost Grouper Roots file can be found at https://digital.nhs.uk/services/national-casemix-office/downloads-groupers-and-tools/costing---hrg4-2018-19-reference-costs-grouper (last accessed 3/02/2022), and NCC guidance can be found at https://www.england.nhs.uk/publication/approved-costing-guidance-2021-integrated-prescribed-guidance-and-tools/ (last accessed 09/02/2022).

- **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 the large change in either volume or value of activity.

Our quality checks identified the following new activity, i.e. activity not previously reported in the NCC data, and hence these were excluded[42] from the NHS setting-specific and overall NHS output growth measures:

- IVF* codes in the High Cost Drugs setting,
- DIM* and ODT* codes in the Radiology setting.

Further, our quality checks picked up large value changes mainly for healthcare services mentioned at the beginning of section 6.4. However, we were also able to identify a few large value/volume changes for the following activity:

- PHCD00050 (Factor VIII inhibitor bypassing factor), PHCD00069 (Adalimumab) and PHCD00210 (Alemtuzumab) drugs in the High Cost Drugs NHS sub-setting;
- RD40Z (Ultrasound Scan with duration of less than 20 minutes, without Contrast) code, specifically for outpatient activity, in the Radiology NHS setting;
- DCF10 (Stroke Patients) code, which falls in our Day Care Facilities NHS sub-setting.

In the next subsections, we will provide sensitivity analyses to check how growth rates are affected when excluding these activities.

It is worth noting that negative changes in the volumes of activity can also be a result of the lower number of NHS Trusts that have been included in the 2019/20 NCC dataset. In 2018/19, 223 out of 227 NHS Trusts were included in the NCC data, whilst in 2019/20 this number reduced to 209 out of 223.[43] Missing NHS Trusts' activity will certainly result in an underestimation 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 a lower bound of NHS output growth.

Finally, it is also worth noting that decreases in activity may be driven by the impact of restrictions due to the COVID-19 pandemic, which may have affected the final month of the 2019/20 financial year. However, since the NCC data are not available on a monthly basis, we are not able to evaluate this impact.

6.4.3. 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 section 9.3, in Appendix A.

Between 2018/19 and 2019/20, the working / total days adjusted Laspeyres output growth for NHS activity as captured by the NCC data was -3.05%, if the outpatient setting is included, and -2.69% otherwise. The negative growth, however, masks a more varied picture across the

[42] For details on activity recorded under excluded codes see the National schedule of NHS costs (last accessed 14/03/2022).
[43] The difference in the total number of NHS Trusts between 2018/19 and 2019/20 is due to three mergers and one acquisition; however, these reorganisations happened between Trusts which have been included in the NCC data in both years.

settings covered by the NCC data, as shown in the remainder of this section, where each of the settings is explored in further detail.

6.4.3.1. Outpatient activity

- **Between 2018/19 and 2019/20, the cost-weighted and working days adjusted Laspeyres outpatient output growth measure, not corrected for missing Trusts, was -3.87%.**[44]

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 have remained fairly stable since 2015/16, with consultant-led activity for Trusts in 2019/20 representing 60% of overall outpatient activity, non-consultant-led 25%, and outpatient procedures 15%.

Note that when calculating growth rates, all 'CA37* – CA43*'activities were excluded from this setting, due to the changes in recording some of the audiological healthcare activity as described in section 6.4.1.

Table 20: Outpatient activity and cost

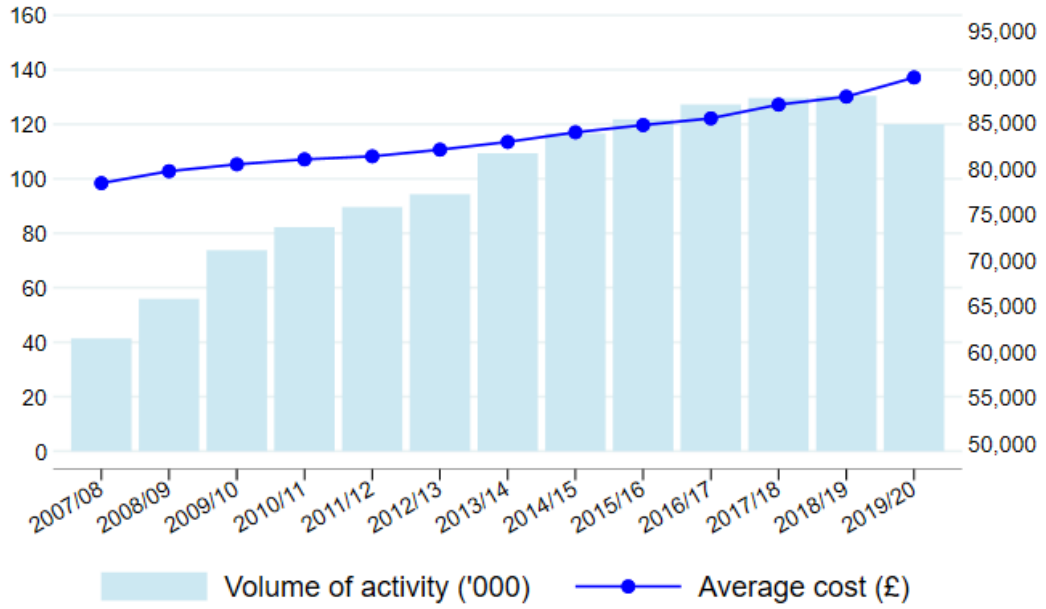
Year	Outpatient	
	Volume of activity	Average cost (£)
2017/18	87,714,235	127
2018/19	87,944,919	130
2019/20	84,849,738	137

The working days adjusted Laspeyres output growth measure for outpatient activity, as captured by the NCC data, was -3.87% between 2018/19 and 2019/20, a decrease of 3.98 percentage points compared to 2017/18 – 2018/19.

Figure 8 shows trends in outpatient activity (right-hand side axis) and average unit costs (left-hand side axis), since 2007/08. Outpatient activity and average unit costs, as captured by the NCC data, have been increasing steadily since 2007/08, with 2019/20 being the first year when a decrease in volumes has been recorded. Average unit costs continue the upward trend.

[44] The baseline (Approach 3) Laspeyres output growth rate for Outpatient setting is 0.33%.

Figure 8: Trends in Outpatient activity (right axis) and average costs (left axis), 2007/08 – 2019/20



6.4.3.2. A&E and ambulance services

- **Between 2018/19 and 2019/20, the cost-weighted total days adjusted Laspeyres output growth measure for A&E services, excluding Ambulance services, and not corrected for missing Trusts, was -0.05%.[45]**

Table 21 reports summary statistics for A&E and Ambulance services. A&E services are provided in both Emergency Departments (EDs) and 'Other A&E' departments.[46] 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).

[45] The baseline (Approach 3) cost-weighted total days adjusted Laspeyres output growth rate is equal to 4.59%.
[46] 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 https://digital.nhs.uk/binaries/content/assets/website-assets/data-and-information/data-tools-and-services/data-services/hospital-episode-statistics/hes-data-dictionary/dd-ae_v12.pdf, p.15 (last accessed 30/11/2020).

Table 21: A&E and Ambulance services activity and average cost

Sub-setting		2017/18		2018/19		2019/20	
		Volume of activity	Average cost (£)	Volume of activity	Average cost (£)	Volume of activity	Average cost (£)
Emergency Departments	AD	4,313,593	247	3,738,454	263	2,911,499	314
	NAD	11,100,308	164	12,215,524	171	10,238,989	185
	Unknown	-	-	-	-	2,317,415	206
	Total	15,413,901		15,953,978		15,467,903	
Other A&E services	AD	280,645	69	48,101	116	93,774	170
	NAD	4,255,912	67	4,388,481	72	3,834,871	76
	Unknown	-	-	-	-	603,672	81
	Total	4,536,557		4,436,582		4,532,317	
Ambulance services	Calls	10,995,578	7	10,039,191	7	-	-
	Hear and treat/refer	886,175	37	799,332	47	950,906	52
	See and treat/refer	2,459,394	192	2,480,819	209	2,705,547	206
	See and treat & convey	5,325,368	252	5,421,377	257	5,362,217	292
	Other	-	-	-	-	1,778,309	70

The total number of emergency department attendances reverted the positive trend and showed a decline of -3.05% between 2018/19 and 2019/20, compared to the 3.5% increase recorded in 2018/19. Due to the re-categorisation within ED visits, we can no longer compare the trend in emergency activity leading to admitted care and that for patients non-admitted, but we note that for both of them the unit costs continue to rise.

In contrast, 'Other A&E services' activity has increased by 2.16%, reversing the negative trend of previous years (between 2017/18 and 2018/19 a 2.2% decrease was observed). 'Other A&E services' have undergone a re-categorisation similar to ED visits, so any comparison across years needs to be taken with a pinch of salt; however, it is noteworthy that A&E attendances subsequently leading to admitted patient care almost doubled compared to the previous year.[47] Similarly to the 24-h Emergency departments, average unit costs continue the increasing trend.

[47] Note that the total number of attendances to 'Other A&E services' leading to AD care is small compared to other sub-categories of A&E services.

Finally, it is noteworthy that as attendances at emergency departments have decreased, activity in 'Other A&E services' has gone up, which may be an indication of a shift of certain types of A&E attendees to the smaller A&E departments.

Overall, the total volume of A&E activity decreased by 1.91% between the two most recent financial years.

As mentioned in section 6.4, in the 2019/20 NCC data Ambulance services have been overhauled and the category 'Calls' is no longer reported as an independent activity type; instead, 'Other' activity type has been introduced, which is not, however, comparable to the previously produced 'Calls' category. In addition, NHSEI suggested that all the other categories, although reported, are not directly comparable anymore. Thus, all Ambulance activity is excluded from the NHS A&E setting-specific and overall NHS output growth rates' calculations.

Keeping this in mind, we note that the 'Hear and treat or refer' and the 'See and treat or refer' categories have shown substantial activity growth, at 18.96% and 9.06% respectively; while the 'See and treat and convey' category activity decreased by 1.09% between 2018/19 and 2019/20.

Due to the comparability issues discussed above, in presenting the long-term trends in volumes of activity and unit costs for A&E and Ambulance services we do not include the most recent 2019/20 financial year. Figure 9 to Figure 12 show trends in activity and their respective average unit costs by type of A&E department from 2007/08 and for Ambulance services from 2011/12. Whilst volumes of A&E activity by type of A&E department are roughly stable over time, an increase is detected in their average unit costs, whether or not these lead to admitted hospital care. Average unit costs for 'Other A&E services' leading to admitted care show some volatility over time, whilst those not leading to admitted care show a moderate increase over time.

Figure 9: Trends of A&E activity (right axis) and related average unit costs (left axis) in ED departments, separately for AD and NAD, 2007/08 – 2018/19

Figure 10: Trends of 'Other A&E services' activity (right axis) and related average unit costs (left axis), separately for AD and NAD, 2007/08 – 2018/19

Figure 11: Volume trends (right axis) in Ambulance services and average unit costs (left axis), separately for 'Calls' and 'Hear and treat or refer' 2011/12 – 2018/19

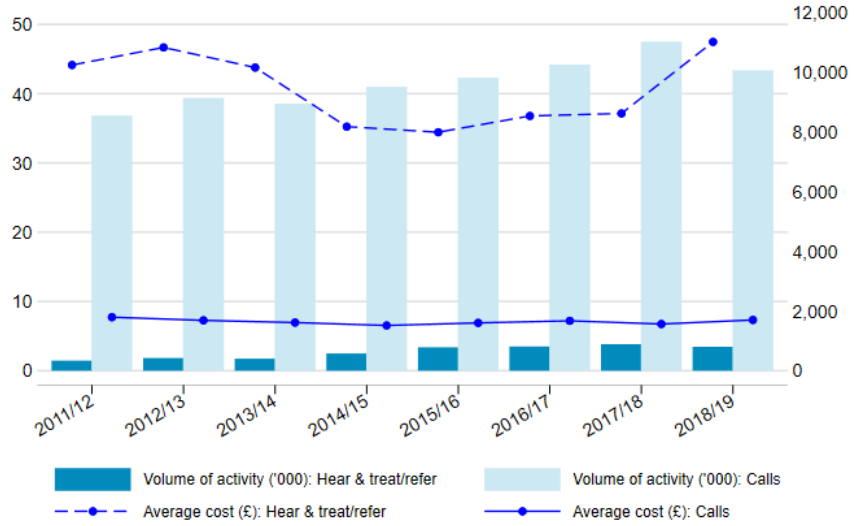
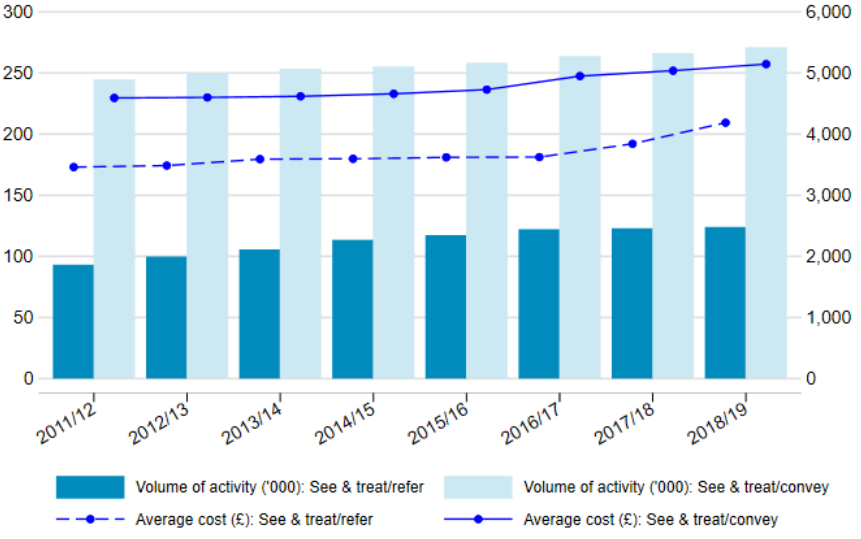


Figure 12: Volume trends (right axis) in Ambulance services and average unit costs (left axis), separately for 'See and treat or refer' and 'See and treat and convey' 2011/12 – 2018/19



6.4.3.3. Chemotherapy, Radiotherapy & High Cost Drugs

- **Between 2018/19 and 2019/20, the cost-weighted and working days adjusted Laspeyres output growth measure for Chemotherapy, Radiotherapy & High Cost Drugs, not corrected for missing Trusts, was 4.56%.[48]**

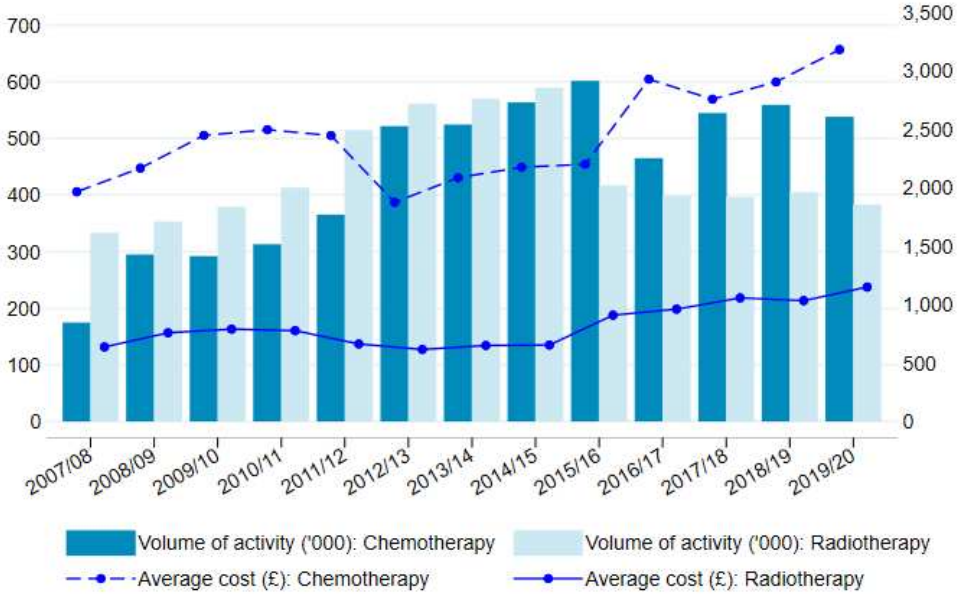
Chemotherapy and Radiotherapy showed similar trends in 2019/20, with both types of healthcare services experiencing a drop in activity by -3.76% and -5.44%, respectively, having had positive growth in 2018/19 (2.6% and 2.14%, respectively for Chemotherapy and Radiotherapy). High Cost Drugs, in contrast, reverted from a negative activity growth of -3.12% to a substantial increase of 12.79% (see Table 22).

Table 22: Chemotherapy, Radiotherapy, High Cost Drugs

Setting	2017/18		2018/19		2019/20	
	Volume of activity	Average cost (£)	Volume of activity	Average cost (£)	Volume of activity	Average cost (£)
Chemotherapy	2,639,406	569	2,707,943	600	2,606,064	657
Radiotherapy	1,921,222	218	1,962,279	213	1,855,549	238
High Cost Drugs	2,557,373	828	2,477,645	799	2,774,471	756

The categories used to describe Chemotherapy, Radiotherapy, and High Cost Drugs have been subject to substantial revisions over time, which explains some of the variation in trends shown in Figure 13 and Figure 14.

Figure 13: Trends in Chemotherapy and Radiotherapy activity (right axis) and average costs (left axis), 2007/08 – 2019/20



[48] The baseline (Approach 3) cost-weighted and working days adjusted Laspeyres output growth measure for this setting is 10.62%.

Figure 14: Trends in High Cost Drugs activity (right axis) and average costs (left axis), 2007/08 – 2019/20

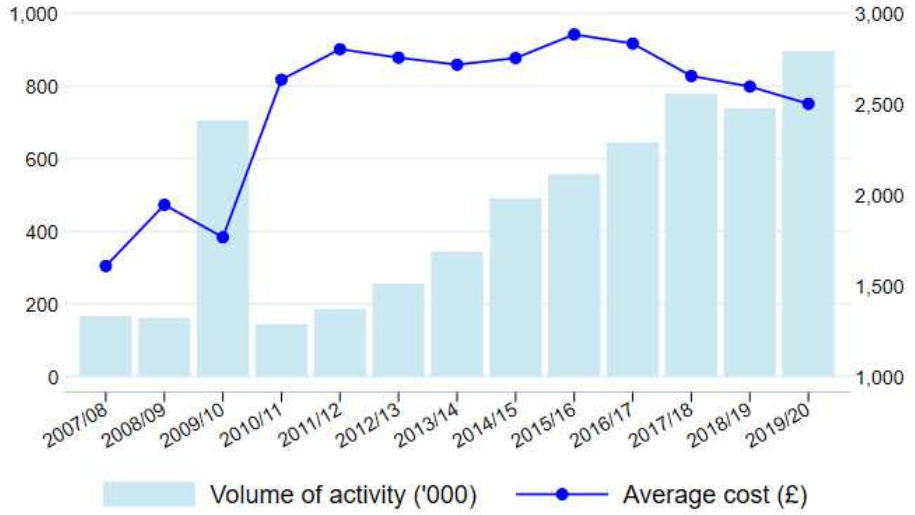


Table 23 reports the contribution to the 2019/20 growth rate of this NHS setting of each of these sub-settings.

Table 23: 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 2018/19	Share of overall spend	Contribution to overall growth rate
Chemotherapy	0.14%	100.14%	£1,624,061,199	40.45%	40.51%
Radiotherapy	-1.29%	98.71%	£418,449,913	10.42%	10.29%
High Cost Drugs	9.45%	109.45%	£1,972,604,594	49.13%	53.77%
Total/overall growth rate			**£4,015,115,706**		**4.56%**

Note: Individual Laspeyres growth rates are adjusted for working days. IVF* codes were excluded from the HCD sub-setting as a new type of activity not previously recorded elsewhere.

We performed a sensitivity check to ascertain whether the substantial increase in the Laspeyres output growth measure is driven by the three high cost drugs flagged up in our quality checks (see section 6.4.2): excluding these drugs from the calculations of the Laspeyres output growth measure changes only marginally the working days adjusted growth rate of this setting to 4.51%.

6.4.3.4. Community care

- **Between 2018/19 and 2019/20, the cost-weighted and working days adjusted Laspeyres output growth measure for Community care activity, not corrected for missing Trusts, was -8.30%.**[49]

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

[49] The baseline (Approach 3) cost-weighted and working days adjusted Laspeyres output growth for Community Care is -4.33%.

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.

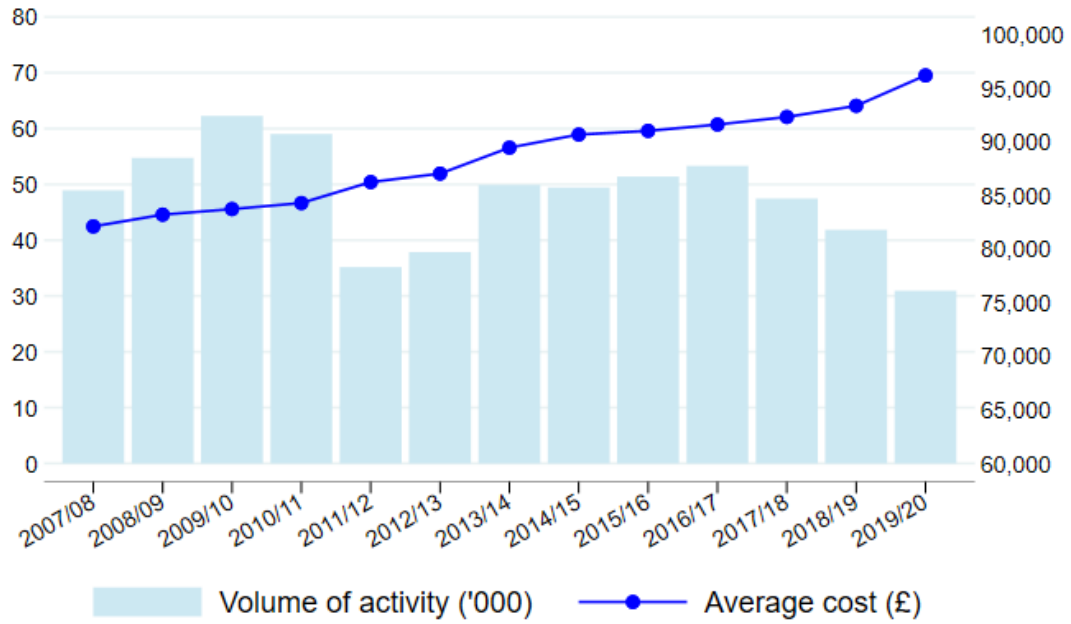
Between 2018/19 and 2019/20, Community care activity continued to decrease with a 6.95% drop in the volume of activity, as shown in Table 24, a more substantial decline as compared to the 3.44% decrease recorded in the previous year. Figure 15 shows trends in community care activity (right-hand side axis) and average unit costs (left-hand side axis), since 2007/08.

The cost-weighted and working days adjusted Laspeyres output growth rate for community care, when not correcting for missing NHS Trusts activity, was -8.30% between 2018/19 and 2019/20, indicating that the negative growth was more substantial in community care services with higher average unit costs.

Table 24: Community care activity and average costs

Year	Community care	
	Volume of activity	Average cost (£)
2017/18	84,708,536	62
2018/19	81,794,290	64
2019/20	76,106,927	70

Figure 15: Trends in Community Care activity (right axis) and average costs (left axis), 2007/08 – 2019/20



6.4.3.5. Diagnostic tests, pathology, and radiology

- **Between 2018/19 and 2019/20, the cost-weighted and working days adjusted Laspeyres output growth rate, not corrected for missing Trusts, for**
  - **Directly accessed diagnostic services was -7.81%;[50]**
  - **Radiology was 11.11%;[51]**
  - **Directly accessed pathology services was -5.84%.[47]**

Between 2018/19 and 2019/20 both Directly accessed diagnostic services and Directly accessed pathology services recorded a drop in their volumes of activity of -7.21%[52] and -7.82% respectively. In contrast, Radiology saw a substantial increase of 15.7%. This appears to be the result of a lower than usual level of activity in 2018/19, which was considerably below the levels observed in the preceding three financial years.

The cost-weighted and working days adjusted Laspeyres output growth rates were -7.81% and -5.84% for Directly accessed diagnostics services and Directly accessed pathology services respectively, whilst the cost-weighted and working days adjusted Laspeyres output growth rate for Radiology was 11.11% between 2018/19 and 2019/20.

As highlighted through our data quality checks (see section 6.4.2), Radiology services do not include DIM* and ODT* codes as these represent activity previously not reported in the NCC data collection.

Table 25: Directly accessed diagnostic and pathology services and radiology

Setting	2017/18		2018/19		2019/20	
	Volume of activity	Average cost (£)	Volume of activity	Average cost (£)	Volume of activity	Average cost (£)
Directly accessed diagnostic services	7,777,205	32	7,613,040	33	7,053,907	36
Directly accessed pathology services	417,460,632	2	426,076,050	2	392,755,757	2
Radiology	10,975,838	99	9,961,010	98	11,524,610	90

Trends in activity (right-hand side axis) and average unit costs (left-hand side axis) for these types of services between 2007/08 and 2019/20 are shown in Figure 16 to Figure 18.

[50] The baseline (Approach 3) cost-weighted and working days adjusted Laspeyres output growth rate for the setting Diagnostic tests, which comprises Directly accessed diagnostic services and Directly accessed pathology services, is equal to -3.15%.

[51] The baseline (Approach 3) cost-weighted and working days adjusted Laspeyres output growth rate for Radiology is equal to 14.94%.

[52] If activity recorded, in codes CA37* – CA41*, is excluded from 2018/19 NCC data.

Figure 16: Volume trends (right axis) in Directly accessed diagnostic services and average costs (left axis), 2007/08 – 2019/20

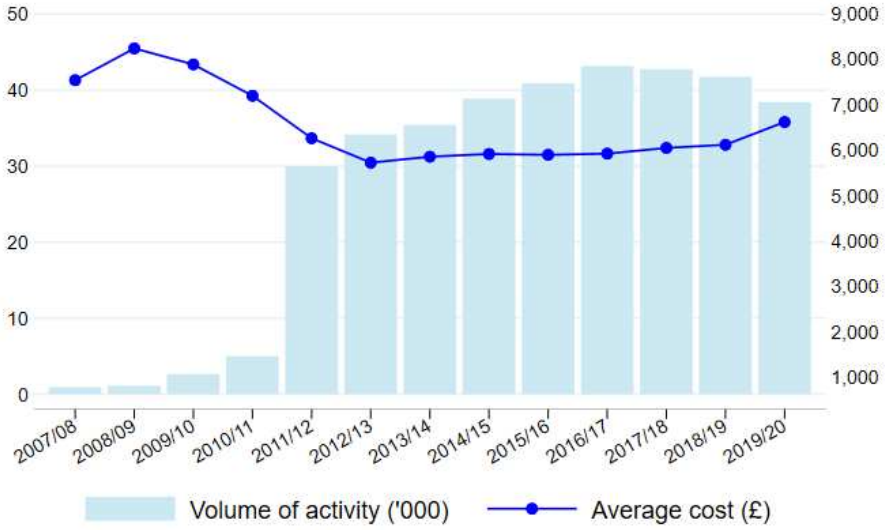


Figure 17: Volume trends (right axis) in Directly accessed pathology services and average costs (left axis), 2007/08 – 2019/20

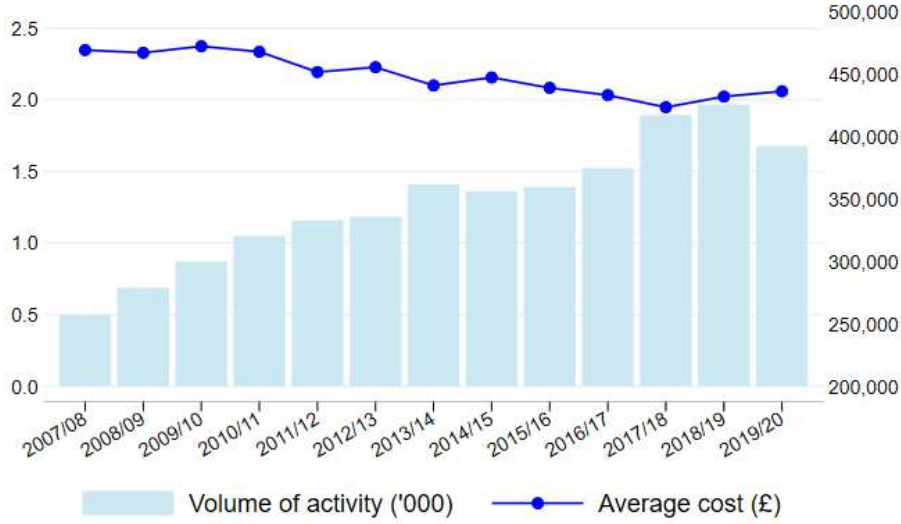
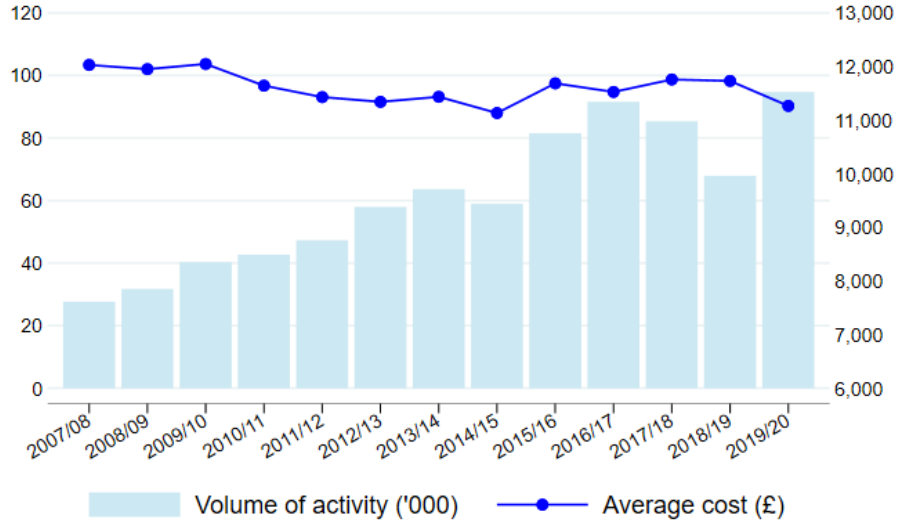


Figure 18: Trends in Radiology activity (right axis) and average costs (left axis), 2007/08 – 2019/20



Finally, we perform a sensitivity analysis to check whether the growth rate of Radiology activity is driven by the RD40Z (Ultrasound Scan with duration of less than 20 minutes, without Contrast) code, which was flagged up in our quality checks as an activity with a large value change (see section 6.4.2). Dropping the RD40Z code yields a much more modest Laspeyres growth rate of 5.37%; but this substantial impact on the setting-specific growth rate is not carried forward to the overall NHS output growth rate (the overall NHS growth rate changes by 0.07 percentage points, from -0.72% to -0.70%), as their contribution to overall value of activity and hence growth is modest compared to other NHS settings.

6.4.3.6. Community Mental Health

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 is 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)). 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 this reason, the Mental Health setting is omitted from our 2019/20 growth estimates.

For historic trends in Community Mental Health activity see Table A 14 in Appendix A.

6.4.3.7. Rehabilitation and renal dialysis

- **Between 2018/19 and 2019/20, the cost-weighted and working/total days adjusted Laspeyres output growth measure, not corrected for missing Trusts, for**
  - **Rehabilitation was -1.83% (working-days adjusted);[53]**
  - **Renal Dialysis was 1.57% (total days adjusted).[54]**

The volumes of activity in both settings continued their trends observed in recent years. Renal Dialysis saw a modest decrease in activity of -0.82%, whereas Rehabilitation activity decreased by 2.07% between 2018/19 and 2019/20; the latter is a much more modest decrease than the -19.79% drop observed in the previous financial year. (see Table 26).

Between 2018/19 and 2019/20, the cost-weighted and total days adjusted Laspeyres output growth measure for Renal Dialysis was 1.57%, implying the small decrease in activity occurred for less costly activity types. The cost-weighted and working days adjusted Laspeyres output measure for Rehabilitation was -1.83%, between 2018/19 and 2019/20, also an indication that activity decreased proportionally more in less costly activity types.

[53] The baseline (Approach 3) cost-weighted and working days adjusted Laspeyres output growth measure for Rehabilitation is -2.47%.
[54] The baseline (Approach 3) cost-weighted and total days adjusted Laspeyres output growth for Renal dialysis is 3.82%.

Table 26: Rehabilitation and Renal dialysis

Setting	2017/18		2018/19		2019/20	
	Volume of activity	Average cost (£)	Volume of activity	Average cost (£)	Volume of activity	Average cost (£)
Rehabilitation	2,865,116	328	2,298,007	378	2,250,425	403
Renal dialysis	4,277,315	135	4,275,328	135	4,240,238	144

Figure 19 and Figure 20 show trends in activity (right-hand side) and average cost (left-hand side) respectively for Rehabilitation and Renal dialysis, since 2007/08. Trends in Renal Dialysis activity are relatively stable over time: both volumes and average costs of activity have been changing gradually in the past 11 years. Rehabilitation, in contrast, has shown more volatility and a more noticeable increase in average costs over time.

Figure 19: Trends in Rehabilitation activity (right axis) and average costs (left axis), 2007/08 – 2019/20

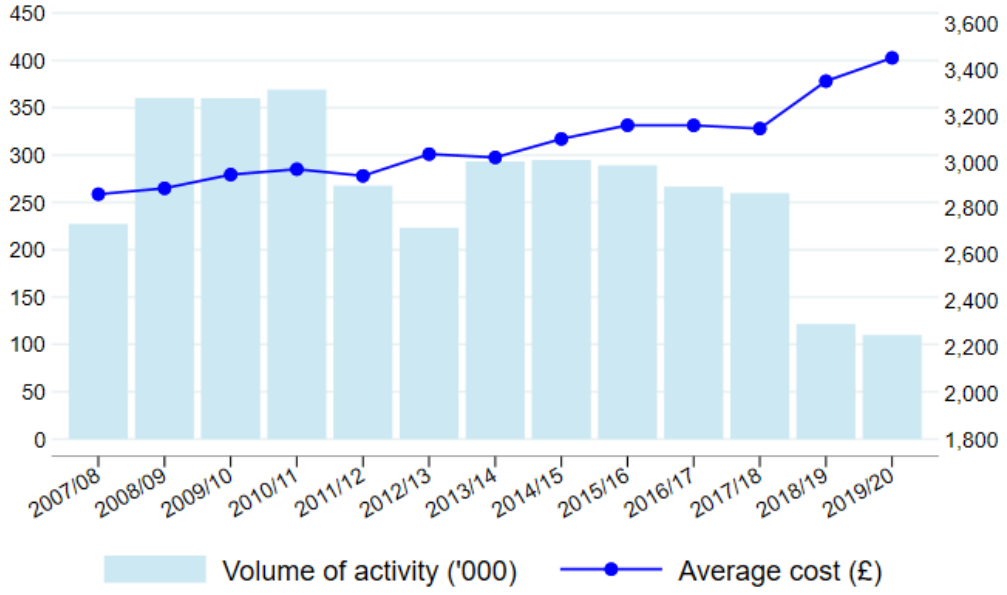
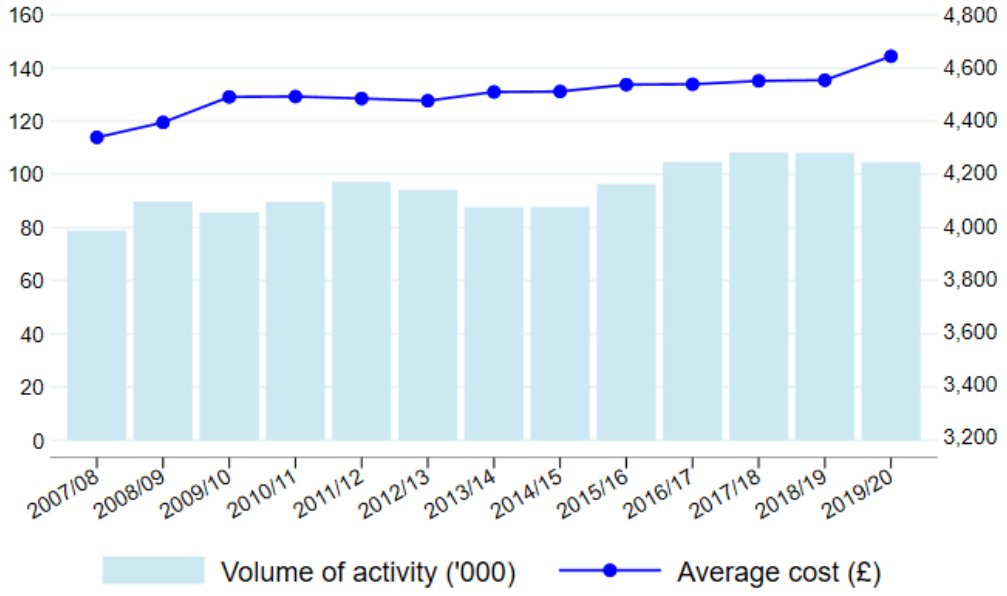


Figure 20: Trends in Renal Dialysis activity (right axis) and average costs (left axis), 2007/08 – 2019/20



6.4.3.8. Specialist services

- **Between 2018/19 and 2019/20, the cost-weighted and working days adjusted Laspeyres output growth measure for Specialist services, not corrected for missing Trusts, was equal to -8.14%.[55]**

The setting Specialist services, as defined in this report, comprises the following services: Critical Care,[56] 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 is now recorded under different NHS settings and the volumes are no longer comparable. Therefore, Cystic Fibrosis is excluded from the calculations of the Laspeyres output growth rate for the Specialist services setting. Activity volumes and average unit costs for the Specialist services sub-settings are reported in Table 27 for the last three financial years.

Table 27: Specialist services

Specialist service	2017/18		2018/19		2019/20	
	Volume of activity	Average cost (£)	Volume of activity	Average cost (£)	Volume of activity	Average cost (£)
Critical Care	2,717,180	1,159	2,698,927	1,218	2,483,865	1,347
Specialist Palliative Care	967,805	153	807,252	181	860,467	181
Cystic Fibrosis	10,934	9,766	12,208	9,343	-	-
Cancer Multi-Disciplinary Team Meetings	1,800,465	114	1,922,238	112	1,890,595	118

Specialist Palliative Care activity increased by 6.59% between 2018/19 and 2019/20, as opposed to the significant drop (-16.59%) recorded in 2018/19. Total volumes of Critical Care services continued the decreasing trend, in all its subcomponents (Adult, Paediatric and Neonatal Critical Care) equal to -7.97% between 2018/19 – 2019/20. Cancer Multi-Disciplinary Team Meetings activity has also seen a decline of 1.65%, reverting the previously observed positive trend.

Between 2018/19 and 2019/20 the cost-weighted and working days adjusted Laspeyres output growth measure for Specialist services as a whole was -8.14%.

Figure 21 to Figure 24 show trends in volume of activity (right-hand side) and average unit costs (left-hand side) since 2007/08 for Critical Care, Specialist Palliative Care, and Cystic Fibrosis (until 2018/19), and since 2011/12 for Cancer Multi-Disciplinary Team Meetings.

[55] The baseline (Approach 3) cost-weighted and working days adjusted Laspeyres output growth rate for Specialist services is -4.63%.

[56] Up to 2017/18, CHE NHS productivity updates referred to Critical Care under the 'Adult critical care' label.

Figure 21: Trends in Critical Care activity (right axis) and average costs (left axis), 2007/08 – 2018/19

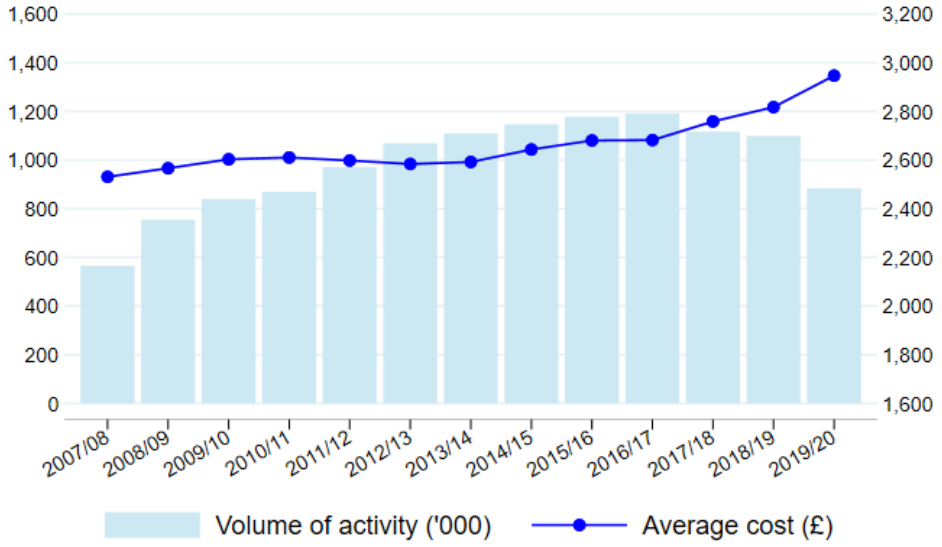


Figure 22: Trends in Specialist Palliative Care activity (right axis) and average costs (left axis), 2007/08 – 2019/20

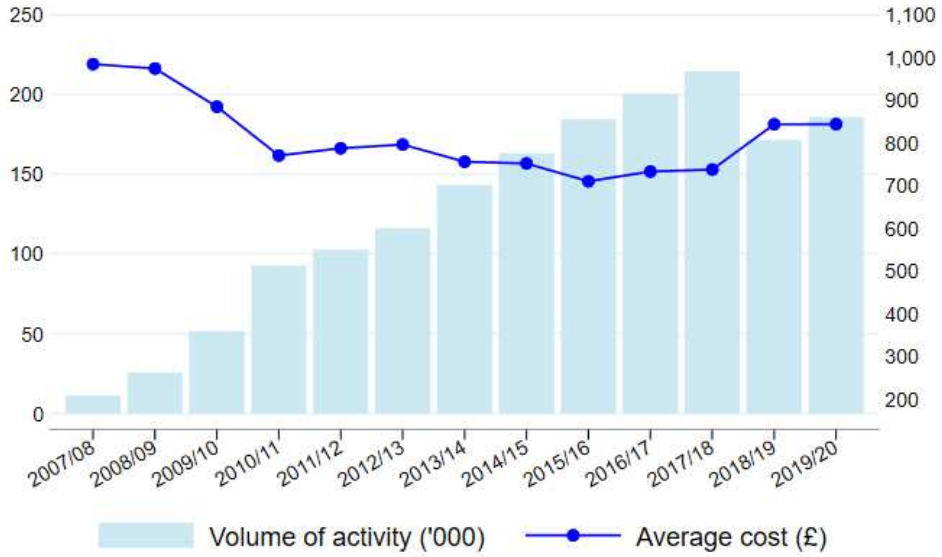


Figure 23: Trends in CMDT activity (right axis) and average costs (left axis), 2007/08 – 2019/20

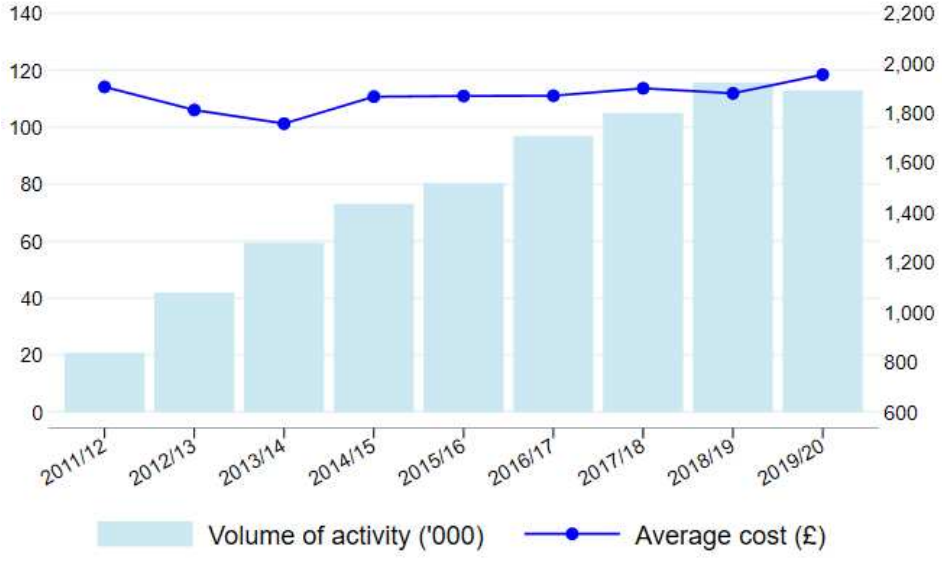
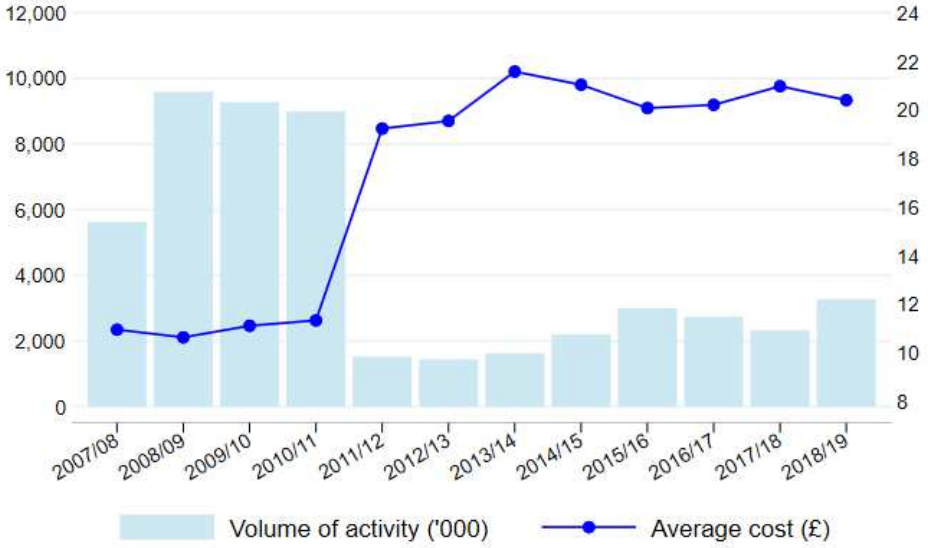


Figure 24: Trends in Cystic Fibrosis activity (right axis) and average costs (left axis), 2007/08 – 2018/19



Volumes of Critical Care activity have been rising gradually until 2016/17 when the trend has reversed; their average unit costs have been increasing gradually since 2016/17. Specialist Palliative Care shows a significant growth in volumes (up to 2017/18) and again in 2019/20, and an overall downward trend in average costs, which changed direction in 2018/19.

Finally, Cancer Multi-Disciplinary Team Meetings continue to show a steady growth in activity since 2011/12, with average unit costs displaying moderate fluctuations.

6.4.3.9. Other NHS activity

- **Between 2018/19 and 2019/20, the cost-weighted and working days adjusted Laspeyres growth measure, not corrected for missing Trusts, for 'Other NHS' activity was -3.41%.**[57]

Other types of activity reported in the NCC are summarised in Table 28. The total volume of Regular Day and Night Attenders (RDNA) showed a 0.68% increase between 2018/19 and 2019/20, which continues the previously observed positive trend, but the growth is much more modest than in the past few years. In contrast, the total volume of Audiological services continued the downward trend, recording a negative growth of -6.51% in 2019/20. Day Care Facilities activity plummeted by 57.49%, which is the most significant change since the beginning of the series (2007/08). This drop was driven by Stroke Patients Attendances, which decreased from 123,497 FCEs to 8,517 FCEs, although the total values of activity recorded for this type of attendances in 2018/19 and 2019/20 are of comparable size.

[57] The baseline (Approach 3) cost-weighted and working days adjusted Laspeyres output growth rate for Other NHS services is -1.07%.

Table 28: Other NHS activity

Activity	2017/18		2018/19		2019/20	
	Volume of activity	Average cost (£)	Volume of activity	Average cost (£)	Volume of activity	Average cost (£)
Regular Day & Night Attenders	284,842	327	328,946	341	331,177	378
Audiological services	3,293,426	58	3,044,139	61	2,846,031	69
Day Care Facilities	277,092	102	220,424	70	93,698	167

Figure 25 to Figure 27 show trends in volumes of activity (right-hand side) and average costs (left-hand side) for all of the activity reported under 'Other NHS activity' since 2007/08. RDNA shows a positive trend in volumes with a volatile trend in average unit costs. A more erratic pattern in activity growth is accompanied by a positive trend in average unit costs for Audiological services. Both activity and average unit costs for Day Care Facilities exhibit substantial volatility, in particular in most recent years.

Figure 25: Trends in RDNA activity (right axis) and average costs (left axis), 2007/08 – 2019/20

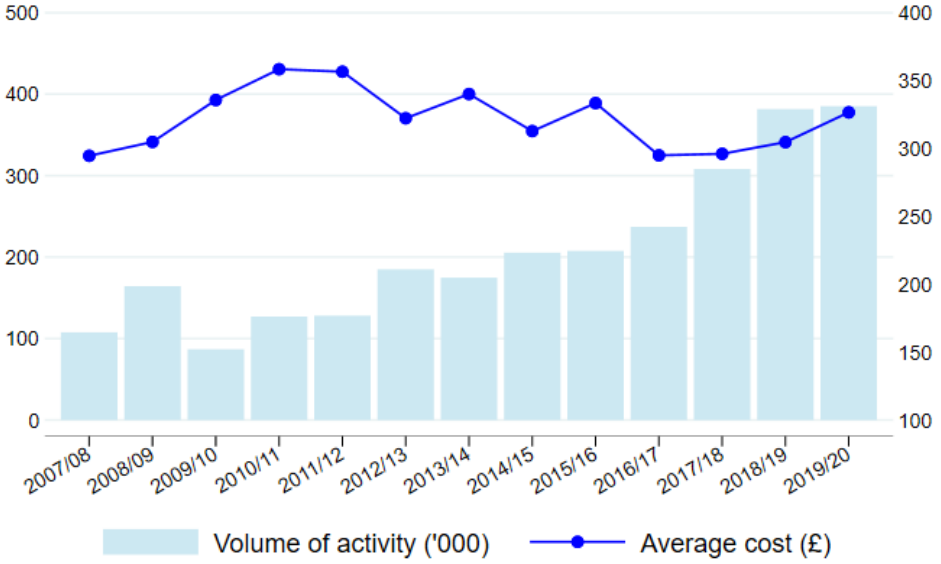


Figure 26: Trends in Audiological activity (right axis) and average costs (left axis), 2007/08 – 2019/20

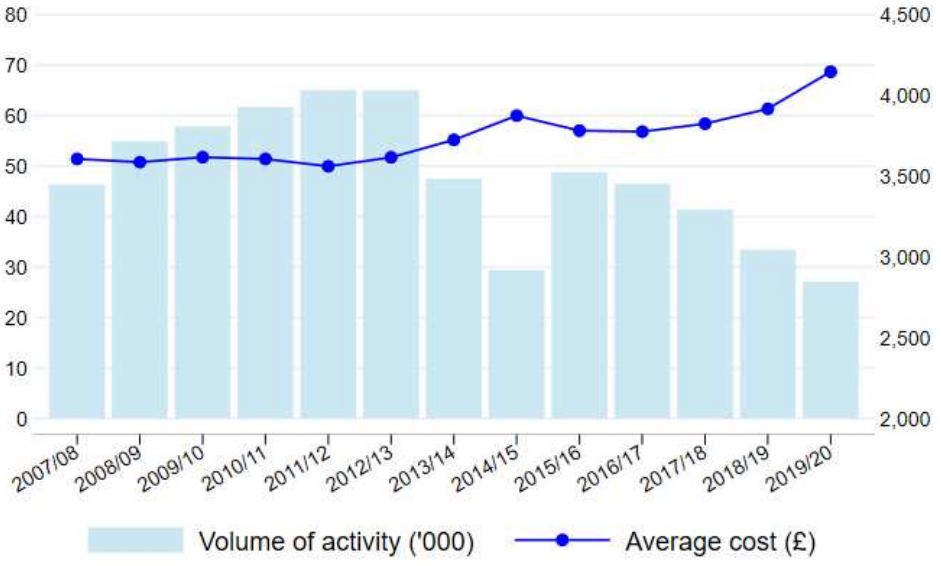
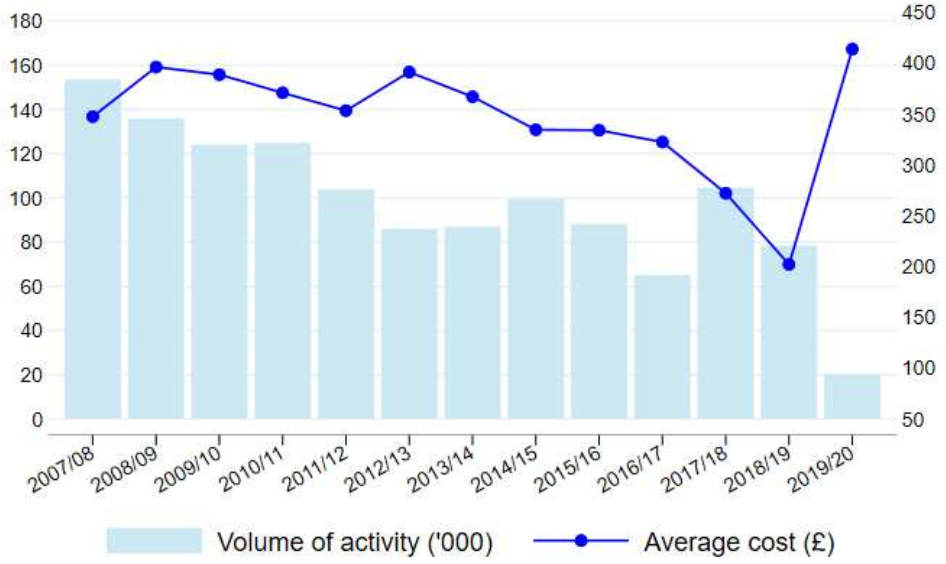


Figure 27: Trends in Day Care Facilities activity (right axis) and average costs (left axis), 2007/08 – 2019/20



Overall, the cost-weighted and working days adjusted Laspeyres output growth measure for 'Other NHS activity' was -3.41% between 2018/19 and 2019/20.[58] If Stroke Patients Attendances were excluded, the growth rate of the 'Other NHS Activity' would be equal to -3.00%.

[58] Cystic Fibrosis activity is excluded when calculating the Laspeyres growth rate. The cost-weighted output growth measure for 'Other NHS' activity is -3.03%, when not adjusted for working days.

6.5. Dentistry and ophthalmology

- **Between 2018/19 and 2019/20, the cost-weighted and working days adjusted Laspeyres output growth measure for**
  - **Ophthalmology was 0.58%;**
  - **Dentistry was -5.41%.**
- **Combining the two activities yielded growth of -4.35%.**

Information about dentistry[59] (activity and costs) and ophthalmology[60] (activity only) is published by NHS Digital. Table 29 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, cost data for Ophthalmological services are provided by the Association of Optometrists.

Table 29: Ophthalmology and Dentistry

Activity		2017/18		2018/19		2019/20	
		Volume of activity	Average cost (£)	Volume of activity	Average cost (£)	Volume of activity	Average cost (£)
Ophthalmology		13,032,582	21	13,225,755	21	13,355,060	21
Dentistry	**Band 1**	22,814,753	21	23,386,880	22	23,009,601	23
	Band 2	10,699,157	56	10,631,216	59	9,777,565	62
	Band 3	1,987,657	244	1,941,217	257	1,833,103	269
	Urgent	3,566,835	21	3,620,927	22	3,637,713	23
	Other	144,888	21	136,476	22	123,192	23
	Total	**39,213,290**	**42**	**39,716,716**	**43**	**38,381,173**	**45**

The raw volume of ophthalmic services increased in 2019/20 by 0.98%, continuing the positive trend recorded since 2015/16, with average costs remaining unchanged. In contrast, dental activity recorded a substantial volume decrease of -3.36% in 2019/20, with the largest drops observed for Bands 1 and 2. Their contribution to cost-weighted growth of dental services is also the highest among all the subcategories (29% and 34% 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 -4.35% between 2018/19 and 2019/20.[61]

[59] https://digital.nhs.uk/data-and-information/publications/statistical/nhs-dental-statistics/2019-20-annual-report (last accessed 18/06/2021).
[60] https://digital.nhs.uk/data-and-information/publications/statistical/general-ophthalmic-services-activity-statistics/england-year-ending-31-march-2020 (last accessed 18/06/2021).
[61] Their cost-weighted output growth measures, when not adjusted for working days, are equal to 0.98% and -5.04%, respectively for Ophthalmology and Dentistry. When combining the two activities, the cost-weighted output growth measure is -3.97%, when not adjusting for working days.

6.6. Primary care activity

- **Between 2018/19 and 2019/20, the cost-weighted and working days adjusted Laspeyres output growth of primary care activity was -0.05%.**
- **The overall negative growth rate was driven by the month of March, which was affected by the pandemic: the cost-weighted and working days adjusted Laspeyres output growth measure for the period April-February was 1.66%, whereas the equivalent figure for March was -17.62%.**

Up to 2017/18, the Primary Care setting output growth measure was estimated using GP Patient Survey data (Castelli et al., 2019, Castelli et al., 2020). Since 2018/19, we have been using the General Practice (GP) appointments dataset released by NHS Digital (Arabadzhyan et al., 2021). The first release of data (October 2018) covered the period from November 2017 to October 2018.[62] 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. All three datasets include breakdowns of appointment counts by appointment status: attended, not attended, unknown; healthcare professional: GP, other practice staff, unknown; mode of appointment: face-to-face, home visit, telephone, video/online, unknown; time between booking date and appointment date (hereafter waiting time): 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. However, only the monthly and daily appointment datasets at the CCG level allow for grouping of GP appointment modes by appointment status and waiting time.

Initially each monthly data release covered the most recent month with updated information on the previous 17 months (18 months in total); however, this has now changed, with each monthly release including updates for the previous 29 months. The data include activity recorded within the appointment systems for the majority of General Practices across England, with patient coverage of about 94%.[63]

In this report, we provide a refinement to the methodology developed to apportion both 'unknown' GP appointment modes and appointment status and introduce a new quality dimension (waiting times) to the primary care sector as a case study. In the remainder of this section, we provide a description of the NHS Digital GP appointments data and their preparation, including the refinement in the methodology to apportion 'unknown' GP appointment modes and appointment status (section 6.6.1), assign unit costs to the different mode of GP appointments (section 6.6.2), discuss the quality adjustment (section 6.6.3), report the output growth rates of the primary care setting, perform several sensitivity checks, and evaluate the possible impact of the COVID-19 pandemic on the primary care output growth figures for 2019/20 (section 6.6.4)

[62] NHS Digital GP appointments data are available at https://digital.nhs.uk/data-and-information/publications/statistical/appointments-in-general-practice/ (last accessed 08/07/2021). For the analysis presented in this section, we used the February 2021 publication.

[63] For more information on data collection, see Appointments in general practice: supporting information - NHS Digital (last accessed 08/07/2021) or our previous report (Arabadzhyan et al., 2021).

For our NHS productivity calculations, we use the monthly CCG-level dataset to obtain monthly appointment data with a breakdown by appointment status and waiting time within each appointment mode, and the national-level dataset for the monthly estimates of patient coverage.

6.6.1. Preparation of GP appointments data and methodological refinement

We follow the five steps below to construct the GP appointment dataset:

- **Step 1:** Aggregating the monthly-level dataset so that a single entry is the number of appointments for each month *m*, appointment mode *j*, appointment status *s* and waiting time *w*;
- **Step 2:** Apportioning 'unknown' mode, status, and waiting time according to the distribution of appointments for which mode, status, and waiting time are known;
- **Step 3:** Dropping unattended appointments;
- **Step 4:** Correcting for patient coverage;
- **Step 5:** Aggregating monthly data to financial years.

To apportion 'unknown' in either mode, status, or waiting time, we have refined the method used in Arabadzhyan et al. (2021). The stepwise procedure adopted in 2018/19 yielded different results depending on the order of the steps; we have, therefore, developed a single step formula,[64] as follows:

$$\hat{x}_{jsw} = a_{jsw} + Unk_{js}^{w}\frac{a_{jsw}}{\sum_{w=1}^{7} a_{jsw}} + Unk_{jw}^{s}\frac{a_{jsw}}{\sum_{s=1}^{2} a_{jsw}} + Unk_{sw}^{j}\frac{a_{jsw}}{\sum_{j=1}^{4} a_{jsw}} + Unk_{j}^{s,w}\frac{a_{jsw}}{\sum_{w=1}^{7}\sum_{s=1}^{2} a_{jsw}} + Unk_{s}^{j,w}\frac{a_{jsw}}{\sum_{w=1}^{7}\sum_{j=1}^{4} a_{jsw}} + Unk_{w}^{j,s}\frac{a_{jsw}}{\sum_{w=1}^{7}\sum_{s=1}^{2} a_{jsw}} + Unk^{j,s,w}\frac{a_{jsw}}{\sum_{w=1}^{7}\sum_{j=1}^{4}\sum_{s=1}^{2} a_{jsw}} \quad \text{(E16)}$$

Where $\hat{x}_{jsw}$ is the total number of GP appointments for each appointment mode *j*, status *s* and waiting time *w* and a_{jsw} is the raw number of appointments with known mode *j*, status *s* and waiting time *w*; Unk_{js}^{w} is the number of appointments with unknown waiting time *w*, but known mode *j* and status *s*; Unk_{jw}^{s} is the number of appointments with unknown status *s*, but known mode *j* and waiting time *w*; Unk_{sw}^{j} is the number of appointments with unknown mode *j*, but known status *s* and waiting time *w*; $Unk_{j}^{s,w}$ is the number of appointments with unknown status *s* and waiting time *w*, but known mode *j*; $Unk_{s}^{j,w}$ is the number of appointments with unknown mode *j* and waiting time *w*, but known status *s*; $Unk_{w}^{j,s}$ is the number of appointments with unknown mode *j* and status *s*, but known waiting time *w*, and $Unk^{j,s,w}$ is the number of appointments with unknown mode *j*, status *s* and waiting time *w*.

After apportioning 'unknowns', unattended appointments are dropped from the dataset and the number of appointments of mode *j* and waiting time *w* are corrected for patient

[64] Sums include only entries with known *j, w, s*. Each quantity is a monthly value, subscript for month is omitted for simplicity.

coverage[65]: $\bar{\bar{x}}_{jwm} = \frac{\hat{x}_{jwm}}{cov_m}$. Finally, we calculate the yearly number of GP appointments by mode of appointment and waiting time: $x_{jwt} = \sum_{m=1}^{12} \bar{\bar{x}}_{jwm}$.

6.6.2. Assigning unit costs to primary care consultations

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.[66] This information is taken from the PSSRU 'Unit Costs of Health and Social Care' reports (Curtis and Burns, 2019, Curtis and Burns, 2020).[67] The per-minute cost of GP contact is equal to £4.30 in both 2018/19 and 2019/20, and as we have no recent data on a change in the duration of each consultation type, the unit costs for the two financial years are by construction the same.

Each consultation mode has a different duration, using the baseline estimates reported in the 2018/19 NHS productivity update (Arabadzhyan et al., 2021) and the above cost per minute of GP time, we obtain the following unit costs for each mode of appointment:

- £39.65 (9.22 min) for a face-to-face appointment;
- £121.68 (23.4 min) for a home visit;
- £21.50 (5 min) for both telephone and video/online consultations.

In Table 30, we report the total volume of GP appointments by mode of appointment and relative unit costs for the years 2018/19 and 2019/20.

Table 30: Volume of GP activity and unit costs (£)

Appointment mode	***2018/19***	***2019/20***	***2018/19 and 2019/20 Unit cost (£)***
Face-to-Face	246,465,461	244,918,881	39.6
Home Visit	2,839,798	2,868,106	121.7
Telephone	42,682,368	46 678,238	21.5
Video / Online	1,434,543	1,914,916	21.5
Total GP appointments	**293,422,170**	**296,380,141**	

Primary care output increased by 1.01% when considering growth in the raw volume of activity, whilst the cost-weighted Laspeyres output growth rate, adjusted for working days, decreased by -0.05%. We note that there has been a shift of GP activity from the more costly

[65] After apportioning 'unknowns' and dropping unattended appointments, appointment status *s* takes only the value 'attended'. Hence, the *s* subscript no longer appears in the formula.

[66] This implies that the value of an appointment is independent of the type of healthcare professional seen. For more details, see Arabadzhyan et al. (2021).

[67] The unit costs are taken from the PSSRU "Unit Costs of Health and Social Care" 2019 (p.120) and 2020 (p.126) (last accessed 08/07/2021).

face-to-face activity to the less costly telephone and video/online activity, which may explain the negative growth of the cost-weighted output growth measure.

The COVID-19 pandemic is likely to be a major reason behind the shift of activity between appointment modes as GP practices increasingly implemented guidelines issued by NHS England on safe working during the pandemic and subsequent lockdown periods. All relevant guidance is summarised in section 2. In sub-section 6.6.4, we perform a sensitivity analysis on the choice of unit costs for the different types of GP appointments, reflecting the fact that the mode of delivering primary care services was heavily affected by the COVID-19 pandemic.

6.6.3. Quality adjustments

6.6.3.1. QOF quality adjustment

Since 2007, we have quality adjusted primary care following an approach developed by Derbyshire et al. (2007), which utilises data captured as part of the Quality and Outcomes Framework (QOF).[68] Following this approach, the quality of primary care output has been measured in terms of improvements in disease management for three conditions: coronary heart disease, history of transient ischaemic attack or stroke, and hypertension. Up to 2018/19, the following QOF indicators were selected as providing information about improvements in disease management for the selected conditions:

- 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;
- 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.

Reflecting the additional value of care which meets these targets for affected patients, a multiplication factor of 1.3 (Derbyshire et al., 2007) is assigned to the total number of consultations falling within the remit of the QOF indicators considered and that meet the quality standards specified. Using prevalence and achievement rates for each condition *i* and year *t*, the quality-adjusted number of appointments for each mode *j* ($\bar{x}_{jt}$) is then calculated using the following formula:

$$\bar{x}_{jt} = x_{jt} * [1 + (1.3 * \sum_i pre_{it} * ach_{it}) - \sum_i pre_{it} * ach_{it}] \qquad \text{(E17)}$$

where pre_{it} indicates the prevalence rate for QOF indicator *i* at time *t* and ach_{it} indicates the achievement rate for QOF indicator *i* at time *t*.

In 2019/20 there has been a change in the definition of these indicators. Prevalence and achievement rates are now provided separately for the following two age groups: 79 years

[68] Further information on and data of the Quality and Outcomes Framework indicators for primary care can be found at https://digital.nhs.uk/data-and-information/publications/statistical/quality-and-outcomes-framework-achievement-prevalence-and-exceptions-data/2019-20 (last accessed 14/03/2022).

old and younger, and 80 years old and older. Moreover, for these two age groups, achievement is now measured differently: for the 80+ year old group, the achievement is considered as obtained if a patient had a last blood pressure reading of 150/90 or less, whereas for the younger patient group this threshold is set to 140/90 or less. Such a change means that some cases which would have been "successes" in 2018/19 (e.g. a 70-year-old patient with a 145/90 reading) would no longer be considered "successes" in 2019/20. As the criteria for a successful blood pressure reading have been tightened up, it is not surprising that we observe lower achievement rates in 2019/20. However, we are not able to disentangle the effect of a change in the achievement criteria from the real change in the quality of care, as the data are no longer comparable.

We propose four approaches to deal with this issue. The first approach (option a) is to assume no change in the reported QOF indicators between 2018/19 and 2019/20, or in other words, to revert to the simple cost-weighted Laspeyres output growth measure. The second approach (option b) is to use the data from the 2019/20 QOF update and calculate the overall prevalence and achievement rates for the whole pool of patients, ignoring the change in the definition of achievement. This way the number of quality-adjusted appointments for 2019/20 will be downward-biased as compared to 2018/19 due to the stricter achievement threshold for younger patients. Finally, the third and fourth approaches (c and d respectively) imply fixing achievement rates either at the 2018/19 or 2019/20 level, while using the original prevalence rates for each financial year. Table 31 presents the total quality-adjusted growth rates for options (b)-(d).

Table 31. Total QOF-adjusted growth rates for 2018/19-19/20

	Est. tot. achievement for 2019/20 (option b)	***Achievement fixed at 2018/19 (option c)***	***Achievement fixed at 2019/20 (option d)***
Raw growth rate	0.38%	1.05%	1.04%
Laspeyres growth rate	-0.28%	0.38%	0.38%

As expected, the quality-adjusted growth rates are lowest when applying option b, with options c and d providing extremely similar results and also higher growth rates for both the raw and the cost-weighted growth rates. However, due to the comparability issues discussed above and given that the collection of QOF indicators was temporarily suspended throughout 2020/21,[69] the QOF quality-adjustment will be omitted from the baseline primary care output growth measure and from the NHS overall output growth measure in the 2019/20 update.[70]

[69] While QOF was suspended throughout 2020/21, its reintroduction was scheduled for April 2021 (https://www.gponline.com/no-plans-repeat-qof-suspension-year-says-nhs-england/article/1718062, last accessed 11/08/2021).

[70] Without any quality adjustment, the cost-weighted and working days adjusted Laspeyres output growth of primary care activity for the 2018/18-19/20 link was -0.05%.

6.6.3.2. Waiting times quality adjustment

A further quality adjustment is to consider the time between booking date and appointment date or waiting time (WT). The NHS Digital GP appointment dataset includes information on the number of appointments by the following time intervals for each appointment mode:

- same day,
- 1 day,
- 2 to 7 days,
- 8 to 14 days,
- 15 to 21 days,
- 22 to 28 days,
- more than 28 days, and
- unknown.

Similar to hospital inpatient and outpatient settings, 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:

$$Wait_{80} = L_{80} + h_{80}\frac{80\% - Cumul_{80-1}}{freq_{80}} \quad \text{(E18)}$$

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 can be implemented alongside the QOF quality adjustment or on its own. If used alongside the QOF adjustment, we use the numbers of consultations for each appointment mode, $\bar{x}_{jt}$, as calculated using expression (E17), with the waiting-time adjustment applied using the formula below. This is the same as the one used for outpatient appointments.

$$\frac{\sum_j \bar{x}_{jt+1} c_{jt} \frac{e^{-r_w W_{jt+1}}}{e^{-r_w W_{jt}}}}{\sum_j \bar{x}_{jt} c_{jt}} \quad \text{(E19)}$$

where 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. If used without the QOF adjustment, we would replace $\bar{x}_{jt}$ with x_{jt}, i.e. the yearly number of consultations for each appointment mode.

Table 32 presents the 80th percentile waiting times for each appointment mode for the financial years 2018/19 and 2019/20. It is worth noting that the waiting times distribution is positively skewed: in 2019/20, about 45% of face-to-face appointments, 80% of home visits, and 76% of telephone consultations took place within 1 day from the booking date. For the video / online appointments the picture is different, with only 30% of appointments being concluded within a day, while about 45% of consultations took place 8 days or later from the

day of booking. Higher waiting times of video / online consultations could be explained by the fact that these appointments might be more likely used as a follow-up appointment, ceteris paribus.

Table 32. Volume of activity, unit costs and waiting time figures for GP appointments, 2018/19 – 2019/20

Appointment mode	***2018/19***	***2019/20***
	80th percentile waiting times	***80th percentile waiting times***
Face-to-Face	13.61	14.0
Home Visit	1	1
Telephone	2.41	3.36
Video / Online	18.1	17.6

Finally, we note that waiting times, as measured by the 80th percentile of the distribution, have slightly worsened for both face-to-face and telephone appointments, whilst narrowly improving for video / online consultations; no change was registered for home visits.

Table 33 reports the cost-weighted Laspeyres growth rates when adjusting for waiting time alone and correcting for the total number of working days (WD) in each financial year. We also include a combined waiting time and QOF adjustment (without the WD adjustment). We find that adjusting for waiting times decreases the cost-weighted Laspeyres growth rate from 0.35% to -0.30%. Correcting for the total number of working days decreases it even further, yielding a -0.69% Laspeyres growth rate (the number of working days in 2019/20 was 254 compared to 253 in 2018/19). Finally, if we were to add the QOF quality adjustment (option c) to the waiting time adjustment, this would increase the resulting Laspeyres growth rate by about 0.04 percentage points.

Table 33. Laspeyres growth rates for 2018/19-19/20 with quality and working days adjustment

WT-adjusted	***WT & WD-adjusted***	***WT and QOF-adjusted****
-0.30%	-0.69%	-0.26%

* Option c

As mentioned earlier, a comparison of the 2018/19 – 2019/20 and 2017/18 – 2018/19 primary care output growth rates is not possible, because the QOF indicators are not comparable for these two financial years. Thus, the only meaningful comparisons are the raw and cost-weighted output growth rates. Table 34 provides the primary care setting growth rates for the 2018/19 – 2019/20 and 2017/18 – 2018/19 links, as well as the growth rates obtained with the stepwise apportioning method adopted in the 2018/19 productivity update.

Table 34. Growth rates comparison

	2017/18-2018/19 (RP182)	2017/18-2018/19	2018/19-2019/20
Raw consultations	0.58%	1.35%	1.01%
Cost-weighted (CW)	0.39%	1.14%	0.35%
CW and WD-adjusted	-0.41%	0.34%	-0.05%

The table indicates the adoption of the refined method of apportioning 'unknowns' yields higher growth rates for the 2017/18 – 2019/20 link, compared to the stepwise procedure used in Arabadzhyan et al. (2021). Regarding the year-to-year comparison, the cost-weighted growth rate in 2018/19 – 2019/20 has decreased by 0.79 percentage points compared to the previous financial year, when considering the figures with the refined apportioning method.

6.6.4. Sensitivity analysis and the impact of the COVID-19 pandemic on primary care

In this subsection, we perform sensitivity analyses to carry out an early assessment of the impact of the recent COVID-19 pandemic on the primary care output growth measure. Guidelines issued by NHS England and Improvement to contain the spread of the SARS-COV-2 virus 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 meant that starting from March 2020, GP practices accelerated the adoption of delivering primary care appointments either by telephone or through video or online consultations. To reflect the fact that since the start of the pandemic, primary care services have been increasingly delivered remotely, we first assign the unit costs of face-to-face appointments also to telephone, video/online consultations (£39.65 vs £21.5). Table 35 reports the results of this change in the column 'Sensitivity'.

Table 35. Primary care output growth measure: sensitivity to the choice of unit costs

	Baseline	Sensitivity
Raw consultations	1.01%	
Cost-weighted	0.35%	1.01%
Cost-weighted and working day adjusted	-0.05%	0.61%
Cost-weighted and waiting time quality-adjusted	-0.30%	0.31%
Cost-weighted, waiting time quality- and working day adjusted	-0.69%	-0.08%

We find, as expected, that assigning the same unit costs to face-to-face, telephone, and video/online consultations yields a higher growth rate of the primary care output growth measure. However, the impact of adjusting for the number of working days, waiting time alone, and then waiting time and working days together still leads to a negative growth rate of primary care output, albeit of a much smaller magnitude.

One of the drivers of this result may be the change in the distribution of appointments across appointment modes triggered by the COVID-19 pandemic. Table 36 contains the number of consultations and waiting times specifically for March 2019 and March 2020. COVID-19 had a significant impact on the number of face-to-face consultations, which were substantially

lower (-23.2%) in March 2020 compared to the same month in 2019.[71] The number of telephone appointments almost doubled in March 2020 compared to March 2019, and an increase is also noted in video/online consultations (+6.6%); however, this increase did not fully compensate for the drop in face-to-face consultations. Overall, primary care appointments decreased by -6.3% in March 2020 compared to March 2019. Unsurprisingly, 80th percentile waiting times increased for all appointment modes, with that for telephone and video/online appointments registering respectively a 51.7% and 17.8% increase.

Table 36. Comparison of March 2019 and March 2020 appointment counts and waiting times

Appointment mode	***March2019***	***March 2020***	***March 2019***	***March 2020***
			80th percentile waiting times	***80th percentile waiting times***
Face-to-Face	21,001,164	16,121,388	13.6	15.3
Home Visit	243,875	175,840	1	3.2
Telephone	3,727,592	7,082,885	2.9	4.4
Video/Online	122,744	130,828	15.7	18.5
Total	**25,095,375**	**23,510,940**		

To understand the impact of this structurally different month of March, we decompose the overall growth rate based on observations falling into the pre-pandemic or pandemic period. We have therefore calculated the primary care output growth measures separately for the period April to February and for March alone. We find that for the April – February period the cost-weighted and working day adjusted Laspeyres primary care output growth rate is 1.66%. If we adjust the primary care output for a change in waiting times, we find that the growth measure is 1.03%. Finally, the cost-weighted and working day adjusted Laspeyres output growth measure for March is -17.62%, and -19.5% when adjusting also for waiting time.

We also check if the change in the type of GP appointments and their total numbers occurs in months before March 2020, as GP practices may have anticipated the forthcoming changes in dealing (e.g. containment procedures) with the SARS-CoV-2 virus and reduced the number of appointments, in particular face-to-face appointments, before NHS England issued its guidance. We find that the total number of appointments in January 2020 was higher than that recorded in January 2019 and that there were fewer appointments in February 2020 than in February 2019. We have, therefore, calculated, an alternative cost-weighted and working day adjusted Laspeyres output growth measure for the period April 2018 – January 2019 to April 2019 – January 2020 and for the period February 2019 – March 2019 and February 2020 – March 2020, which were equal to 1.93%, and -9.78%, respectively.

[71] It is worth noting that, according to the NHS Digital Primary Care Domain Team, the data are likely to overestimate the number of face-to-face appointments and underestimate the number of video/online consultations for March 2020, because GP practices may not have updated the status of some appointments, which were originally booked as face-to-face, but were actually carried out remotely as required by the NHS England guidelines introduced in March. For further information, see https://digital.nhs.uk/data-and-information/publications/statistical/appointments-in-general-practice/appointments-in-general-practice-supporting-information (last accessed 14/03/2022).

6.7. Community prescribing

- **The Laspeyres cost-weighted and total days adjusted output growth measure for Community Prescribing was 4.25% between 2018/19 and 2019/20.**

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. Data on the number and cost of prescriptions of different drugs are published monthly and freely 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

The analysis of Community Prescribing data for 2019/20 uncovered that for a small number of drugs which retained the same identifier (PropGenLinkCode), the quantities or expenditure reported for a specific month were of a different order of magnitude to data for the same month in previous years. Of drug-month combinations ultimately dropped, quantities were on average 16,000 times larger in 2019/20 than in 2018/19, with the difference reaching as high as 3.6 million times. Due to the combined use of quantity and expenditure in calculating unit costs (unit costs are determined as the ratio of total expenditure to quantities), this group of drugs had a profound impact on the overall growth measure for prescribing if retained. When quantity changes are so large, it is likely that the comparison being made is not like-for-like. However, we did 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 algorithm was used to identify quantity changes which were highly likely to not represent a like-for-like comparison.

For both quantity and expenditure, we adopted the following approach. First, we calculated 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 calculated a ratio of the two ratios (a ratio of ratios, RoR). That is, for each drug-month we calculated the following expression:

$$RoR = \frac{quantity/median\ quantity}{expenditure/median\ expenditure} \quad \text{(E20)}$$

This statistic allowed 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 our analysis. In calculating growth between 2018/19 and 2019/20, 168 out

of 75,033 (0.22%) of drug-month combinations from 2018/19 and 438 out of 74,016 (0.59%) of drug-month combinations from 2019/20 were identified as implausible outliers. We then proceeded to attribute a zero to the volume of prescriptions of the relevant drugs in the months identified as outliers.

6.7.2. Activity and growth rates

Table 37 reports summary statistics for Community Prescribing. To reflect the methodological refinement described in the previous section, we report two different figures for the financial year 2018/19; the row '2018/19' repeats the figures reported in Arabadzhyan et al. (2021), whilst the row '2018/19*' reports the figures for Community Prescribing as calculated for this update, which are comparable to those reported for 2019/20*.

In 2019/20, 7,623 distinct Community Prescribed drug items were observed, continuing a gradual downward trend of recent years. The total number of prescriptions made out increased by 23 million (2.1%). This represents a sharp increase compared to the recent past. Proportional increases in total spend and activity weighted prescription unit costs are larger still, at around 4%. However, the increase in total items prescribed is smaller at around 0.6% and a level still lower than that reported in 2017/18. This suggests a larger number of more expensive prescriptions in 2019/20 than in 2018/19.

The total number of prescriptions and expenditure in 2019/20 is similar but higher than equivalent information reported for England for the 2019 calendar year by NHS Digital.[72] Including the month of March 2020 in our analysis is an important difference. We consider the potential impact on measured prescription growth of the COVID-19 pandemic in section 6.7.3.

Table 37: Community Prescribing, summary data 2017/18 – 2019/20

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
2018/19*	7,755	1,109,084,896	87,944,499,163	£8,831,046,458	7.96	0.10
2019/20*	7,623	1,132,043,733	88,504,273,870	£9,224,298,376	8.15	0.10

In 2019/20, 571 new drug items appeared, amounting to a total expenditure of £29 million in 2019/20 prices. 703 drugs prescribed in 2018/19 were not prescribed in 2019/20, representing £23.3 million of expenditure in 2018/19 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 38. Between 2018/19 and 2019/20, the Paasche Price ratio indicates negative growth between 2018/19

[72] https://www.nhsbsa.nhs.uk/statistical-collections/prescription-cost-analysis-england/prescription-cost-analysis-england-2019 (last accessed 02/10/2021).

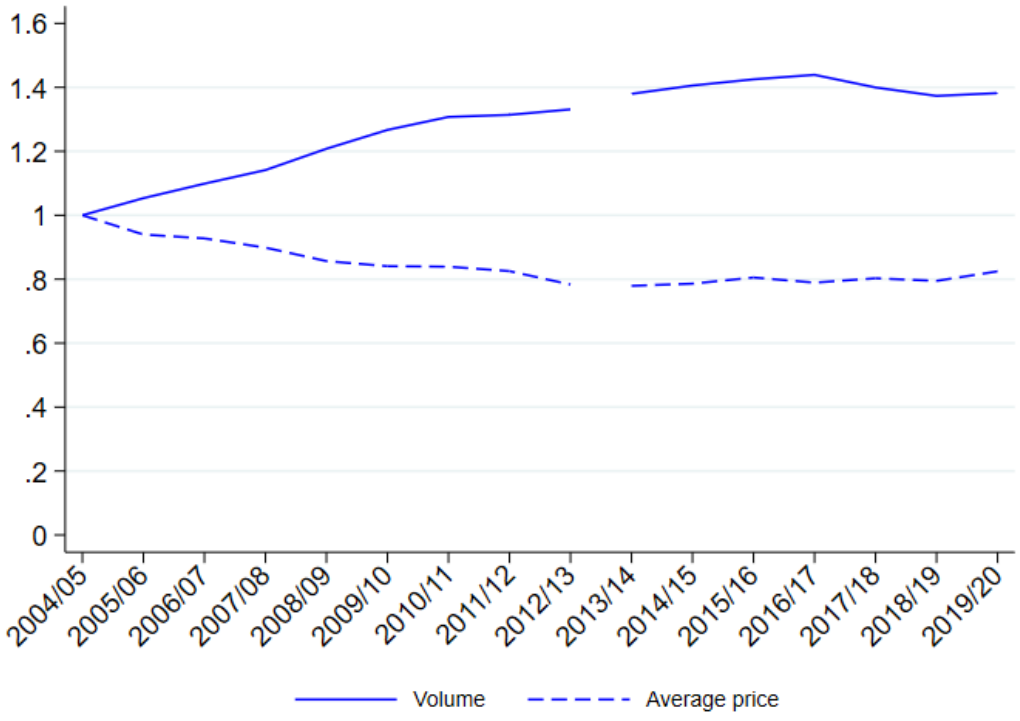
and 2019/20. This continues the general trend observed from 2004/05 but is a smaller fall than in recent past years.[73] The Laspeyres volume index was positive between 2018/19 and 2019/20 and substantially higher than in the recent past. The Laspeyres cost-weighted and total days adjusted output growth measure for Community Prescribing was 4.25% between 2018/19 and 2019/20.[74] These results indicate a relatively sharp increase in the use of prescriptions in 2019/20 compared with 2018/19.

Table 38: Community Prescribing: price and volume indices 2016/17 – 2019/20

Years	Paasche Price Ratio	Laspeyres Volume Ratio
2016/17 – 2017/18	0.9742	1.0155
2017/18 – 2018/19	0.9477	1.0249
2018/19 – 2019/20	0.9992	1.0425

From the base year of 2004/05, trends in the volume and prices of items prescribed are shown in Figure 28. This figure highlights that while the increase in volume observed is larger than in the most recent years, it remains comfortably below the peak of 2016/17. The observed slight increase in average price contrasts with a generally flat recent trend but similarly does not overhaul the more general trend from 2004/05. The slight increase in mean contemporaneous prices differs from the small fall in Paasche Price ratio and suggests a shift between 2018/19 and 2019/20 towards prescribing more expensive drugs.

Figure 28: Price and volume changes for community prescribed pharmaceuticals



[73] See Table A 25 for earlier equivalent figures, beginning from 2004/05.

[74] The Laspeyres volume index between 2018/19 and 2019/20 without adjusting for the change in total days is 4.54%.

6.7.3. Impact of the COVID-19 pandemic on Community Prescribing

To identify the potential impact of the COVID-19 pandemic on Community Prescribing, we calculate growth rates for the periods April 2018-February 2019 to April 2019-February 2020, March 2019 with March 2020, April-December 2018 to April-December2019 and January-March 2019 to January-March 2020. The intention is to distinguish between growth rates in an entirely pre-lockdown period and comparing the lockdown period with an equivalent pre-lockdown period. As discussed in section 2, GPs were asked to reduce face-to-face contacts as much as possible during March of 2020. This may have led to changes in prescribing behaviour either in response to this instruction or even ahead of it, as the virus spread across and between countries since January 2020.

6.7.3.1. Imputation

Throughout this report, we employ an imputation method (Castelli et al., 2011) when price information is missing for new drugs. Specifically, we deflate (inflate) prices when a drug is prescribed in year t (t-1), which was not prescribed in year t-1 (t), to estimate a price for the year t-1 (t). In the case of Community Prescribing, we use the Fisher price index. As such, when analysing subsets of full year data, the set of drugs being imputed can differ, along with the set and distribution of drugs used to construct the deflator. This arises if, for instance, a drug is prescribed during February of year t and year t-1 but only during March in year t. This is most likely when a drug is rarely prescribed or its prescription is seasonal. Also, by definition, the deflator calculated from the March only dataset is likely to differ more from the deflator calculated for the full year than a deflator constructed from a dataset of April-February.

This methodological approach is adopted because it ensures that the comparison of non-lockdown months is not contaminated by events during March 2020 and equivalently the comparison of March 2020 and March 2019 is not contaminated by events in other months through the imputation of missing prices. As a result, we are not able to precisely reconstruct the growth measure for the full year from its constituent time periods.

Table 39 presents the contribution to overall growth in Community Prescribing of the two time periods (April-February and March alone). The table highlights that the growth rate in Community Prescribing is substantially higher when comparing March 2020 with March 2019 than when comparing April 2019-February 2020 with April 2018-February 2019. This might be due to a larger number of prescriptions being issued in anticipation of an imminent lockdown in early March, a shift to increasing the rate of prescriptions made during lockdown, or some combination of these. It is not possible to disentangle these mechanisms based on the month of March alone.

The table also includes the implied overall growth from taking a base year expenditure weighted average of growth rates in the two time periods. It can be seen that this figure (bottom row of Contribution to growth rate column) differs slightly from the growth in Community Prescribing observed when using the full year dataset (bottom of the Growth rate for full year column). This is due to the imputation method described above.

Table 39: Contribution to Community Prescribing growth 2018/19-19/20 for April-February and March

	Growth rate	Time period specific growth index	Value of Activity in 2018/19 prices	Share of overall spend	Contribution to growth rate	Growth rate for full year
Apr-Feb	3.38%	1.03	£8,094,292,941.74	91.66	94.75%	
March	13.33%	1.13	£736,753,518.27	8.34	9.45%	
Total			**£8,831,046,460.01**		**4.21%**	**4.25%**

Notes: Growth rates are total days adjusted, taking the number of days throughout 2018/19 and 2019/20.

Table 40 presents equivalent information to Table 39 for the periods April-December and January-March. The results highlight that growth from comparing output for the period April-February is very similar to comparing output for the period April-December. In contrast, growth from comparing output between January-March is much lower than when considering March alone. These findings suggest that while output might have increased to some extent in January and February of 2020 in response to COVID-19, any reaction is heavily concentrated into the month of March when explicit requests to change practice were made.

Table 40: Contribution to Community Prescribing growth 2018/19-19/20 for April-December and January-March

	Growth rate	Time period specific growth index	Value of Activity in 2018/19 prices	Share of overall spend	Contribution to growth	Growth rate for full year
Apr-Dec	3.27%	1.03	£6,663,202,967.94	75.45	77.92%	
Jan-March	6.54%	1.07	£2,167,843,489.82	24.55	26.15%	
Total			**£8,831,046,457.76**		**4.08%**	**4.25%**

Note: Growth rates are total days adjusted, taking the number of days throughout 2018/19 and 2019/20.

7. Growth in input categories

7.1. Direct labour growth measure

- **Between 2018/19 and 2019/20, the cost (salary)-weighted Laspeyres volume growth for NHS staff was 2.54%.**

From 2007/08, the direct labour growth measure is calculated using the Electronic Staff Record (ESR) data, provided by NHS Digital.[75,76,77] 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.[78] 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. [79,80]

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'.

Since 2016, information about FTE staff counts and earnings for 'core' and 'wider' services providers have been combined with wage information by taking an FTE weighted average of wages of 'core' and 'wider' services occupation codes. If wage information is missing for either 'core' or 'wider' services providers for a specific occupation code, we assume the observed wage also reflects the average for equivalent staff in the other organisation group.[81]

Table 41 shows the number of organisations reporting FTE counts information by organisation type.[82] Both Clinical Commissioning Groups (CCGs) and Trusts' figures have been decreasing over time, a fall due to mergers. The number of Commissioning Support Units (CSUs) remained the same between 2018/19 and 2019/20. Table 41 also reports total expenditure on staff by organisation type. Expenditure is calculated as the summed products of FTE staff

[75] Before 2007/08, the number of staff was extracted from the Workforce Census.
[76] More precisely, NHS Digital shares the ESR and NHS combined Payroll data with us, but these can be accessed from the NHS iView database (https://digital.nhs.uk/services/iview-and-iviewplus), which is constructed from the ESR and NHS combined Payroll and Human Resources System.
[77] 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).
[78] We drop ESR returns made by private providers, NHS Arm's-length bodies, Special Health Authorities and other NHS bodies that report to the ESR but do not fall into the included categories (e.g. Sussex Health Informatics Service (YDD81)). GP Practices do not report to ESR.
[79] If a provider-staff group cell contains fewer than 5 staff, the provider reports 0 or 5 at random.
[80] https://digital.nhs.uk/data-and-information/publications/statistical/nhs-workforce-statistics (last accessed 30/06/2021).
[81] 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.
[82] A time series of equivalent information from 2010/11 is presented in Table A 26.

employed in each occupation code and the national average total earnings for each occupation code. Differences in expenditure between 2018/19 and 2019/20 broadly reflect a continuation of existing trends.[83] The total expenditure for CCGs increased due to higher expenditure per CCG. Since April 2019, NHS England and NHS Improvement work together as a single institution. Therefore, we observe a sharper increase in NHS England's expenditure. The increase in expenditure among Trusts was greater than in most recent years. See Table A 27 for historic trends in expenditure by provider type from 2010/11 to 2019/20.

Table 41: Number of reporting organisations and expenditure by type 2017/18 – 2019/20

Organisation type	2017/18		2018/19		2019/20	
	Orgs	Exp (£m)	Orgs	Exp (£m)	Orgs	Exp (£m)
CCGs	205	849	186	895	182	939
CSUs	4	154	4	168	4	182
NHS England & NHS Improvement	1	201	1	228	1	321
Non-geographical staff	1	72	1	72	1	76
NHS Trusts	234	38,062	231	39,949*	226	42,132

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.

Table 42 reports the number of FTE staff employed by Trusts and other NHS organisations (hereafter non-Trusts) by broad categories for each year from 2017/18 to 2019/20.[84] 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 were stable over the past three years, except for 'health care assistants and other support staff' employed by other NHS organisations, which decreased from 2.2% in 2018/19 to 0.8% in 2019/20.

[83] A time series of equivalent information from 2010/11 onwards is presented in Table A 27.
[84] Table A 28 provides a longer time series of staff employed within Trusts from 2007/08 to 2019/20.

Table 42: Count of FTE staff employed by category

NHS Staff type	2017/18		2018/19		2019/20	
	Trust	Non-Trust	Trust	Non-Trust	Trust	Non-Trust
Medical staff	108,729	1,246	111,896	1,442	115,084	1,446
Ambulance staff	28,403	1	29,271	3	33,165	3
Administration and estates staff	222,946	42,730	228,686	42,471	236,469	42,652
Health care assistants and other support staff	136,183	2,020	139,600	1,201	142,077	433
Nursing, midwifery, and health visiting staff and learners	362,564	4,075	368,418	4,249	374,532	4,430
Scientific, therapeutic and technical staff and health care scientists	178,698	4,697	184,949	5,108	190,177	5,083
Unknown and Non-funded staff	4,314	164	4,529	184	2,619	109
Total	**1,041,837**	**54,933**	**1,067,349**	**54,658**	**1,094,123**	**54,156**

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.

Figure 29 shows the growth in NHS Trusts' FTE staff by the same broad staff categories from 2017/18 to 2018/19 and 2018/19 to 2019/20. Growth was faster between 2018/19 and 2019/20 for ambulance staff and administration and estates than between 2017/18 and 2018/19, but slower for all other categories. Ambulance FTE staff increased by 13% between 2018/19 and 2019/20 (29,271 FTE to 33,165 FTE) with some variations across NHS Trusts. Positive growth was seen for all categories. A residual group of unknown and unfunded staff (0.2% of the FTE total in 2019/20) is not included in the figure.

Figure 29: Growth in FTE staff by group 2017/18 to 2019/20 in Trusts

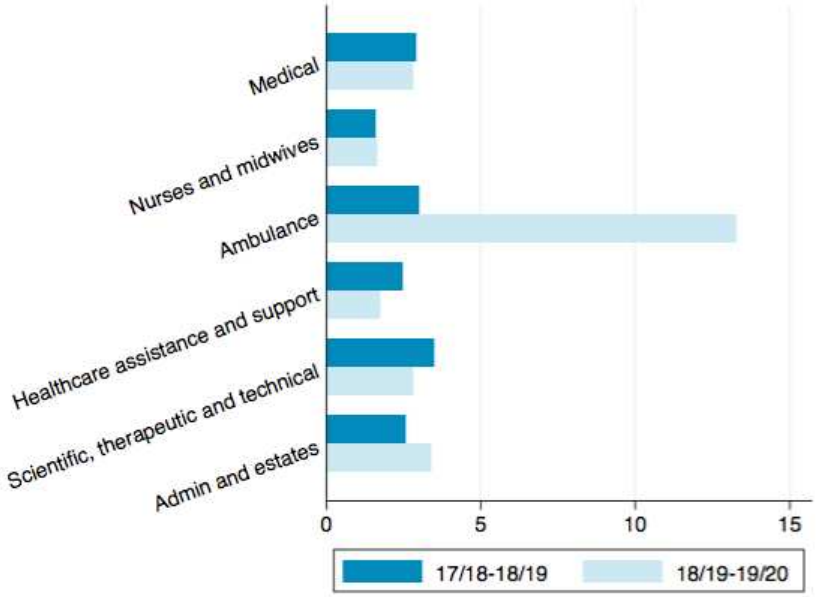


Figure 30 provides equivalent information for growth in staff employed by other NHS organisations. It indicates much larger and variable percentage changes in staff FTEs over time. Of note is the further decrease (-63% between 2018/19 and 2019/20 following -40% in

the previous financial year) in the number of FTEs classified as 'health care assistance and support staff'. This category represents 1% of the FTE total in 2018/19, a reduction by 1 percentage point compared to the previous financial year. Ambulance staff FTEs did not change between 2018/19 and 2019/20, staying at 3 FTEs. The figure does not include the ambulance staff group due to small numbers of FTEs. As shown in Table 42, large(r) proportional changes in non-Trust staff numbers are more likely but have a much smaller impact on employment in the NHS as a whole than equivalent proportional changes of employment by NHS Trusts, due to the far smaller absolute number of staff employed by other NHS organisations.

Figure 30: Growth in FTE staff by group 2017/18 to 2019/20 in non-Trusts

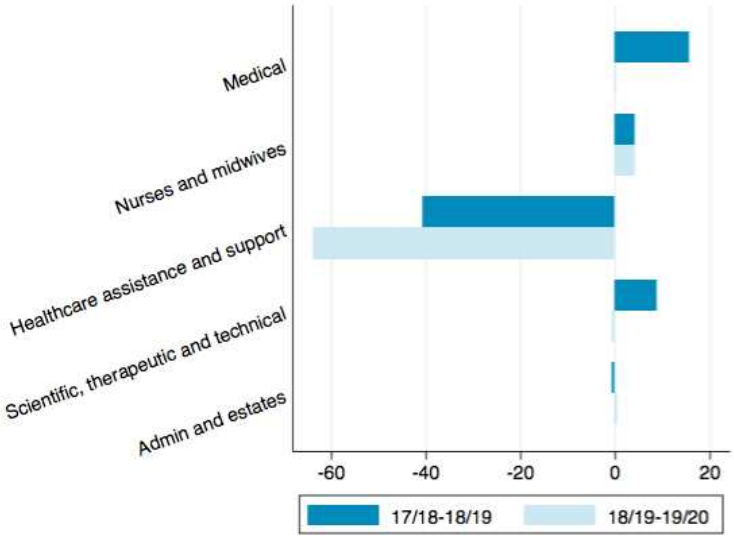


Table 43 presents nominal expenditure growth and Laspeyres volume growth in labour for the NHS overall and for Trusts alone from 2017/18 to 2019/20.[85] Laspeyres volume indices indicated growth of 2.54% overall and 2.68% for the group of Trusts between 2018/19 and 2019/20. These growth rates were larger than those recorded between 2017/18 and 2018/19. Nominal expenditure increased by 0.5 percentage points between 2017/18-18/19 and 2018/19-19/20. This applies to both the NHS as a whole and Trusts only. This reflects an increase in the unit cost of staff, supported by a Paasche price growth rate of 2.7% for Trusts and the NHS overall, and an increase in the nominal number of FTEs.

Table 43: Growth in direct labour 2017/18 – 2019/20

Years	**Nominal expenditure growth**		**Laspeyres volume growth**	
	All*	Trusts	All*	Trusts
2017/18 – 2018/19**	4.86%	4.96%	2.44%	2.54%
2018/19 – 2019/20	5.35%	5.46%	2.54%	2.68%

* All NHS organisations.

** This row gives totals for the 2018/19 year as calculated when 2019/20 was included. Differential driven by imputation from future values.

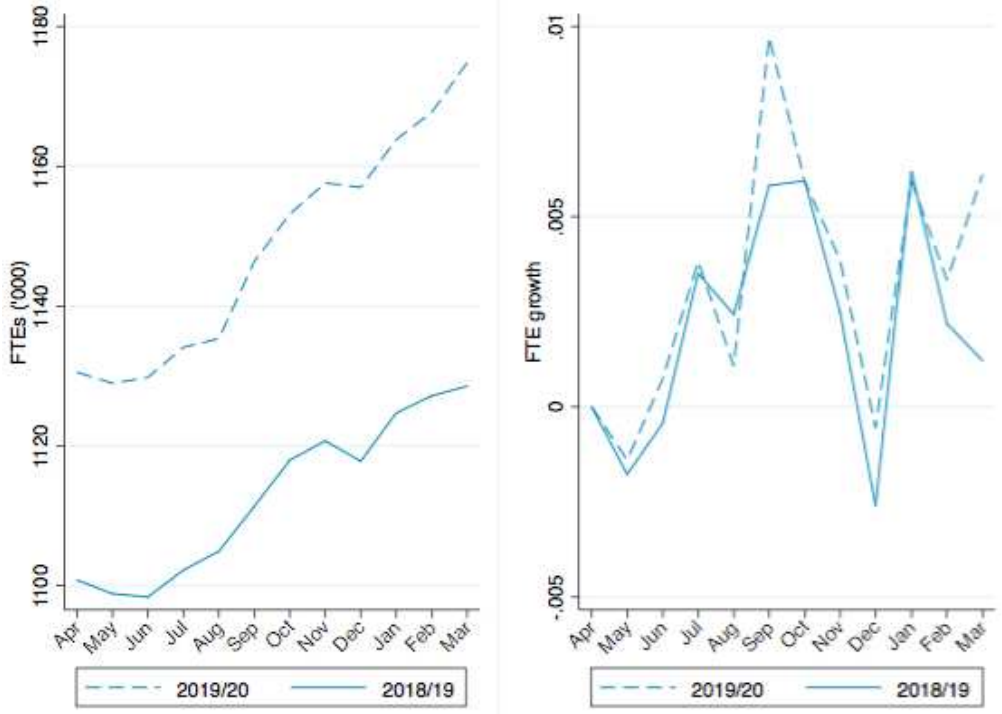
[85] See Table A 29 for the equivalent series from 2007/08 to 2019/20.

7.1.1. The impact of the COVID-19 pandemic on NHS staff inputs (direct labour)

To understand if the increase in the volume of staff in 2019/20 was significantly affected by COVID-19, we compared the monthly count and growth rates of FTEs between 2018/19 and 2019/20. Figure 31 presents both monthly counts of FTEs (left-hand side) and FTE growth rates (right-hand side).

The total number of FTEs in 2019/20 was higher than in 2018/19, but fluctuations over the year were similar. On average, in 2019/20 we observe higher growth rates compared to 2018/19. Specifically, FTEs grew by 0.6% between February and March 2019/20, whilst these grew only by 0.1% in the same period in 2018/19. We cannot find any information to link the observed increase to COVID-19. We did, however, explore NHS England and NHS Improvement management information on bank and agency staff spend and shifts to check whether we could detect an unusual increase (spike) in either of them in the same time period. Our data seem to support the fact that an increase in the workforce capacity to deal with the COVID-19 pandemic was mainly carried out through a redeployment of current NHS staff (NHS England, 2020b, NHS England, 2020a).

Figure 31: Monthly count and growth of staff FTE, 2018/19 – 2019/20



* All NHS organisations.

7.2. Indirect and mixed NHS input growth measures

- **Between 2018/19 and 2019/20, the indirect growth rate for NHS inputs was 2.41% and the mixed NHS input growth rate was 2.44%.**

7.2.1. Expenditure data sources

We employ data from published financial accounts to determine expenditure on inputs by the NHS England Group[86] 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).[87] Reporting of this information has been consistent in recent years, as shown in Table 44. The items of expenditure used to calculate Labour, Materials, and Capital in the 2018/19 – 2019/20 accounts are presented in Table 45. 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.[88,89]

Table 44: 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 – 2019/20	Trust accounts consolidation		

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. In 2017/18, the system of accounts published by all Trusts was overhauled and unified, so that items of expenditure across FTs and Non-FTs could be harmonised. 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 44 reports the sources of expenditure data used.

[86] NHS England Group includes CCGs and NHS England and NHS Improvement.
[87] https://www.gov.uk/government/publications/dhsc-annual-report-and-accounts-2019-to-2020 (last accessed 14/03/2022).
[88] https://www.parliament.uk/business/publications/written-questions-answers-statements/written-question/Commons/2014-10-22/211600/ (last accessed 09/03/2022).
[89] Information on NHS bank staff expenditure for 2018/19 is reported in https://www.england.nhs.uk/financial-accounting-and-reporting/quarterly-performance-of-the-nhs-provider-sector-quarter-4-2018-19/ (last accessed 13/12/2021), whilst that for 2019/20 was based on unpublished management information from NHSEI.

Table 45: 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 – general • 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 (not including drugs) • 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 2017/18. The items used in previous years can be found in Table A 30.

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 11.1 in Appendix B.[90]

Table 46 presents current expenditure on Labour, Materials, and Capital of the NHS England Group from 2017/18 to 2019/20. Expenditure on Labour and Materials continued the upward trend and grew by 9.09% and 2.26% respectively between 2018/19 and 2019/20. In contrast, Capital expenditure exhibits a more volatile trend but also represents a much smaller proportion of the NHS England Group expenditure compared to both Labour and Materials expenditures.

[90] A summary of NHS input growth in real terms is presented in section 5.2.

Table 46: Current expenditure by NHS England Group (£000)

Year	Labour	Materials	Capital
2017/18	1,843,108	1,747,863	518,621
2018/19	1,949,260	1,965,603	564,040
2019/20	2,126,458	2,010,019	540,885

Expenditure on Labour, Materials, and Capital among NHS Trusts is reported in Table 47. 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 9.43% in 2019/20 (5.16% if the above mentioned additional pension contributions are excluded).

Table 47: Current expenditure by NHS Trusts (£000)

Year	Labour	Materials	Capital
2017/18	51,868,888	23,470,269	7,691,102
2018/19	54,467,368	24,381,034	8,460,613
2019/20	59,601,842*	25,041,698	8,769,510

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

NHS expenditure on all input items from 2017/18 to 2019/20 is summarised in Table 48. 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 all categories continued an increasing trend, with the exception of Community Prescribing, which also saw an increase in expenditure, but has a more volatile dynamic. Expenditure on NHS staff constitutes the largest proportion of total input expenditure and saw an increase of 9.87% in 2019/20 (6.04% if additional pension contributions are excluded). In contrast, Materials and Capital recorded lower growth in nominal expenditure of 2.68% and 3.42% respectively. We also note that although expenditure on bank staff continued to rise, the decrease in agency staff's current expenditure was very moderate between 2018/19 and 2019/20, as opposed to the one observed in the previous year.

Table 48: Total NHS current expenditure 2017/18 – 2019/20 (£000)

Year	NHS Staff	Agency**	Material	Capital	Prescribing	Primary Care	TOTAL
2017/18	51,305,198	2,406,798	25,218,132	8,209,723	9,095,228	13,378,869	109,613,947
2018/19	54,016,983	2,399,645	26,346,637	9,024,653	8,833,869	13,934,642	114,556,430
2019/20	59,348,146*	-	27,051,717	9,333,550	9,281,577	14,751,852	122,146,996

* Amounts to 57,277,947 if additional pension contributions are excluded. ** Agency expenditure figures for 2019/20 are suppressed as it is unpublished management information.

[91] For further information on additional pension costs derived from an increase of the NHS Pension Scheme employer contribution rate, please see https://www.nhsbsa.nhs.uk/employer-contribution-rate-arrangements-remain-202021 (last accessed 14/03/2022).

8. Concluding remarks

NHS productivity fell by 2.14% between 2018/19 and 2019/20 when applying our preferred 'mixed' method and making maximum use of good quality output data. This continues the negative trend of the last year and also represents a higher reduction in productivity than the previous year. The indirect productivity measure also shows negative growth at a very similar rate (-2.11%) to the mixed measure. The fall in productivity growth observed between 2018/19 and 2019/20 is primarily driven by a very modest increase in output growth, coupled with a relatively more substantial increase in input growth.

NHS quality- and working days-adjusted output growth was -0.25% between 2018/19 and 2019/20, substantially lower than the 2.20% growth reported between 2017/18 and 2018/19. Input growth for the mixed measure was 2.44%, which is lower than the one recorded in the previous year (3.03%), whereas the indirectly measured input growth was equal to 2.41%, also lower than the previous year (2.93%).

Negative growth in NHS productivity is especially striking when compared to continued modest positive growth in the economy as a whole (Figure 3). In part, this can be explained by the impact of the COVID-19 pandemic, which was directly felt by the healthcare sector in March 2020, before infiltrating all elements of economic life from the very end of March and into following months and years. However, it is noteworthy that while the response to COVID-19 had a dramatic impact on measured output growth in March 2020, we are not able to ascertain the impact of this on NHS productivity growth, as input growth measure is built from expenditure data (TACs), with the exclusion of the NHS staff directly measured growth rate. For example, growth in inpatient and outpatient settings remains lower between 2018/19 and 2019/20 than between 2017/18 and 2018/19, even if comparing the months of April-February in each financial year.

Looking ahead, the impact of COVID-19 on healthcare provision in the financial year 2020/21 is dramatic and will have vital implications for how productivity growth can be measured between 2020/21 and 2019/20. The interactions between primary and secondary healthcare provision and public health will also be important.

9. Appendix A

9.1. Historic tables for productivity, output, and input growth

Table A 1: Historical series of NHS Productivity Growth

Years	Mixed	Indirect
2004/05 – 2005/06	-0.07%	0.01%
2005/06 – 2006/07	4.50%	5.07%
2006/07 – 2007/08	-0.21%	-0.04%
2007/08 – 2008/09	1.44%	1.43%
2008/09 – 2009/10	-1.25%	-1.63%
2009/10 – 2010/11	3.21%	3.74%
2010/11 – 2011/12	2.13%	2.38%
2011/12 – 2012/13	0.36%	-0.28%
2012/13 – 2013/14	2.20%	2.07%
2013/14 – 2014/15	0.53%	0.95%
2014/15 – 2015/16	0.04%	-0.19%
2014/15 – 2015/16[92]	-0.15%	-0.58%
2015/16 – 2016/17*	1.94%	1.71%
2016/17 – 2017/18*	1.70%	0.54%
2017/18 – 2018/19*'	-0.80%	-0.71%
2018/19 – 2019/20*	-2.14%	-2.11%♯

* Productivity growth obtained using working and total days adjusted output and explicitly accounting for bank staff when calculating input growth.

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

♯ Calculated excluding additional employer NHS pension contributions.

[92] The Mixed and Indirect NHS Productivity growth rates for the years 2014/15 – 2015/16 have been updated to reflect the methodological change in assigning PROMs values to activity with a UZ01 code for hospital inpatients. More details are provided in Castelli et al. (2019).

Table A 2: Historical series of NHS output growth

Years	Cost-weighted Growth (CW)	Quality-adjusted CW growth
2004/05 – 2005/06	6.53%	7.11%
2005/06 – 2006/07	5.88%	6.50%
2006/07 – 2007/08	3.41%	3.66%
2007/08 – 2008/09	5.34%	5.73%
2008/09 – 2009/10	3.44%	4.11%
2009/10 – 2010/11	3.61%	4.57%
2010/11 – 2011/12	2.38%	3.15%
2011/12 – 2012/13	2.58%	2.34%
2012/13 – 2013/14	2.37%	2.64%
2013/14 – 2014/15	2.53%	2.49%
2014/15 – 2015/16	2.16%	2.58%
2015/16 – 2016/17*	2.81%	2.98%
2016/17 – 2017/18*	2.23%	2.58%
2017/18 – 2018/19*	1.65%	2.20%
2018/19 – 2019/20*	0.38%	0.25%

* Working and total days adjusted output.

Table A 3: Historical series of NHS input growth

Years	All NHS	
	Mixed	Indirect
2004/05 – 2005/06	7.19%	7.10%
2005/06 – 2006/07	1.92%	1.36%
2006/07 – 2007/08	3.88%	3.70%
2007/08 – 2008/09	4.23%	4.24%
2008/09 – 2009/10	5.43%	5.83%
2009/10 – 2010/11	1.33%	0.80%
2010/11 – 2011/12	1.00%	0.75%
2011/12 – 2012/13	1.98%	2.63%
2012/12 – 2013/14	0.43%	0.55%
2013/14 – 2014/15	1.94%	1.52%
2014/15 – 2015/16	2.59%	2.82%
2014/15 – 2015/16*	2.73%	3.18%
2015/16 – 2016/17**	1.02%	1.25%
2016/17 – 2017/18**	0.87%	2.02%
2017/18 – 2018/19**'	3.03%	2.93%
2018/19 – 2019/20	2.44%	2.41%♯

* Updated to reflect previously missing Trusts and the shift of impairments from materials to capital expenditure.

** Figures for mixed method are obtained accounting for bank staff. Note that discrepancies with previously published figures for the indirect NHS input measures are due to corrections of a coding error.

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

♯ Calculated excluding additional employer NHS pension contributions.

9.2. Historic tables for HES inpatient day-case, mental health, and outpatient data

Table A 4: Historical series of Organisational coverage of HES activity in FCEs

Year	NHS Trusts	Private providers	Other	Total
2012/13	18,649,728	406,078	13,754	19,069,560
2013/14	19,061,786	470,454	1,873	19,534,113
2014/15	19,639,539	537,998	3,501	20,181,038
2015/16	20,049,753	557,574	1,204	20,608,531
2016/17	20,532,853	590,517	165	21,123,535
2017/18	20,826,151	611,745	192	21,438,088
2018/19*	21,603,364	625,830	115	22,229,308
2019/20*	21,736,110	633,579	404	22,370,093

* Presents figures following the translation of code from SAS 9.2 to STATA 17 and minor refinements detailed in section 6.2.1.

Table A 5: Historical series of Number of CIPS & average cost for electives and non-electives HES inpatient data

Year	Elective and day-case activity			Non-elective activity	
	# CIPS	Average cost (£)		# CIPS	Average cost (£)
2004/05	6,433,933	1,031		6,009,802	1,210
2005/06	6,864,612	1,041		6,291,117	1,241
2006/07	7,194,697	1,036		6,363,388	1,244
2007/08	7,598,796	1,091		6,593,136	1,237
2008/09	8,148,229	1,147		6,826,035	1,354
2009/10	8,465,757	1,227		6,951,379	1,413
2010/11	8,755,081	1,263		7,109,358	1,460
2011/12	8,946,909	1,287		7,049,528	1,498
2012/13*	9,030,530	1,341	1,465	7,327,228	1,532
2013/14	9,336,918	1,373	1,501	7,112,856	1,555
2014/15	9,651,505		1,523	7,414,368	1,569
2015/16	9,862,587		1,590	7,451,526	1,577
2015/16**	9,862,566		1,590	7,450,701	1,577
2016/17	10,103,760		1,569	7,579,909	1,570
2017/18	10,028,396		1,641	7,769,004	1,599
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

* From 2012/13, we use unit costs for elective inpatient care, instead of the activity weighted average unit cost of both elective inpatient care and day-cases. ** From 2015/16, CIPS are calculated using the new CIPS methodology, following the changes in the HES variable 'admission method'. *** The year 2018/19 is repeated to reflect results from minor refinements and translation from SAS 9.2 to STATA 17. Details are given in section 6.2.1

Table A 6: Historical series of Number of CIPS and average cost for electives and non-electives HES inpatient Mental Health data

Year	Elective and day-case activity		Non-elective activity	
	# CIPS	Average cost (£)	# CIPS	Average cost (£)
2004/05	45,624	689	123,983	1,012
2005/06	41,439	673	120,203	1,012
2006/07	38,408	656	115,560	1,012
2007/08	33,993	1,141	112,475	1,364
2008/09	25,792	1,133	109,636	1,319
2009/10	28,143	1,195	121,610	1,365
2010/11	30,714	1,297	125,823	1,445
2011/12	31,142	1,318	135,315	1,318
2012/13	31,078	1,358	145,787	1,358
2013/14	25,438	1,368	136,916	1,385
2014/15	24,757	1,384	131,029	1,401
2015/16	20,478	1,396	126,899	1,417
2015/16*	20,483	1,396	126,867	1,417
2016/17	19,933	1,450	114,956	1,472
2017/18	19,573	1,440	113,834	1,461
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

* From 2015/16, CIPS are calculated using the new CIPS methodology, following the changes in the HES variable 'admission method'.
** The year 2018/19 is repeated to reflect results from minor refinements and translation from SAS 9.2 to STATA 17. Details are given in section 6.2.1.

Table A 7: Historical series of Volume and average costs for HES outpatient data

Year	All providers (excl. ISHP and 'Other providers')	
	Volume of activity	Average cost (£)
2011/12	88,926,968	114
2012/13	90,850,009	116.98
2013/14	96,690,559	117.18
2014/15	101,382,540	118.26
2015/16	107,092,657	118.37
2016/17	112,038,760	121.74
2017/18	112,986,081	127.27
2018/19*	90,972,391	131.67
2019/20*	91,004,047	137.11

* Due to refinements made in identifying outpatient activity described in detail in section 6.3, activity and mean costs in 2018/19 are repeated with these refinements included, so as to be comparable with information for 2019/20.

9.3. Historic tables for Reference Costs/National Cost Collection data

Table A 8: Historical series of Volume and average costs of Outpatient data

Year	Outpatient			
	All providers		Trusts only	
	Volume of activity	Average cost (£)	Volume of activity	Average cost (£)
2007/08	69,679,600	94	61,508,362	98
2008/09	74,421,017	98	65,804,814	103
2009/10	80,093,906	101	71,115,142	105
2010/11	81,301,615	105	73,621,984	107
2011/12	-	-	75,826,947	108
2012/13	-	-	77,222,725	111
2013/14	-	-	81,699,802	114
2014/15	-	-	83,856,229	117
2015/16	-	-	85,394,479	120
2016/17			87,017,943	122
2017/18			87,714,235	127
2018/19			87,944,919	130
2019/20			84,849,738	137

Table A 9: Historical series of Volume and average costs of Accident & Emergency data

Year	Emergency departments						Other A&E services					
	AD		NAD		Unknown		AD		NAD		Unknown	
	Volume of activity	Average cost (£)	Volume of activity	Average cost (£)	Volume of activity	Average cost (£)	Volume of activity	Average cost (£)	Volume of activity	Average cost (£)	Volume of activity	Average cost (£)
2006/07	3,464,869	107	10,327,147	83			281,135	50	3,900,718	36		
2007/08	3,326,719	121	9,058,765	89			531,498	70	3,769,765	43		
2008/09	3,566,642	129	9,708,958	95			1,000,986	49	4,184,796	49		
2009/10	4,047,176	134	10,075,701	103			1,090,650	49	3,628,469	50		
2010/11	4,004,868	141	9,881,747	108			1,145,125	62	3,800,261	55		
2011/12	4,040,760	157	10,405,762	108			616,812	83	3,253,452	52		
2012/13	4,345,100	160	10,292,933	115			362,656	90	3,426,231	59		
2013/14	4,218,480	177	10,189,225	127			494,549	80	3,639,355	59		
2014/15	4,050,701	206	10,636,666	133			446,779	65	3,972,875	61		
2015/16	4,101,720	219	10,921,696	140			473,723	69	4,202,986	60		
2016/17	3,966,820	238	11,039,457	152			472,913	78	4,515,570	67		
2017/18	4,313,593	247	11,100,308	164			280,645	69	4,255,912	67		
2018/19	3,738,454	263	12,215,524	171			48,101	116	4,388,481	72		
2019/20	2,911,499	314	10,238,989	185	2,317,415	206	93,774	170	3,834,871	76	603,672	81

Table A 10: Historical series of Volume and average costs of Ambulance services data

Year	Ambulance services									
	Calls		Hear and treat or refer		See and treat or refer		See and treat and convey		Other	
	Volume of activity	Average cost (£)	Volume of activity	Average cost (£)	Volume of activity	Average cost (£)	Volume of activity	Average cost (£)	Volume of activity	Average cost (£)
2011/12	8,530,563	8	338,022	44	1,862,892	173	4,895,376	230		
2012/13	9,120,422	7	423,821	47	1,997,327	174	4,984,296	230		
2013/14	8,926,215	7	400,005	44	2,113,757	180	5,069,806	231		
2014/15	9,491,159	7	575,168	35	2,270,229	180	5,107,902	233		
2015/16	9,794,437	7	782,665	34	2,347,808	181	5,167,876	236		
2016/17	10,238,451	7	806,804	37	2,441,651	181	5,277,120	247		
2017/18	10,995,578	7	886,175	37	2,459,394	192	5,325,368	252		
2018/19	10,039,191	7	799,332	47	2,480,819	209	5,421,377	257		
2019/20	-	-	950,906	52	2,705,547	206	5,362,217	292	1,778,309	70

Table A 11: Historical series of Volume and average costs of Chemotherapy, Radiotherapy and High Cost Drugs data

Year	Chemotherapy		Radiotherapy		High Cost Drugs	
	Volume of activity	Average cost (£)	Volume of activity	Average cost (£)	Volume of activity	Average cost (£)
2004/05	777,312	363	1,622,278	113		-
2005/06	763,806	432	1,634,156	126		-
2006/07	1,642,444	280	1,743,490	123	26,277,491	17
2007/08	846,425	406	1,613,135	132	1,332,996	305
2008/09	1,428,561	448	1,710,525	157	1,322,354	473
2009/10	1,414,872	505	1,835,695	163	2,412,988	384
2010/11	1,515,845	515	2,001,798	161	1,288,460	818
2011/12	1,769,727	505	2,492,431	137	1,372,131	902
2012/13	2,525,935	387	2,717,024	127	1,511,644	878
2013/14	2,540,353	431	2,760,237	134	1,687,711	859
2014/15	2,729,954	449	2,855,371	135	1,982,162	877
2015/16	2,913,719	454	2,018,956	188	2,115,966	942
2016/17	2,253,067	605	1,929,548	198	2,288,895	917
2017/18	2,639,406	569	1,921,222	218	2,557,373	828
2018/19	2,707,943	600	1,962,279	213	2,477,645	799
2019/20	2,606,064	657	1,855,549	238	2,774,471	756

Table A 12: Historical series of Volume and average costs of Community Care data

Year	Community care	
	Volume of activity	Average cost (£)
2004/05	75,673,792	39
2005/06	85,092,838	38
2006/07	83,895,139	40
2007/08	85,470,688	42
2008/09	88,513,663	45
2009/10	92,412,727	46
2010/11	90,724,524	47
2011/12	78,315,576	50
2012/13	79,709,044	52
2013/14	85,975,592	57
2014/15	85,733,534	59
2015/16	86,767,072	60
2016/17	87,751,894	61
2017/18	84,708,536	62
2018/19	81,794,290	64
2019/20	76,106,927	70

Table A 13: Historical series of Volume and average costs of Diagnostic Tests data

Year	Directly accessed diagnostic services		Directly accessed pathology services		Radiology	
	Volume of activity	Average cost (£)	Volume of activity	Average cost (£)	Volume of activity	Average cost (£)
2004/05	369,988	44	180,676,234	3	5,152,720	31
2005/06	465,622	44	221,966,384	2	5,784,605	33
2006/07	735,569	137	236,269,050	2	23,918,500	59
2007/08	776,368	41	257,249,379	2	7,614,437	103
2008/09	804,607	46	278,917,852	2	7,852,498	102
2009/10	1,063,744	43	300,010,031	2	8,347,404	104
2010/11	1,458,025	39	320,418,662	2	8,491,834	97
2011/12	5,640,762	34	333,108,317	2	8,758,136	93
2012/13	6,339,016	30	335,941,593	2	9,381,616	92
2013/14	6,553,727	31	361,952,265	2	9,709,456	93
2014/15	7,128,172	32	356,528,477	2	9,440,280	88
2015/16	7,467,097	31	359,911,813	2	10,755,438	97
2016/17	7,849,478	32	374,847,731	2	11,342,904	95
2017/18	7,777,205	32	417,460,632	2	10,975,838	99
2018/19	7,613,040	33	426,076,050	2	9,961,010	98
2019/20	7,053,907	36	392,755,757	2	11,524,610	90

Table A 14: Historical series of Volume and average costs of Community Mental Health data

Year	Community mental health		
	Volume of activity	Volume of activity	Average cost (£)
2004/05	16,389,891		164
2005/06	17,738,894		170
2006/07	19,259,205		167
2007/08	21,751,043		153
2008/09	22,674,811		157
2009/10	23,440,616		161
2010/11	24,341,950		159
2011/12*		224,329,080	28
2012/13		260,266,214	24
2013/14		259,659,214	25
2014/15		262,460,243	25
2014/15		259,036,112	25
2015/16		253,275,018	26
2015/16		253,346,232	23
2016/17		250,019,639	24
2017/18		244,730,237	25
2018/19		236,958,442	27

* Due to the reclassification of activity in Community Mental Health, data from 2011/12 are not directly comparable with those reported in previous years. Hence, Community mental health activity was excluded from the calculations of both the Community Mental Health and the overall NHS output growth indices for the pair of years 2010/11 to 2011/12.

Table A 15: Historical series of Volume and average costs of Rehabilitation and Renal Dialysis data

Year	Rehabilitation		Renal dialysis	
	Volume of activity	Average cost (£)	Volume of activity	Average cost (£)
2004/05	4,095,087	178	8,232,432	52
2005/06	4,509,489	185	6,819,136	64
2006/07	3,028,598	241	4,200,298	104
2007/08	2,732,048	259	3,980,793	114
2008/09	3,277,757	265	4,091,245	120
2009/10	3,277,430	279	4,050,658	129
2010/11	3,314,085	285	4,088,817	129
2011/12	2,897,721	278	4,166,150	129
2012/13	2,715,650	301	4,135,914	128
2013/14	3,002,512	298	4,069,460	131
2014/15	3,008,889	317	4,070,447	131
2015/16	2,985,717	332	4,157,008	134
2016/17	2,893,451	332	4,240,850	134
2017/18	2,865,116	328	4,277,315	135
2018/19	2,298,007	378	4,275,328	135
2019/20	2,250,425	403	4,240,238	144

Table A 16: Historical series of Volume and average costs of Specialist services data

Year	Critical care		Specialist palliative care		Cystic fibrosis		Cancer multi-disciplinary team meetings	
	Volume of activity	Average cost (£)	Volume of activity	Average cost (£)	Volume of activity	Average cost (£)	Volume of activity	Average cost (£)
2004/05	2,184,333	828	-	-	16,317	1,919	-	-
2005/06	2,197,135	895	-	-	13,704	2,316	-	-
2006/07	2,468,777	840	93,880	269	13,944	2,290	-	-
2007/08	2,165,060	931	208,410	219	15,383	2,349	-	-
2008/09	2,354,447	967	262,305	216	20,756	2,116	-	-
2009/10	2,439,661	1,003	359,121	192	20,323	2,468	-	-
2010/11	2,470,065	1,011	512,972	162	19,942	2,631	-	-
2011/12	2,570,571	998	550,417	166	9,852	8,476	837,418	114
2012/13	2,669,343	984	600,848	169	9,735	8,709	1,079,297	106
2013/14	2,708,897	992	701,439	158	9,990	10,213	1,279,567	101
2014/15	2,746,664	1,044	775,488	157	10,767	9,810	1,434,580	111
2015/16	2,777,403	1,081	855,702	146	11,845	9,100	1,517,387	111
2016/17	2,792,536	1,082	914,564	152	11,489	9,198	1,708,174	111
2017/18	2,717,180	1,159	967,805	153	10,934	9,766	1,800,465	114
2018/19	2,698,927	1,218	807,252	181	12,208	9,343	1,922,238	112
2019/20	2,483,865	1,347	860,467	181	-	-	1,890,595	118

Table A 17: Historical series of Volume and average costs of 'Other NHS' activity data

Year	Regular day and night admissions		Audiological services		Day care facilities		Hospital at home/Early discharge schemes*	
	Volume of activity	Average cost (£)	Volume of activity	Average cost (£)	Volume of activity	Average cost (£)	Volume of activity	Average cost (£)
2004/05	122,447	248	1,902,390	41	735,070	124	434,698	73
2005/06	177,131	245	1,692,721	40	649,963	131	593,586	60
2006/07	179,927	271	2,905,175	50	439,932	135	470,737	74
2007/08	164,651	324	3,447,049	51	384,048	137	405,271	73
2008/09	198,573	341	3,716,333	51	345,371	159	522,047	68
2009/10	152,079	393	3,807,539	52	319,706	156	495,961	81
2010/11	176,169	431	3,927,780	51	321,386	148	364,352	91
2011/12	176,877	428	4,033,290	50	275,819	140	323,213	113
2012/13	210,984	371	4,030,693	52	237,040	157	285,754	108
2013/14	204,831	400	3,483,549	55	239,032	146	-	-
2014/15	223,302	355	2,918,029	60	266,333	131	-	-
2015/16	224,523	389	3,523,847	57	241,756	131	-	-
2016/17	242,322	325	3,452,571	57	191,547	125	-	-
2017/18	284,842	327	3,293,426	58	277,092	102	-	-
2018/19	328,946	341	3,044,139	61	220,424	70	-	-
2019/20	331,177	378	2,846,031	69	93,698	167	-	-

* Hospital at Home services are now captured under Community Intermediate Care activities in the Community Care setting.

9.4. Historic tables for Dentistry and ophthalmology

Table A 18: Historical series of Volume and average costs of Ophthalmological Services data

Year	Ophthalmology		
	Volume of activity	Average cost (£)	Average cost (£) - New source
2004/05	10,148,978	33	
2005/06	10,354,682	35	
2006/07	10,484,922	36	19
2007/08	11,047,890	28	19
2008/09	11,278,474	28	20
2009/10	11,811,651	28	20
2010/11	11,938,529	28	21
2011/12	12,305,727	28	21
2012/13	12,339,253	28	21
2013/14	12,787,430	28	21
2014/15	12,764,485	28	21
2015/16	12,979,762	28	21
2016/17	12,995,512	28	21
2017/18	13,032,582	28	21
2018/19	13,225,755	28	21
2019/20	13,355,060	28	21

Table A 19: Historical series of Volume and average costs of Dental Services data

Year	Dentistry										
	Band 1		Band 2		Band 3		Urgent		Other		Total
	Volume of activity	Average cost (£)	Volume of activity	Average cost (£)	Volume of activity	Average cost (£)	Volume of activity	Average cost (£)	Volume of activity	Average cost (£)	
2004/05*											2,241,095,331
2005/06*											2,433,471,413
2006/07	19,012,890	16	10,687,669	42	1,529,129	189	2,881,205	16	939,871	16	1,096,089,020
2007/08	19,275,334	17	10,991,870	46	1,684,537	198	3,133,209	17	901,975	17	1,219,391,145
2008/09	19,803,371	17	11,489,585	46	1,859,524	198	3,343,459	17	930,279	17	1,289,383,127
2009/10	20,346,012	17	11,699,635	46	2,086,179	198	3,509,055	17	948,634	17	1,355,827,865
2010/11	20,718,874	17	11,804,774	46	2,187,483	198	3,615,027	17	918,371	17	1,388,081,816
2011/12	20,886,648	17	11,862,329	46	2,217,060	198	3,685,411	17	919,217	17	1,400,506,136
2012/13	21,016,444	18	11,750,849	48	2,239,287	209	3,712,031	18	603,054	18	1,475,353,493
2013/14	21,685,314	18	11,801,493	49	2,232,243	214	3,852,470	18	190,216	18	1,519,077,159
2014/15	22,028,232	19	11,446,920	51	2,177,960	219	3,780,401	19	178,531	19	1,535,805,234
2015/16	22,437,889	18.8	11,251,942	51.3	2,129,467	222.5	3,693,752	18.8	169,831	18.8	1,545,498,706
2016/17	22,939,419	20	11,080,848	54	2,082,785	234	3,664,913	20	156,905	20	1,611,200,931
2017/18	22,814,753	21	10,699,157	56.3	1,987,657	244	3,566,835	21	144,888	21	1,634,392,550
2018/19	23,386,880	22	10,631,216	59	1,941,217	257	3,620,927	22	136,476	22	1,712,543,539
2019/20	23,009,601	23	9,777,565	62	1,833,103	269	3,637,713	23	123,192	23	1,708,531,889

* Units of Dental Activity (UDAs) are reported from 2006/07 onwards. For the financial years 2004/05 and 2005/06, we calculated UDAs by multiplying the respective volumes of activity by the average weight of dental course treatments in 2006/07 (Bojke et al., 2015).

9.5. Historic tables for Primary care activity

The figures for Primary care activity reported in Table A 20, Table A 21, and Table A 23 use data derived from the General Practice Patient Survey data, which were used to estimate change in primary care activity up until 2017/18. A new source of data is now used – see section 6.6 in the main report for further details.

Table A 20: Historical series for CHE GPPS based measure of volume of consultations data

Year	Patients who report having seen a GP in previous 3 months	Patients who report having seen a nurse in previous 3 months	Number of consultations	Population adjusted number of consultations	Quality and population adjusted number of consultations
			QR		
2004/05				265,600	274,122
2005/06				283,100	293,733
2006/07				293,000	305,517
2007/08				292,500	305,291
2008/09				300,400	313,815
			GLS		
2009/10	53.55%		300,400	300,400	313,988
			GPPS		
2010/11	52.37%		293,517		303,355
2011/12	54.00%		303,820		317,893
			Population Adjustment*		
2011/12	54.00%		303,764	319,661	334,468
2012/13	54.83%		308,433	327,301	342,667
2013/14	54.28%		305,328	328,199	343,942
			Age & Gender Adjustment		
2013/14**	54.28%	35.91%	301,253	314,366	329,415
2014/15**	53.28%	35.86%	298,024	313,865	328,965
2015/16**	51.47%	34.81%	288,092	306,093	321,736
2016/17	50.32%	35.87%	287,569	313,792	328,841
2017/18***	50.32%	35.87%	287,569	316,558	331,701

* The population adjustments are based on estimates for England only, and since 2013/14 these have also been adjusted for age and gender.

** Up to 2013/14, the number of consultations was based on those reporting they had seen a GP within the previous 3 months. From 2013/14 onwards, the number also includes those who had seen a primary care nurse. As a baseline, this calculation also takes the number of consultations reported by QResearch for the 2008/09 financial rather than calendar year (303,900,000) (http://content.digital.nhs.uk/pubs/gpcons95-09 (last accessed 27/02/2021)).

*** 2017/18 responses assumed to be the same as in 2016/17.

Table A 21: Historical series for PSSRU unit costs for consultation types (£) data

Year	GP Home visit	GP Telephone	GP Surgery	GP Other	Practice Nurse	Other Consultations
2004/05	69	30	24	24	10	15
2005/06	69	27	24	24	10	15
2006/07	55	21	34	34	9	14
2007/08	58	22	36	36	11	15
2008/09	117	21	35	35	11	14
2009/10	120	22	36	36	12	17
2010/11	121	22	36	36	13	25
2011/12	110	26	43	43	14	25
2012/13	114	27	45	45	13	25
2013/14	114	28	46	46	14	25
2014/15	114	27	44	44	14	25
2015/16	114	15[a]	36[b]	36	11	N/A
2016/17	114	15	37	37	11	N/A
2017/18	114	15	37	37	11	N/A
2018/19	122	22	40	22[c]	-	-
2019/20	122	22	40	22	-	-

[a] Estimates extracted from a telephone triage GP-led cost estimates; [b] Duration of GP consultation contact has been reduced from 11.7 to 9.22 minutes. [c] Other refers to Video / online GP-led consultations.

Table A 22: Historical series for Quality adjustment for primary care data (%)

Year	Prevalence			QOF achievement		
	CHD	Stroke	Hypertension	CHD	Stroke	Hypertension
2004/05	3.57	1.63	10.41	78.6	73.13	64.33
2005/06	3.57	1.66	11.48	84.44	81.22	71.05
2006/07	3.54	1.61	12.49	88.86	86.92	77.62
2007/08	3.5	1.63	12.79	89.41	87.51	78.35
2008/09	3.47	1.66	13.13	89.68	87.88	78.56
2009/10	3.44	1.68	13.35	89.77	88.12	78.72
2010/11	3.4	1.71	13.52	90.16	88.57	79.3
2011/12	3.38	1.74	13.63	90.14	88.61	79.65
2012/13	3.4	1.7	13.68	90.57	89.26	80.79
2013/14	3.29	1.72	13.73	91.27	89.84	83.09
2014/15	3.25	1.73	13.79	91.98	88.17	83.61
2015/16	3.2	1.74	13.81	91.89	87.63	82.9
2016/17	3.15	1.75	13.83	92.43	88.06	83.36
2017/18	3.13	1.77	13.94	92.11	87.40	82.60
2018/19	3.10	1.77	13.96	92.37	87.66	83.01
2019/20 a	3.09	1.80	14.10	82.02	79.01	72.42
2019/20 b				89.54	88.84	84.84

Note: in 2019/20 the achievement measures are defined differently and reported for 2 separate age groups: below 80 (a), and 80 and above (b).

Table A 23: Historical series of primary care growth

Years	Unadjusted Growth rate	Population adjusted growth rate	Population and quality-adjusted growth rate
2004/05 – 2005/06		6.59%	7.15%
2005/06 – 2006/07		3.50%	4.01%
2006/07 – 2007/08		-0.17%	-0.07%
2007/08 – 2008/09		2.70%	2.79%
2008/09 – 2009/10		0.00%	0.06%
2009/10 – 2010/11	-2.61%	-1.11%	-0.99%
2010/11 – 2011/12	3.83%	4.66%	4.70%
2011/12 – 2012/13	1.54%	2.39%	2.45%
2012/13 – 2013/14	-1.01%	0.27%	0.37%
2013/14 – 2014/15	-1.07%	-0.16%	-0.14%
2014/15 – 2015/16	-3.33%	-2.48%	-2.51%
2015/16 – 2016/17	-0.18%	-0.86%	-0.89%
2016/17 – 2017/18	0.00%	0.88%	0.87%

9.6. Historic tables for Community prescribing

Table A 24: Historical series of Community prescribing

Year	Unique drug codes observed	Total Prescriptions	Total items prescribed	Total Spend	Activity weighted prescription unit cost (£)	Activity weighted prescribed item unit cost (£)
2004/05	8,779	691,948,868	61,657,885,237	£8,094,174,944	11.7	0.124
2005/06	8,535	733,010,929	64,042,525,435	£8,013,483,226	10.93	0.126
2006/07	8,218	762,631,738	67,468,607,795	£8,250,323,893	10.82	0.119
2007/08	8,769	803,297,137	70,369,213,090	£8,303,500,918	10.34	0.117
2008/09	8,276	852,482,281	73,093,309,000	£8,376,264,432	9.83	0.114
2009/10	8,072	897,727,347	77,363,704,790	£8,621,421,130	9.6	0.108
2010/11	7,860	936,743,859	81,139,818,758	£8,880,735,344	9.48	0.106
2011/12	7,856	973,381,568	83,740,259,688	£8,777,964,802	9.02	0.106
2012/13	7,699	1,001,825,994	84,155,589,191	£8,397,492,181	8.38	0.104
2013/14	7,353	1,031,703,347	85,248,941,535	£8,540,423,964	8.28	0.099
2013/14*	7,809	1,039,535,998	88,367,797,837	£8,703,169,718	8.37	0.098
2014/15	7,926	1,071,065,672	90,023,427,433	£8,942,734,216	8.35	0.099
2015/16	8,021	1,087,838,465	91,268,963,611	£9,288,424,660	8.54	0.102
2016/17	8,147	1,108,965,909	92,167,433,244	£9,193,912,893	8.29	0.100
2017/18	7,803	1,106,431,880	89,638,486,058	£9,095,228,060	8.22	0.101
2018/19	7,755	1,109,084,896	87,947,789,280	£8,833,869,014	7.96	0.101
2018/19**	7,755	1,109,084,896	87,944,499,163	£8,831,046,458	7.96	0.101
2019/20**	7,623	1,132,043,733	88,504,273,870	£9,224,298,376	8.15	0.101

* In February 2017, NHS Digital released a new set of prescribing data to include previously omitted drug codes. The 2012/13 – 2013/14 growth figures for prescribing are based on the earlier data; whilst the 2013/14 – 2014/15 growth figures are based on the new data.

** Due to refinements in the methodology for calculating community prescribing in the 2019/20 update, detailed in section 6.7.1

Table A 25: Historical series of Community prescribing
Price and Volume growth

Years	Paasche Price Ratio	Laspeyres Volume Ratio
2004/05 – 2005/06	0.9014	1.0984
2005/06 – 2006/07	0.9659	1.0659
2006/07 – 2007/08	0.9376	1.0735
2007/08 – 2008/09	0.9485	1.0636
2008/09 – 2009/10	0.9626	1.0693
2009/10 – 2010/11	0.9833	1.0476
2010/11 – 2011/12	0.9564	1.0335
2011/12 – 2012/13	0.9284	1.0356
2012/13 – 2013/14	0.9855	1.032
2013/14 – 2014/15*	0.9869	1.0411
2014/15 – 2015/16	0.9993	1.0394
2015/16 – 2016/17	0.9300	1.0644
2016/17 – 2017/18	0.9742	1.0155
2017/18 – 2018/19	0.9477	1.0249
2018/19 – 2019/20	0.9992	1.0425

* In February 2017, NHS Digital released a new set of prescribing data to include previously omitted drug codes. The 2012/13 – 2013/14 growth figures for prescribing are based on the earlier data; whilst the 2013/14 – 2014/15 growth figures are based on the new data.

9.7. Historic tables for direct labour

Table A 26: Historical series of NHS organisations reporting ESR data

Year	Organisation Type						
	CCGs	CSUs	NHS England	Non-geographical staff	PCTs	SHA	NHS Trusts
2010/11	n/a	0	0	0	147	10	248
2011/12	n/a	0	0	1	142	10	260
2012/13	9	0	1	1	132	10	260
2013/14	152	24	1	1	40	2	251
2014/15	202	25	1	1	26	0	249
2014/15*	202	22	1	1	10	4	249
2015/16	201	11	1	1	0	0	249
2016/17	204	8	1	1	0	0	239
2017/18	205	4	1	1	0	0	234
2018/19	186	4	1	1	0	0	231
2019/20	182	4	1	1	0	0	226

Note: CCGs: Clinical Commissioning Groups; CSUs: Commissioning Support Units; Non-Geographic Central Staff, code AHO; PCTs: Primary Care Trusts; SHA: Strategic Health Authorities; n/a not applicable.
* This row corresponds to NHS staff numbers for the financial year 2014/15 updated to the new methodology implemented by NHS Digital in March 2016.

Table A 27: Historical series of Expenditure (£000) on NHS staff by organisation type

Year	Organisation Type						
	CCGs	CSUs	NHS England	Non-geographical staff	PCTs	SHA	NHS Trusts
2010/11	0	0	0	0	5822	133	28,809
2011/12	0	0	0	157	3742	114	31,761
2012/13	7	0	1	143	1329	110	33,753
2013/14	434	318	221	76	89	0.4	34,510
2014/15	535	306	205	71	1	0	35,820
2014/15*	530	333	202	16	0.15	0.32	35,131
2015/16	618	261	171	8	0	0	36,319
2016/17	722	211	173	57	0	0	37,492
2017/18	849	154	201	72	0	0	38,062
2018/19	895	168	228	72	0	0	39,949**
2019/20	939	182	321	76	0	0	42,132

* This row corresponds to NHS staff numbers for the financial year 2014/15 updated to the new methodology implemented by NHS Digital in March 2016.
** This value was updated when 2019/20 was included. Differential driven by imputation from future values.

Table A 28: Historical series of count of FTE staff employed by category in NHS Trusts

	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2014/15[b]	2015/16	2016/17	2017/18	2018/19	2019/20
GPs[a]	33,730	34,043	36,085	35,243	35,319	35,871	36,294	n/a	n/a	n/a	n/a	n/a	n/a	n/a
GP Practice staff	75,085	73,292	72,153	73,306										
GP Practice staff – new method				82,802	84,609	85,546	87,114	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Medical staff	84,811	90,460	93,393	95,531	99,331	100,878	100,797	104,189	102,764	104,009	105,565	108,729	111,896	115,084
Ambulance staff	21,149	23,084	24,489	25,056	24,908	24,566	24,757	25,381	25,028	26,008	27,451	28,403	29,271	33,165
Administration and estates staff	237,264	243,018	262,479	263,723	250,539	242,980	239,359	245,504	208,961	213,880	218,700	222,946	228,686	236,469
Health care assistants and other support staff	101,114	106,406	112,710	114,786	116,643	116,018	119,138	123,870	121,564	126,549	133,050	136,183	139,600	142,077
Nursing, midwifery, and health visiting staff and learners	366,520	372,132	379,841	380,114	377,948	363,781	366,246	372,060	359,221	359,826	362,774	362,564	368,418	374,532
Scientific, therapeutic and technical staff and health care scientists	141,754	150,056	159,538	165,454	168,750	164,312	165,683	173,536	165,188	167,438	173,399	178,698	184,949	190,177
Unknown and Non-funded staff	4,327	3,595	3,462	3,351	3,055	2,652	2,423	0	3,544	3,757	4,194	4,314	4,529	2,619
Total	1,065,754	1,096,086	1,144,150	1,239,366	1,161,102	1,136,604	1,141,811	1,044,540	986,270	1,001,467	1,025,133	1,041,837	1,067,349	1,094,123

Notes: FTE data up to 2006/07 are taken from the Workforce Census data. FTE data from 2007/08 onwards are taken from organisational returns of Electronic Staff Records. When there are 5 or less people employed in an occupational group, organisations report either 5 or 0; these totals therefore will differ from those derived from national level data.

[a] Data for GPs and GP practice staff are not available from ESR; Workforce Census data are used instead; there were also changes in the counting of GP Practice staff, therefore data from 2010/11 onwards are not comparable to previous years. NHS Digital stopped reporting the GP figures in 2014/15.

[b] This column corresponds to NHS staff numbers for the financial year 2014/15 updated to the new methodology implemented by NHS Digital in March 2016.

Table A 29: Historical series of direct NHS Labour growth

Years	Nominal expenditure growth		Laspeyres volume growth	
	All*	Trusts	All*	Trusts
2007/08 – 2008/09	7.61%	7.21%	4.14%	3.77%
2008/09 – 2009/10	7.03%	6.55%	4.54%	4.15%
2009/10 – 2010/11	2.62%	3.70%	1.42%	2.95%
2010/11 – 2011/12	2.91%	10.25%	0.10%	7.26%
2011/12 – 2012/13	-1.21%	6.27%	-1.97%	5.50%
2012/13 – 2013/14	0.87%	2.24%	0.38%	1.71%
2013/14 – 2014/15	3.67%	3.80%	2.80%	2.92%
2014/15 – 2015/16	3.17%	3.38%	1.32%	1.47%
2015/16 – 2016/17	3.42%	3.19%	2.36%	2.19%
2016/17 – 2017/18	2.04%	1.52%	2.36%	1.88%
2017/18 – 2018/19**	4.86%	4.96%	2.44%	2.54%
2018/19 – 2019/20	5.35%	5.46%	2.54%	2.68%

* All NHS organisations.
** This row gives totals for the 2018/19 year as calculated when 2019/20 was included. Differential driven by imputation from future values.

9.8. Historic tables for expenditure on inputs

Table A 30: Materials and capital items pre-2017/18

Organisation	Materials	Capital
Foundation Trusts and NHS Trusts *Source: Financial Monitoring & Accounts Consolidated NHS Financial Trusts Accounts*	• Services from Other NHS Trusts • Services from PCTs • Services from Other NHS Bodies • Services from Foundation Trusts • Purchase of Health care from Non-NHS Bodies • Supplies & Services – Clinical • Supplies & Services – General • Consultancy Services • Transport • Audit fees • Other Auditors Remuneration • Clinical Negligence • Research & Development (excluding staff costs) • Education & Training • Establishment • Other	• Premises • Impairments & Reversals of Receivables • Inventories write downs • Depreciation • Amortisation • Net Impairment of Property, Plant & Equipment • Net Impairment of Intangible Assets • Net Impairment of Financial Assets • Net Impairment for Non-Current Assets held for sale • Net Impairments for Investment Properties
NHS England Group *Source: DH Annual Report & Accounts*	• Consultancy Services • Transport • Clinical Negligence Costs • Establishment • Education, Training & Conferences • Supplies & Services – Clinical • Supplies & Services – General • Inventories consumed • Research & Development Expenditure • Other	• Premises • Impairment of Receivables • Rentals under operating leases • Depreciation • Amortisation • Impairments & reversals • Interest Charges

Table A 31: Historical series of current expenditure by PCTs and NHS England Group (£000)

Organisation	Year	Labour	Materials	Capital
PCTs	2007/08	6,701,228	2,617,114	1,174,841
	2008/09	7,478,953	2,526,610	1,247,997
	2009/10	8,230,341	2,623,459	1,703,974
	2010/11	7,175,399	2,638,638	1,171,813
	2011/12	2,328,314	2,052,029	892,604
	2011/12*	2,358,373	860,860	1,721,795
	2012/13*	1,938,770	885,265	1,814,809
NHS England Group	2013/14*	1,529,067	1,420,027	696,400
	2014/15*	1,726,006	1,457,798	536,383
	2015/16*	1,741,655	1,960,006	502,897
	2016/17*	1,781,455	1,714,391	470,188
	2017/18*	1,843,108	1,747,863	518,621
	2018/19*	1,949,260	1,965,603	564,040
	2019/20	2,126,458	2,010,019	540,855

* Data up to 2010/11 are taken from Financial Returns and from 2011/12 onwards from DH Annual Report and Accounts. Material and capital items are identified differently in each source.

Table A 32: Historical series of current expenditure by Trusts (£000)

Year	Labour	Materials	Capital
2007/08	30,884,556	10,140,836	6,452,630
2008/09	33,435,219	11,322,441	6,340,019
2009/10	35,983,781	12,115,273	6,529,977
2010/11	38,222,951	12,961,217	6,839,898
2011/12	42,647,889	14,941,588	7,278,435
2011/12*	42,701,684	17,477,370	12,097,485
2012/13*	43,797,935	19,681,855	12,377,259
2013/14*	45,360,562	21,108,612	13,217,703
2014/15*	46,847,155	21,983,076	12,747,384
2014/15*§	47,170,735	22,125,031	12,787,098
2015/16*§~	48,748,162	23,644,352	13,396,241
2015/16*§~ξ	48,748,162	22,486,985**	8,223,306**
2016/17*	50,479,070	23,478,496**	8,978,553**
2016/17*-	49,817,304	22,540,716**	8,205,040
2017/18*-	51,868,888	23,470,269**	7,691,102
2018/19*-	54,467,368	24,381,034	8,460,613
2019/20*-	59,601,842ǂ	25,041,698	8,769,510

* For NHS Trusts, data up to 2011/12 are derived from Financial Returns; for 2011/12 and following years data are derived from Financial Monitoring and Accounts. Material and capital items are identified differently in each source. § Figures updated to include previously missing Trusts. ~ Figures updated to reflect shift of 'impairments' from intermediates to capital. ξ Capital updated to reflect the use of expenditure figures from the 2016/17 accounts for financial year 2015/16. - Expenditure from TACs (Trust Accounts Consolidated). ** Discrepancies with previously published figures are due to the corrections of a coding error. ǂ Amounts to 57,277,947 if additional pension contributions are excluded.

Table A 33: Historical series of Total NHS current expenditure (£000)

Year	NHS Staff	Agency[ŦŦ]	Materials	Capital	Prescribing	Primary Care	DH Admin	TOTAL
2004/05	31,334,252	1,557,282	8,757,990	5,115,514	8,094,175	9,569,836	278,000	64,707,050
2005/06	33,926,746	1,459,936	10,271,344	5,839,664	8,013,483	11,162,141	262,000	70,935,314
2006/07	35,177,509	1,185,244	11,378,727	6,568,363	8,250,324	11,209,422	229,000	73,998,589
2007/08	36,561,167	1,207,654	13,036,200	7,784,592	8,303,501	11,697,639	226,000	78,816,753
2008/09	39,264,185	1,895,423	13,991,803	7,426,031	8,376,264	12,074,672	242,958	83,271,336
2009/10	42,104,673	2,302,578	14,911,074	7,635,390	8,621,421	12,683,418	241,608	88,500,162
2010/11	43,513,839	2,127,889	16,077,609	8,025,361	8,880,735	12,962,081	212,245	91,799,759
2011/12	43,360,622	1,872,598	17,221,673	8,265,079	8,777,965	13,250,874	453,000	93,201,811
2011/12[*]	43,457,477	1,862,385	19,154,991	13,892,358	8,777,965	13,250,874	453,000	100,849,049
2012/13[*]	43,654,591	2,345,552	21,442,537	14,273,017	8,397,492	13,419,803	457,000	103,989,992
2013/14[*]	44,310,698	2,578,931	22,528,639	13,914,103	8,540,424	13,294,670	n/a	105,167,465
2013/14[**]					8,703,170			105,330,221
2014/15[**]	45,239,355	3,333,806	23,440,874	13,283,767	8,942,734	13,460,552	n/a	107,701,088
2014/15[**§]	45,562,935		23,582,829	13,323,481			n/a	108,206,337
2015/16[**§~ξ]	46,787,408	3,702,409	25,604,358	13,632,724	9,288,425	13,759,292	n/a	113,041,031
2015/16[**§~ξ]			24,446,991'	8,726,203'			n/a	106,710,729'
2016/17[**]	49,325,649	2,934,876	25,192,887'	9,448,741'	9,193,913	13,427,480	n/a	109,523,546'
2016/17[**-]	48,663,883		24,255,107'	8,675,228			n/a	107,150,486'
2017/18[**-]	51,305,198	2,406,798	25,218,132'	8,209,723	9,095,228	13,378,869	n/a	109,613,947'
2018/19[**-]	54,016,983	2,399,645	26,346,637	9,024,653	8,833,869	13,934,642	n/a	114,556,430
2019/20[**-]	59,348,146[♯]	-	27,051,717	9,333,550	9,281,577	14,751,852	n/a	122,146,996

[*] Prior to 2011/12, data for NHS Trusts are taken from Financial Returns, from 2011/12 onwards from Financial Monitoring and Accounts. Agency costs, material, and capital items are identified differently in each source. [**] In February 2017, NHS Digital released a new set of prescribing data to include previously omitted drug codes. The 2013/14 and 2014/15 expenditure figures for prescribing are based on the new data. [§] Figures updated to include previously missing Trusts. [~] Figures updated to reflect the shift of impairment from intermediates to capital. [ξ] Capital updated to reflect the use of expenditure figures from the 2016/17 accounts for the financial year 2015/16. [-] Expenditure from TACs (Trust Accounts Consolidated).' Discrepancies with previously published figures are due to the corrections of a coding error. [♯] Amounts to 57,024,251 if additional pension contributions are excluded. [ŦŦ]Agency expenditure figures for 2019/20 are suppressed as it is unpublished management information.

10. Appendix B

10.1. Dealing with missing NHS Trust information

10.1.1. Full derivation of Approach 4

The following method has been developed at the level of a single NHS setting (*s*). For each setting, the Laspeyres output growth index takes the form:

$$X_{(0,t)}^{D,s} = \frac{\sum_{j=1}^{J} x_{jt} c_{j0}}{\sum_{j=1}^{J} x_{j0} c_{j0}} \quad [A1]$$

where a total of *J* categories of healthcare services and/or goods are observed. If a service of type *j* was not observed in the previous year ($x_{j0} = 0$), its cost is imputed via the imputation method (Castelli et al., 2011).

The above expression can be rewritten as follows:

$$X_{(0,t)}^{D,s} = \frac{\sum_{j=1}^{J} x_{jt} c_{j0}}{\sum_{j=1}^{J} x_{j0} c_{j0}} = \sum_j \frac{x_{jt}}{x_{j0}} \times \frac{x_{j0} c_{j0}}{\sum_j x_{j0} c_{j0}} = \sum_j \frac{x_{jt}}{x_{j0}} \times \theta_{j0} \quad [A2]$$

Here θ_{j0} is the share of the value of healthcare output *j* in the total value of the services produced in a given setting.

We now consider a case when some of the value produced in year t is unobserved. In particular, we assume that output and unit costs produced by Trusts of type A are observed in both years, and that output and unit costs produced by Trusts of type B are observed only in *t* = 0. The Laspeyres index in the standard notation will take the form

$$X_{(0,t)}^{D,s} = \frac{\sum_j x_{jt}^A c_{j0}^A + \sum_j x_{jt}^B c_{j0}^B}{\sum_j x_{j0}^A c_{j0}^A + \sum_j x_{j0}^B c_{j0}^B} \quad [A3]$$

Here $x_{jt}^A = \sum_{h=1}^{H^A} x_{jht}$, i.e. x_{jt}^A is the total volume of healthcare output *j* produced by Trusts of type A (H^A) at time *t*. Please note that the term $x_{jt}^B c_{j0}^B$ (in the numerator of [A3]) is not observed, or more precisely x_{jt}^B is not observed as this represents activity produced by Trusts with missing information in year *t*. A transformation similar to [A2] will yield:

$$X_{(0,t)}^{D,s} = \frac{\sum_j x_{jt}^A c_{j0}^A + \sum_j x_{jt}^B c_{j0}^B}{\sum_i x_{j0}^A c_{j0}^A + \sum_j x_{j0}^B c_{j0}^B} =$$

$$= \frac{\sum_j x_{jt}^A c_{j0}^A}{\sum_j x_{j0}^A c_{j0}^A + \sum_j x_{j0}^B c_{j0}^B} + \frac{\sum_j x_{jt}^B c_{j0}^B}{\sum_j x_{j0}^A c_{j0}^A + \sum_j x_{j0}^B c_{j0}^B} = \sum_j \frac{x_{jt}^A}{x_{j0}^A} \times \theta_{j0}^A + \sum_j \frac{x_{jt}^B}{x_{j0}^B} \times \theta_{j0}^B \quad [A4]$$

Making the further assumption that the growth in volume for each category *j* is the same for Trusts of type A and type B, i.e. $x_{jt}^B / x_{j0}^B = x_{jt}^A / x_{j0}^A$, we obtain:

$$\sum_j \frac{x_{jt}^A}{x_{j0}^A} \times \theta_{j0}^A + \sum_j \frac{x_{jt}^B}{x_{j0}^B} \times \theta_{j0}^B =$$

$$= \sum_j \frac{x_{jt}^A}{x_{j0}^A} \times \theta_{j0}^A + \sum_j \frac{x_{jt}^A}{x_{j0}^A} \times \theta_{j0}^B = \sum_j \frac{x_{jt}^A}{x_{j0}^A} \times (\theta_{j0}^A + \theta_{j0}^B) = \sum_j \frac{x_{jt}^A}{x_{j0}^A} \times \theta_{j0} = X_{(0,t)}^{D\_3,s} \quad [A5]$$

In calculating [A5], we may encounter cases of activity $x_{jt}^A > 0$, for which $x_{j0}^A = 0$; this would mean that x_{jt}^A / x_{j0}^A is unidentified. Therefore, we replace zeros with a very small positive value to ensure that this activity is accounted for in the growth index.

10.2. Steps followed with Approaches 3 and 4

We implemented the following algorithm when preparing and calculating the Laspeyres growth estimates by NHS setting for Approaches 3 and 4:

- **Step 1**: Using Hospital Trust-level data for 2018/19 and 2019/20, we encode every activity type *j* so that its unique identifier matches the one used in the national level dataset used for the Laspeyres output growth rates computations.
- **Step 2:** For every x_{jht} with missing information due to small number suppression, we explore three different options and set the quantities equal to (in turn): (i) 1; (ii) 4; and (iii) 7. The aim is to have a better understanding of the approximate magnitude of missing activity information.
- **Step 3:** For each of the resulting activity levels, we check how well they approximate the real volumes of activity by sub-setting, comparing their respective quantities with those obtained from the national level dataset. The results of this step suggest that, on average, setting missing values to 4 provides the total volume of activity closest to the national level figures, with the exception of Regular Day and Night Attendances. For this sub-setting, the resulting number of activity carried out is about 4-5 percent higher than the national level figure when missing values are set to 4 (see Table B 1 below[93]). However, since the total numbers for all remaining settings match fairly well when imputing a value of 4, we conclude that setting missing volumes to 4 is the most reasonable, and adopt it as our baseline value to determine NHS setting-specific output growth rates for Approach 3, as well as in the calculations of Approach 4.

[93] Day care facilities are excluded from the table since this sub-setting does not contain any suppressed values at Trust level.

Table B 1: Actual and Estimated volume of activity by NHS setting/sub-setting, 2018/19 and 2019/20

Year	NHS setting/ sub-setting	Volume of activity (national-level NCC data)	Est. volume of activity, missing = 1	% of actual volume	Est. volume of activity, missing = 4	% of actual volume	Est. volume of activity, missing = 7	% of actual volume
1819	A&E	20,390,560	20,389,722	99.996	20,390,940	100.002	20,392,158	100.008
1920	A&E	20,000,220	19,998,728	99.993	20,001,092	100.004	20,003,456	100.016
1819	Audiology	3,044,139	3,044,087	99.998	3,044,144	100.000	3,044,201	100.002
1920	Audiology	2,846,031	2,846,006	99.999	2,846,039	100.000	2,846,072	100.001
1819	Chemotherapy	2,707,943	2,706,900	99.961	2,708,367	100.016	2,709,834	100.070
1920	Chemotherapy	2,606,064	2,604,986	99.959	2,606,495	100.017	2,608,004	100.074
1819	Community Care	81,794,288	81,793,769	99.999	81,794,426	100.000	81,795,083	100.001
1920	Community Care	76,106,927	76,106,448	99.999	76,107,021	100.000	76,107,594	100.001
1819	DADS	7,601,707	7,601,604	99.999	7,601,772	100.001	7,601,940	100.003
1920	DADS	7,053,907	7,053,817	99.999	7,053,949	100.001	7,054,081	100.002
1819	DAPS	426,076,050	426,076,038	100.000	426,076,050	100.000	426,076,062	100.000
1920	DAPS	392,755,757	392,755,751	100.000	392,755,763	100.000	392,755,775	100.000
1819	High Cost Drugs	2,477,645	2,460,667	99.315	2,489,761	100.489	2,518,855	101.663
1920	High Cost Drugs	2,774,471	2,751,948	99.188	2,788,149	100.493	2,824,350	101.798
1819	Outpatient	87,083,632	87,041,358	99.951	87,141,804	100.067	87,242,250	100.182
1920	Outpatient	84,314,125	84,270,457	99.948	84,370,600	100.067	84,470,743	100.186
1819	RDNA	328,937	319,714	97.196	344,629	104.771	369,544	112.345
1920	RDNA	331,162	321,347	97.036	347,729	105.003	374,111	112.969
1819	Radiology	9,961,010	9,887,350	99.261	10,027,753	100.670	10,168,156	102.080
1920	Radiology	11,524,610	11,516,068	99.926	11,532,103	100.065	11,548,138	100.204
1819	Radiotherapy	1,962,279	1,961,820	99.977	1,962,522	100.012	1,963,224	100.048
1920	Radiotherapy	1,855,549	1,855,154	99.979	1,855,769	100.012	1,856,384	100.045
1819	Rehabilitation	2,298,007	2,297,765	99.989	2,298,080	100.003	2,298,395	100.017
1920	Rehabilitation	2,250,425	2,250,273	99.993	2,250,495	100.003	2,250,717	100.013
1819	Renal Dialysis	4,275,328	4,275,260	99.998	4,275,365	100.001	4,275,470	100.003
1920	Renal Dialysis	4,240,238	4,240,166	99.998	4,240,268	100.001	4,240,370	100.003
1819	Specialist Services	5,428,417	5,428,010	99.993	5,428,577	100.003	5,429,144	100.013
1920	Specialist Services	5,234,927	5,234,370	99.989	5,235,144	100.004	5,235,918	100.019

- **Step 4:** Having removed from the sample those Trusts that are missing in either 2018/19 or 2019/20, the data are aggregated to the national level. The average unit costs are then derived as the ratio of total value (which is present in the NCC Trust-level data) of each activity *j* to the total volume of activity obtained from the Trust-level data, including imputed missing values.
- **Step 5:** The resulting datasets for both 2018/19 and 2019/20 are then appended to the national level data covering earlier years, so to perform year-on-year cost checks and impute any missing unit cost information, following our standard imputation method.

At the end of step 5 and for Approach 3, we derive the Laspeyres output growth rates for each setting and adjust them for working/total days.

In order to complete Approach 4, we need to implement two additional steps:

- **Step 6:** For each activity type *j*, the national level NCC dataset is used to derive θ_{j0}: the share of value of activity *j* in the total value of activity in each setting. For those activity types *j* which appear only in 2019/20, we set their x_{j0} to be equal to a very small positive number (e.g. 10^{-12}). This step is necessary because when calculating the Laspeyres output growth rates these cases (unless deemed as new activity and thus excluded from the output growth calculations) can be retained and missing cost information for the base year, c_{j0} , obtained through the imputation method (Castelli et al., 2011). Since activity type *j* was not recorded as *j* in t = 0, c_{j0} does not exist. For these *j* cases, θ_{j0} are also imputed and constitute an infinitesimal proportion. The resulting set of θ_{j0} is then merged into the dataset obtained in step 5.
- **Step 7:** Since Approach 4 relies on the ratios of volumes of each activity type *j* in Trusts present in both years (which is a restricted sample), more cases with $x_{j0} = 0$ are observed, which should also be set to a very small positive number for the reasons described above. Importantly, this may happen even when x_{j0} is a positive number when the whole sample is considered. This violates the main assumption of Approach 4 of equal activity growth for each *j* in Trusts present in both years and those missing in either of the years, and it becomes a serious issue when this activity type has a significant value weight in the total value produced within the setting (i.e. a relatively high θ_{j0}). As a result, the Laspeyres growth rates obtained for these *j* are extremely high and implausible values (when x_{j0} is set to a very small positive number, x_{jt}^{A}/x_{j0}^{A} multiplied by a non-negligible θ_{j0} becomes a very large value). For this reason, we have decided not to pursue this approach further.

10.3. Estimated NHS setting specific and overall output growth measures

Table B 2 reports the Laspeyres output growth rates by NHS settings using the 2019/20 and 2018/19 NCC data without correcting for missing NHS Trusts information, and the growth rates obtained using three of the four approaches developed to deal with missing NHS Trust information and presented in section 3.5. 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. Depending on the approach used, the overall NHS Laspeyres output growth rate, quality, and working/total days adjusted, varies from -0.72% (not corrected for missing NHS Trusts) to 0.75% (Approach 2).

The implied NHS productivity growth measures are reported in Table B 3. All NHS productivity growth rates are negative, despite the correction for missing NHS Trust information, although of smaller magnitude.

Table B 2: Cost-weighted, quality and working/total days adjusted setting-specific output growth

Setting	Growth rate				Contribution to overall growth rate**			
	Not corrected for missing Trusts	Approach 1	Approach 2	Approach 3 (baseline)	Not corrected for missing Trusts	Approach 1	Approach 2	Approach 3 (baseline)
Hospital Inpatient*		-0.15%				36.08%		
Outpatient*		-2.61%				13.77%		
Primary care		-0.05%				13.06%		
Community Prescribing		4.25%				10.87%		
Community care	-8.30%	-4.14%	-1.66%	-4.33%	5.67%	5.93%	6.09%	5.92%
Chemo-/Radiotherapy/High Cost Drugs	4.56%	11.02%	12.89	10.62%	4.96%	5.26%	5.35%	5.24%
A&E	-0.05%	5.21%	6.94%	4.59%	4.00%	4.21%	4.27%	4.18%
Specialist Services	-8.14%	-4.81%	91.86%	-4.63%	3.96%	4.10%	4.13%	4.11%
Ophthalmology & Dentistry		-4.35%				2.35%		
Radiology	11.11%	16.66%	18.09%	14.94%	1.28%	1.35%	1.36%	1.33%
Diagnostic Tests	-6.28%	-2.77%	-0.62%	-3.20%	1.23%	1.27%	1.30%	1.27%
Rehabilitation	-1.83%	-2.94%	-0.64%	-2.47%	1.01%	1.00%	1.02%	1.00%
Renal Dialysis	1.57%	4.12%	5.15%	3.82%	0.69%	0.71%	0.72%	0.71%
Other	-3.41%	-1.21%	0.04%	-1.07%	0.36%	0.37%	0.37%	0.37%
Total/NHS output growth rate					-0.72%	0.32%	0.75%	0.25%

* Hospital Inpatient and Outpatient activity are quality-adjusted. ** The contribution of each setting to growth in 2019/20 is expressed as a percentage of the total output in 2018/19. Where numbers in this column are lower than numbers in the preceding column, this represents negative growth in outputs for that setting. *** This value has been taken from Approach 3, as the value obtained with Approach 4 is implausibly large.

Table B 3: NHS productivity growth rates, 2018/19 - 2019/20

		Quality-adjusted productivity growth			
		Not corrected for missing Trusts	Approach 1	Approach 2	Approach 3 (baseline)
Input growth	**Indirect**	-3.05%	-2.04%	-1.63%	-2.11%
	Mixed	-3.08%	-2.07%	-1.66%	-2.14%

11. Appendix C

11.1. 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 3.2 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 C 1.

Table C 1: Sources of deflator data

<table>
<tr><th>Years</th><th>Labour</th><th>Materials & Capital</th><th>Primary Care</th><th>Prescribing</th></tr>
<tr><td>2013/14 – 2014/15</td><td rowspan="3">ESR deflator</td><td rowspan="2">Hospital and Community Health Services (HCHS) deflator</td><td rowspan="2">Pay and Price deflator
0.1 + 0.4*ESR deflator + 0.4*HCHS deflator</td><td rowspan="2">PCA / NHS BSA</td></tr>
<tr><td>2014/15 – 2015/16</td></tr>
<tr><td>2015/16 – 2016/17</td><td rowspan="2">NHS Cost Inflation Index: Provider Non-Pay Index (NHSCII-PNPI)</td><td rowspan="2">NHS Cost Inflation Index: General Practice Index (NHSCII-GPI)</td><td rowspan="2"></td></tr>
<tr><td>2016/17 – 2017/18</td><td rowspan="2">ESR deflator and Agency deflator (from NHSCII)</td></tr>
<tr><td>2017/18 – 2019/20</td></tr>
</table>

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

[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 at https://www.pssru.ac.uk/pub/uc/uc2019//NHS-Cost-Inflation-Index.docx (last accessed 30/11/2021). For a comparison of HCSC and NHSCII see p.154 of https://www.pssru.ac.uk/pub/uc/uc2019/sources-of-information.pdf (last accessed 30/11/2021).

(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.

In addition, starting from 2018/19, a separate deflator for agency staff was produced within the NHSCI index. The data, collected by NHS England and NHS Improvement from all NHS Trusts, cover NHS Trusts' agency staff spending and the number of shifts worked, thus allowing one to calculate the change in the cost of an agency staff shift. Therefore, the agency staff deflator assumes that the length of an agency staff shift is constant, which we deem reasonable.[97] In 2018/19 agency expenditures accounted for about 2.8% of total NHS providers' nominal expenditures, being the 6th largest expenditure category. Thus, 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 C 2.

Table C 2 shows deflation figures for each category of expenditure from 2017/18 – 2018/19 to 2018/19 – 2019/20. 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 C 2: Deflator values 2017/18 – 2019/20

Years	Labour	Materials and Capital	Primary Care	Prescribing
2017/18 – 2018/19	2.36% (-9.01%)	2.37%	2.89%	-5.23%
2018/19 – 2019/20	2.73%	1.44%	3.18%	-0.08%

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.

11.2. 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. As shown in Table C 3, considering only activity delivered by NHS Trusts, the working, total days, and quality-adjusted output index decreased to -0.10% with Approach 3 (baseline) and to -1.41% when not corrected for missing Trusts, (as opposed to respectively 0.25% growth for the

[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.

[97] As highlighted by ONS (https://www.ons.gov.uk/economy/economicoutputandproductivity/publicservicesproductivity/methodologies/methodologicaldevelopmentstopublicserviceproductivityhealthcare2021update (last accessed 27/02/2021)), discussions with the NHS experts suggest agency staff shift lengths have been stable in recent years.

overall NHS output (baseline) and -0.72% growth for the uncorrected overall NHS output growth rate).

Trust specific input growth was equal to 2.34% using the mixed method and 2.14% 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 C 3 for full details).

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

Years	Quality and working days adjusted Output growth		Input growth		Productivity growth rate	
	Not corrected for missing Trusts	Approach 3 (baseline)			Not corrected for missing Trusts	Approach 3 (baseline)
2017/18 – 2018/19*	2.63%	-	Mixed	3.27%	-0.62%	-
			Indirect	3.08%	-0.44%	-
2018/19 – 2019/20	-1.41%	-0.10%	Mixed	2.34%	-3.67%	-2.39%
			Indirect	2.14%	-3.48%	-2.20%

* 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.

In comparison with the previous financial year, the difference between input growth rates derived through the two methods remains of a similar magnitude: the input growth yielded by the mixed method exceeds that measured by the indirect approach by about 0.2 percentage points.

11.3. Working and Total Days

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

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

Year	Total days	Working days
2017/18	365	251
2018/19	365	253
2019/20	366	254

12. References

ARABADZHYAN, A., CASTELLI, A., CHALKLEY, M. J., GAUGHAN, J. M. & MATIAS, M. A. 2021. *Productivity of the English National Health Service: 2018/19 update,* York, Centre for Health Economics Research Paper 182, University of York.

ATKINSON, T. 2005. *Atkinson Review: Final Report. Measurement of Government Output and Productivity for the National Accounts,* Basingstoke, Palgrave Macmillan.

ATKINSON, T. 2010. *Measuring Health Output, Productivity and Equity,* London, Office of Health Economics.

BOJKE, C., CASTELLI, A., GRAŠIČ, K., HOWDON, D. & STREET, A. 2016. *Productivity of the English NHS: 2013/14 update,* York, Centre for Health Economics Research Paper 126, University of York.

BOJKE, C., CASTELLI, A., GRAŠIČ, K., HOWDON, D. & STREET, A. 2017. Productivity growth in the English National Health Service from 1998/99 to 2013/14. *Health Economics,* 26**,** 547-565.

BOJKE, C., CASTELLI, A., GRAŠIČ, K. & STREET, A. 2014. *Productivity of the English National Health Service from 2004/5: updated to 2011/12,* York, Centre for Health Economics Research Paper 94, University of York.

BOJKE, C., CASTELLI, A., GRAŠIČ, K. & STREET, A. 2015. *Productivity of the English NHS: 2012/13 update,* York, Centre for Health Economics Research Paper 110, University of York

CASTELLI, A., CHALKLEY, M. J., GAUGHAN, J. M., PACE, M. L. & RODRIGUEZ SANTANA, I. 2019. *Productivity of the English National Health Service: 2016/17 update,* York, Centre for Health Economics Research Paper 163, University of York.

CASTELLI, A., CHALKLEY, M. J., GAUGHAN, J. M. & RODRIGUEZ SANTANA, I. 2020. *Productivity of the English National Health Service: 2017/18 update,* York, Centre for Health Economics Research Paper 171, University of York.

CASTELLI, A., CHALKLEY, M. J. & RODRIGUEZ SANTANA, I. D. L. N. 2018. *Productivity of the English National Health Service: 2015/16 update,* York, Centre for Health Economics Research Paper 152, University of York.

CASTELLI, A., DAWSON, D., GRAVELLE, H., JACOBS, R., KIND, P., LOVERIDGE, P., MARTIN, S., O'MAHONY, M., STEVENS, P., STOKES, L., STREET, A. & WEALE, M. 2007. A new approach to measuring health system output and productivity. *National Institute Economic Review,* 200**,** 105-117.

CASTELLI, A., LAUDICELLA, M., STREET, A. & WARD, P. 2011. Getting out what we put in: productivity of the English National Health Service. *Health Economics, Policy and Law,* 6**,** 313-335.

CURTIS, L. & BURNS, A. 2019. *Unit Costs of Health and Social Care*, Personal Social Services Research Unit, University of Kent, Canterbury.

CURTIS, L. & BURNS, A. 2020. *Unit Costs of Health and Social Care*, Personal Social Services Research Unit, University of Kent, Canterbury.

DAWSON, D., GRAVELLE, H., O'MAHONY, M., STREET, A., WEALE, M., CASTELLI, A., JACOBS, R., KIND, P., LOVERIDGE, P., MARTIN, S., STEVENS, P. & STOKES, L. 2005. *Developing new approaches to measuring NHS outputs and productivity, Final Report,* York, Centre for Health Economics Research Paper 6, University of York.

DEPARTMENT OF HEALTH 2012. *Reference Costs 2011-12,* Leeds, NHS Information Centre.

DERBYSHIRE, K., ZERDEVAS, P., UNSWORTH, R. & HASLAM, M. 2007. *Further developments in measuring quality adjusted healthcare output,* Leeds, Department of Health.

DIEWERT, W. E., BALK, B. M., FIXLER, D., FOX, K. J. & NAKAMURA, A. O. 2010. *Price and Productivity Measurement: Volume 6 - Index Number Theory*, Trafford Press.

EUROSTAT 2001. *Handbook on price and volume measures in national accounts*, Luxembourg: Office for Official Publications of the European Communities.

NHS ENGLAND 2020a. COVID-19: Deploying our people safely, Version 1.2. London: NHS England.

NHS ENGLAND 2020b. Redeploying your secondary care medical workforce safely Version 2. *In:* ENGLAND, N. (ed.). London: NHS England.

NHS ENGLAND & NHS IMPROVEMENT 2021. *National Cost Collection 2019/20 Report*, NHS England.
OECD 2001. *OECD Productivity Manual: a guide to the measurement of industry-level and aggregate productivity growth*, Paris: Organisation for Economic Cooperation and Development.
WORLD HEALTH ORGANIZATION 2020a. Digital tools for COVID-19 contact tracing: annex: contact tracing in the context of COVID-19, 2 June 2020. World Health Organization.
WORLD HEALTH ORGANIZATION 2020b. Infection prevention and control during health care when COVID-19 is suspected: interim guidance, 19 March 2020. World Health Organization.