1. Summary

This note sets out the sources and methods used to generate estimates of productivity in publicly funded healthcare, as presented in Public Service Productivity Estimates: Healthcare 2010 (ONS 2012a). It contains (a) a summary of the data sources employed, (b) a breakdown of how ONS calculates estimates of productivity in healthcare, (c) a description of recent methodological changes and (d) a discussion of the strengths and weaknesses of this approach.

At the most aggregate level, ONS estimates of healthcare productivity are based on the ratio of output to inputs. Adopting \( p \), \( O \) and \( I \) to indicate productivity, output and inputs respectively, and including a subscript \( t \) for time-periods:

\[
 p_t = \frac{O_t}{I_t} \tag{1} 
\]

Estimates of the volume of healthcare output are calculated using detailed data on activity and costs in several different healthcare sectors, comprising Hospital and Community Health Services (HCHS), Family Health Services (FHS) and drugs prescribed by General Practitioners (GP drugs). Services which are paid for by the Health Service but provided by Non-NHS bodies (Non-NHS Provision) are also included. In all but the final sector, the number of consultations, procedures or products is weighted by the corresponding unit cost to produce a cost-weighted activity index. Where available, these data are added to an indirect measure of Non-NHS Provision to produce a single volume of healthcare output series for each country. These separate indices for England, Scotland, Wales and Northern Ireland are adjusted for changes in the quality of delivered healthcare and weighted by their share in aggregate healthcare expenditure to produce a UK index of healthcare output.

Estimates of the volume of healthcare inputs are calculated using data on healthcare expenditure and direct measures of healthcare inputs. Data are gathered on the extent of (a) Labour, (b) Goods and Services and (c) Capital consumption. Volume estimates for each component of inputs are estimated for the UK. These in turn are weighted by their respective shares in aggregate...
healthcare expenditure and combined to produce a single volume of healthcare inputs series for
the UK.

The methodology for calculating aggregate healthcare inputs, output and productivity is complex as
a consequence of the variety of data sources used and the detailed nature of the data employed. A
simplified overview is shown in Figure 1, including recent changes to the methodology enacted for
ONS (2012a) which are described in Section 5 and in more detail in Methods Changes for Public

**Figure 1: Overview of production process**

<table>
<thead>
<tr>
<th>Raw Data</th>
<th>Calculations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expenditure Weights</td>
<td>Healthcare Quality</td>
</tr>
<tr>
<td>HCHS, FHS &amp; GP Drugs Activity</td>
<td>Healthcare ‘Output’</td>
</tr>
<tr>
<td>Non-NHS Provision</td>
<td>Healthcare ‘Quantity’</td>
</tr>
<tr>
<td>Non-NHS Provision</td>
<td>Healthcare Productivity</td>
</tr>
<tr>
<td>Labour, Goods &amp; Services, Capital consumption</td>
<td>Healthcare ‘Inputs’</td>
</tr>
<tr>
<td>Expenditure Weights</td>
<td></td>
</tr>
</tbody>
</table>

Notes: Non-NHS Provision is measured indirectly and was included for the first time in ONS (2012a)

The rest of this note proceeds as follows.

Section 2 sets out the data sources and the methods used to produce estimates of the quantity of
delivered healthcare in the UK.

Section 3 outlines the process of quality adjustment which converts measures of healthcare
quantity into estimates of healthcare output, including the assumptions adopted and the datasets
required.

Section 4 sets out the data sources and methods used to generate estimates of healthcare inputs.

Section 5 discusses recent methodological improvements and explains the differences between
the output measures presented here and those included in the National Accounts.

Section 6 presents a worked example of healthcare productivity estimates

Section 7 considers how this methodology meets user needs and Section 8 offers a discussion of
the strengths and weaknesses of the ONS (2012a) approach.
2. Output

Following ONS conventions for non-market activity, two concepts are used to measure healthcare output in the UK. The ‘quantity’ of delivered healthcare is a cost-weighted activity index for all publicly funded health services. Healthcare ‘output’ is defined as the quantity of healthcare adjusted for changes in the quality of delivery.

Both the ‘quantity’ and ‘output’ measures of delivered healthcare use data on the number of procedures and consultations carried out in four different healthcare sectors:

- Hospital and Community Health Services (HCHS): Includes information about inpatient, outpatient and day-case procedures as well as other hospital activity.
- Family Health Services (FHS): Includes data on publicly provided ophthalmic and dental services, as well as General Practice consultations.
- General Practitioner Prescription Drugs (GP drugs): Includes all items prescribed by GPs.
- Non-NHS Provision: Includes indirectly estimated healthcare activity which is paid for by the Health Service but delivered by external bodies.

Data on all four sectors are not available for all parts of the UK. HCHS and GP Prescription drugs data are provided by England, Wales, Scotland and Northern Ireland. Wales does not provide data on FHS activity, while at present no data are available from Scotland or Northern Ireland on Non-NHS provision. Data are available for England from 1994-95, for Northern Ireland from 2003-04 and for Wales and Scotland from 2004-05. Both measures of healthcare are calculated using all available data in each time period.

Table 1 summarises information about the data sources used in the calculation process for each sector, sub-sector and geographical area. While data for Wales, Scotland and Northern Ireland is largely assembled by the devolved administrations, ONS has responsibility for processing the activity and cost data for England.
Table 1: Data sources for estimates of UK healthcare quantity and output

<table>
<thead>
<tr>
<th>Geographical Area</th>
<th>England</th>
<th>Wales</th>
<th>Scotland</th>
<th>Northern Ireland</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hospital &amp; Community Health Services</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inpatients</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>HSC IC</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>Family Health Services</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ophthalmic</td>
<td>General Ophthalmic Council</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dental</td>
<td>General Dental Council</td>
<td>SG analysis 2004-05 - 2010-11</td>
<td>DHSSPS analysis 2003-04 - 2010-11</td>
<td></td>
</tr>
<tr>
<td>GP Consultations</td>
<td>Survey Data 1997-98 - 2008-09</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Imputed 2008-09 - 2010-11</td>
<td></td>
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</tr>
<tr>
<td><strong>GP Drugs</strong></td>
<td></td>
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<tr>
<td><strong>Non-NHS Provision</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expenditure</td>
<td>DH 1997-98 - 2010-11</td>
<td>WG analysis 2004-05 - 2010-11</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>


Information on each sector is provided at a different level of detail. HCHS data on Inpatients, Day Case procedures and other hospital activity, provided by all countries, are highly detailed. English Reference Costs documentation published by the Department for Health and data provided by the devolved administrations identifies the activity and costs associated with each ‘Health Resource Group’ (HRG) within a number of different delivery settings. These data offer a highly detailed

---

3 HRGs define a specific procedure or consultation type for a particular type of patient (for instance: HRG CZ21V: Minor head, neck and ear disorders in patients aged 19 or more with Continuing Care) while delivery settings reflect the nature of the interaction between the
picture of the activities of the health service across the UK. Changes in the classification of HRGs has significantly complicated the estimation of HCHS quantity and output because of the scale of the datasets involved. The 2010-11 Reference Costs document for England identifies 1,534 individual HRGs delivered over 159 patient settings. Data on Outpatient activity are taken from the Reference Costs document until 2002-03, since when Health and Social Care Information Centre Hospital Episode Statistics records are used.

Family Health Service data for England are provided by DH, and include both the number of consultations and the total amount of expenditure on Primary Care Dental Services and General Ophthalmic Services. Data on General Practice in England was previously provided by a comprehensive survey of GP surgeries. However, more recent data are difficult to obtain. Section 8 gives some more information on this issue. FHS data for Scotland and Northern Ireland are provided by the devolved administrations.

Prescription data for the four areas of the UK are drawn from the Prescription Costs Analysis. In England, this is published by the Department for Health and details the number and cost of each item prescribed by GPs. In 2010-11, this amounted to more than 13,000 different product types, dispensed in more than 21,000 different forms. Similar, detailed data are provided by the devolved administrations.

Finally, the estimates of the quantity of delivered healthcare published in ONS (2012a) include services paid for by the health service, but delivered by outside organisations. The details of this change are set out elsewhere (ONS 2012a, 2012b). Expenditure data for Non-NHS provision was provided for England and Wales by the Department for Health and the Welsh Government respectively.

**Calculating estimates of healthcare quantity**

The methodology used to construct estimates of non-market output is governed by ESA (1995), SNA (2008) and is set out in both ONS (2012c) and Atkinson (2005). As a consequence of their non-market setting and the absence of a complete and competitive set of product prices, valuing health services is difficult. ONS (2012a) adopts a volume based approach, in which each differentiated type of activity is weighted by the costs of production. This method can be broken into several steps analogous to those published in ONS (2012c):

1. Detailed data are assembled separately for each healthcare sector in England, Wales, Scotland and Northern Ireland, including information about (a) healthcare activity (the number of procedures performed, the number of consultations delivered, the number of drugs prescribed) and (b) costs (the cost of performing each procedure, the cost of each consultation and the cost of each prescription item).

medical professionals and the patient (Elective Inpatient, Non-Elective inpatient, etc). Consequently, a given HRG may appear in more than one delivery setting.

**Footnotes:**

4 'Products' here refer to a specific drug or good, while 'forms' reflects the different delivery methods and quantities involved. For instance, the product 'Nurofen Express', was prescribed as a capulet, a tablet and in liquid form, in two (liquid and tablets) or three (capulets) packet sizes. Consequently, this single 'product' was delivered in seven different 'forms'.

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2. ONS matches activity and cost data to produce a time series dataset. For each year, activity data is linked with the cost of delivery, and then this data is linked through time.\(^5\)

3. A chain-linked Laspeyres volume index of healthcare quantity is produced for each country of the UK such that:

\[
I_{i,t} = \frac{\sum_j \sum_k \epsilon_{i,j,k,t} - a_{i,j,k,t-1} l_{i,j,k,t-1}}{\sum_j \sum_k a_{i,j,k,t-1} u_{i,j,k,t-1}}
\]

Where:
- \(i, j, k\) and \(t\) index countries, healthcare sectors, differentiated activities and time respectively.
- \(l_{i,t}\) is a chain-linked Laspeyres index of healthcare quantity
- \(a_{i,j,k,t}\) is the number of procedures performed
- \(u_{i,j,k,t}\) is the unit cost associated with a given procedure
- quantity in the initial period, \(t=0\), is set equal to 100.

4. To produce a UK level, chain-linked Laspeyres volume index of healthcare quantity, the country level indices are weighted by their share in aggregate healthcare expenditure, such that:

\[
L_t = L_{t-1} \sum_i \frac{I_{i,t}}{l_{i,t-1}} \frac{E_{i,t-1}}{\sum_i E_{i,t-1}}
\]

Where:
- \(i\) and \(t\) index countries and time respectively
- \(L_t\) is a chain-linked aggregate UK Laspeyres volume index of healthcare quantity
- \(l_{i,t}\) is a country level chain-linked aggregate UK Laspeyres volume index of healthcare quantity
- \(E_{i,t}\) is the level of expenditure on healthcare by country
- UK quantity in the initial period, \(t=0\), is set equal to 100.

The result of this process is a UK level chain-linked Laspeyres volume index of healthcare quantity, which places a proportionate weight on the magnitude of each healthcare sector within each country. Each country is then given their appropriate weight in overall healthcare quantity.

This UK index, minus the component of non-NHS provision, is used in National Accounts to represent the chained volume estimate of General Government Final Consumption Expenditure. This is a component of GDP(E), and represented around 8% of overall GDP in 2012.

\(^5\) As a consequence of this matching process, ONS estimates of the growth of healthcare quantity are based on the subset of activities which occur in both years.
3. **Quality Adjustment**

While estimates of healthcare quantity reflect the level of cost-weighted activity, Atkinson (2005) advised that changes in the quality of service delivery must be taken into account. This is in line with the methodology outlined in ESA (1995).

To quality-adjust estimates of healthcare quantity in the UK, ONS (2012a) uses several measures of quality for different areas of delivery which capture the extent to which the service (a) succeeds in delivering intended outcomes and (b) is responsive to users’ needs. More specifically, five separate measures of quality are used to adjust delivery in two of the four healthcare sectors. These are shown in Table 2.

### Table 2: Measures of quality

<table>
<thead>
<tr>
<th>Measure</th>
<th>Sector</th>
<th>Health Gain</th>
<th>Short term Survival</th>
<th>Waiting Times</th>
<th>National Patient Survey</th>
<th>Primary Care Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Hospital &amp; Community Health Care</strong></td>
<td></td>
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<tr>
<td></td>
<td>Day Cases</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Elective Inpatients</td>
<td>Y</td>
<td>Y</td>
<td></td>
<td></td>
<td>Y</td>
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<tr>
<td></td>
<td>Non-elective Inpatients</td>
<td>Y</td>
<td></td>
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<tr>
<td></td>
<td>Outpatients</td>
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<td></td>
<td>Emergency</td>
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<td></td>
<td>Mental Health</td>
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<td></td>
<td>Other</td>
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<td></td>
<td><strong>Family Health Services</strong></td>
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<td></td>
<td>GP Consultations</td>
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<td></td>
<td>Ophthalmic Serv.</td>
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<tr>
<td></td>
<td>Dental Serv.</td>
<td></td>
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<td></td>
<td>Other</td>
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<tr>
<td></td>
<td><strong>Prescription Drugs</strong></td>
<td></td>
<td>Y</td>
<td></td>
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<tr>
<td></td>
<td><strong>Non-NHS Provision</strong></td>
<td></td>
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</tbody>
</table>

Estimates of Health gain, Short-term survival and Waiting times are provided by the Centre for Health Economics (CHE) at the University of York. These are derived from patient-level records and offer detailed information at the level of the individual procedure for Inpatients and Day-cases. These are combined into a single measure of quality following the guidance of CHE et al (2005) and applied to HCHS activity at the level of the procedure.

The National Patient Survey is a set of annual surveys of inpatients and outpatients, as well as users of Primary Care, Emergency and Mental Health services. It asks questions about (a) Access & waiting times, (b) Safety, quality and co-ordination of care, (c) Information and choice, (d)
Relationship building and (e) Cleanliness and approachability, which are aggregated into a single series for each service area. These final quality changes are then applied to the appropriate sub-sector across HCHS and FHS.

Finally, Primary Care Outcomes captures information about the performance of General Practitioners in carrying out tests for different conditions and general health assessments. Changes in this measure are applied solely to Primary Care. No quality adjustment is applied to GP prescribing or to Non-NHS provision. As all these measures of quality are only available for England, the rate of quality improvement in England is applied to quantity data for the whole of the UK.

Calculating estimates of healthcare output

The method for producing estimates of healthcare output in the UK can therefore be broken into several steps:

1. Detailed, time-series data are assembled for each healthcare sector in England, Wales, Scotland and Northern Ireland, including information about (a) healthcare activity (the number of procedures performed, the number of consultations delivered, the number of drugs prescribed), (b) costs (the cost of performing each procedure, the cost of each consultation and the cost of each prescription item) and (c) changes in the quality of delivery (capturing health gain, survival rates, waiting times, patient experience and primary care outcomes).

2. ONS matches activity, cost and quality data to produce a time series dataset. For each year, activity and quality data are linked with the cost of delivery, and then this data is linked through time. Where estimates of healthcare quality are incomplete, a 'no change' assumption is used.\[6\]

3. For each pair of consecutive years, ONS then estimates (a) the quantity of delivered healthcare in the base year and (b) the quantity of delivered healthcare in the current year. For each of the three aggregated measures of quality – outcomes (comprising health gain, survival rates and waiting times), patient experience and primary care outcomes – ONS also calculates (c) the volume of quality-adjusted activity in the current year in England such that:

\[ v_{e,t-1} = \sum_j \sum_k a_{e,j,k,t-1} \cdot u_{e,j,k,t-1} \]  \[4\]

\[ v_{e,t} = \sum_j \sum_k a_{e,j,k} \cdot u_{e,j,k,t} \]  \[5\]

\[ v_{z,e,t} = \sum_j \sum_k \left( a_{e,j,k,t-1} - \hat{a}_{e,j,k,t-1} \right) \cdot u_{z,e,j,k,t-1} \cdot u_{e,j,k,t} \]  \[6\]

Where:

\[6\] As a consequence of this matching process, ONS estimates of the growth of healthcare quantity are based on the subset of activities which occur in both years.
\[ q_{z,e,j,k,t,t-1} = \frac{Q_{z,e,j,k,t}}{Q_{z,e,j,k,t-1}} \]  \[7\]

And where:
- \( e \) indicates England
- \( z, j, k \) and \( t \) index quality measures, healthcare sectors, differentiated activities and time respectively.
- \( v_{z,e,t} \) is a volume measure of the quantity of services delivered
- \( a_{z,j,k,t} \) is the number of procedures performed
- \( q_{z,j,k,t} \) is the change in the quality of delivery
- \( u_{z,j,k,t} \) is the unit cost associated with a given procedure
- \( Q_{z,e,j,k,t} \) is the level of quality associated with a given procedure in England

4. Using these three elements, an aggregate index of quality change in England is calculated. The growth of this series is determined by the ratio of the level of quality-adjusted output in the current period to the quantity of delivered healthcare in the base period, such that:

\[ P_{e,t} = P_{e,t-1} \times \frac{v_{e,t} + \sum_z v_{z,e,t} - v_{e,t-1}}{v_{e,t-1}} \]  \[8\]

Where \( P \) is a series showing the path of quality change in healthcare delivery.

5. This series of quality change is then used to adjust the quantity of delivered healthcare in each country of the UK:

\[ o_{i,t} = o_{i,t-1} \left( \left( \frac{\sum_j \sum_k (a_{i,j,k,t-1} - a_{i,j,k,t-1} \cdot u_{i,j,k,t-1})}{\sum_j \sum_k a_{i,j,k,t-1} \cdot u_{i,j,k,t-1}} + \frac{P_{e,t} - P_{e,t-1}}{P_{e,t-1}} \right) + 1 \right) \]  \[9\]

Where the notation is as above, including \( i \) to index countries of the UK.

6. Finally, healthcare output growth in England, Wales, Scotland and Northern Ireland is aggregated to yield total UK healthcare output growth. This is accomplished by weighting the growth in each country of the UK by their share in total healthcare expenditure given by PESA (Public Expenditure Statistical Analysis) expenditure weights:

\[ O_t = O_{t-1} \sum_i \left( o_{i,t} \cdot \frac{Ex_{i,t-1}}{o_{i,t-1} \cdot \sum_i Ex_{i,t-1}} \right) \]  \[10\]

The result of this process is an aggregate, chain-linked measure of quality-adjusted healthcare output in the UK.
4. Inputs

ONS publishes estimates of healthcare inputs in the UK from 1995 onwards. The aggregate inputs index is based on data for three inputs elements: Labour, Goods and Services and Capital:

- **Labour:** Includes information on the number and average salaries of hospital consultants, registrars, nurses, technical staff, ambulance staff and support, General Medical Practitioners (GPs) and practice staff.
- **Goods and services:** Includes pharmaceutical services, dental and ophthalmic services, and intermediate consumption by hospitals and GP practices. This component also includes GP prescribed drugs and services provided by Non-NHS organisations.
- **Capital consumption:** Measured in volume terms, this captures an estimate of the amount of capital stock used each year and is made up of depreciation and other capital charges.

The geographical coverage of the inputs data varies across the countries of the UK and was improved for ONS (2012a). Table 3 provides details. These separate estimates are weighted and aggregated to produce a single healthcare inputs volume index. Where data is not provided by a country, it is assumed that this component grows in line with the rest of the UK.
**Labour**

Labour inputs estimates are based on direct measurement of FTEs employed by the health service in England, Scotland, Wales and Northern Ireland, including GPs and practice staff. In England, an indirect measurement of administrative labour inputs is also included.

The number of full-time equivalent staff and average salary data is available for England from 1995 onwards, for Wales from 2003 and for Scotland and Northern Ireland from 2004 and 2008 respectively. These data use Workforce Census categories of the number of staff in different occupations and grades. This offers a detailed picture of the staff working in the health service through time.

Access to more detailed Electronic Staff Records for NHS staff is now possible across the four countries and used in work by the Centre of Health Economics (CHE, 2013). ONS will consider whether using a more detailed data source offers an improvement in quality, as resources allow.

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**Table 3: Data sources for estimates of UK healthcare inputs**

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>England</td>
</tr>
<tr>
<td>Labour</td>
<td>HCHS</td>
</tr>
<tr>
<td></td>
<td>GP Services Health Administration</td>
</tr>
<tr>
<td>Goods &amp; Services</td>
<td>HCHS</td>
</tr>
<tr>
<td></td>
<td>Dental</td>
</tr>
<tr>
<td></td>
<td>Ophthalmic</td>
</tr>
<tr>
<td></td>
<td>CHMS</td>
</tr>
<tr>
<td></td>
<td>GP Drugs</td>
</tr>
<tr>
<td></td>
<td>Non-NHS Provision</td>
</tr>
<tr>
<td>Capital</td>
<td>UK Capital consumption</td>
</tr>
</tbody>
</table>

Goods & Services

Goods and Services inputs data involves several components. These are:

- Non-pay costs in HCHS
- GP intermediate consumption
- NHS Dental services
- NHS Ophthalmic services
- Pharmaceutical services
- Central Health and Miscellaneous Services (CHMS) – England and Wales only
- Volume of GP Drugs and
- Health service expenditure on Non-NHS Provision – England and Wales only

Apart from the volume of GP drugs component, goods and services volume estimates follow an indirect method. This means that current price expenditure is divided by an appropriate deflator series in order to take into account movements in pay and prices. This gives a constant price expenditure series, or a volume series of inputs estimates.

Table 4 gives each component of expenditure and its matched deflator and data source. The geographic coverage of the expenditure components is England, Wales and Scotland, except where indicated. Where expenditure data is not available for a country, it is assumed that its growth rate in volume terms is equivalent to that of the UK estimate based on the available data.

The geographic coverage for the deflators is either UK-wide or England only. In the case of England only deflators, e.g. sight test deflator, the same rate of price increase is assumed for the other countries of the UK.
### Table 4: Goods and services components, deflators and data sources for deflators

<table>
<thead>
<tr>
<th>Expenditure component</th>
<th>Deflator</th>
<th>Geographic basis of deflator</th>
<th>Data source for deflator</th>
</tr>
</thead>
<tbody>
<tr>
<td>HCHS non-pay</td>
<td>ONS-adjusted Health Service Cost Index (HSCI) : see Note 2</td>
<td>England only – assumed to apply to whole of UK</td>
<td>ONS analysis of HSCIC data</td>
</tr>
<tr>
<td>GP intermediate consumption</td>
<td>All items RPI</td>
<td>UK</td>
<td>ONS</td>
</tr>
<tr>
<td>NHS Dental services</td>
<td>Dental deflator based on up-rated NHS dentist practice contract value</td>
<td>England only – assumed to apply to whole of UK</td>
<td>DH</td>
</tr>
<tr>
<td>NHS Opthalmic services</td>
<td>Sight deflator based on price rise in NHS sight test fees</td>
<td>England only - assumed to apply to whole of UK</td>
<td>DH</td>
</tr>
<tr>
<td>Pharmaceutical services</td>
<td>Expenditure per item dispensed (unit cost)</td>
<td>Separate unit cost increases estimated for each country of the UK</td>
<td>DH, WG, SG, DHSSPSNI</td>
</tr>
<tr>
<td>Central Health and Miscellaneous services (CHMS)</td>
<td>All items RPI</td>
<td>UK</td>
<td>ONS</td>
</tr>
<tr>
<td>Volume of GP prescribed drugs</td>
<td>As for output estimation</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Non-NHS provision</td>
<td>ONS adjusted Health Services Cost Index (HSCI) combined with an adjusted Pay Cost Index (PCI) : see Note 2</td>
<td>HSCI and PCI apply to England only – assumed to apply to whole of UK</td>
<td>ONS analysis of HSCIC data on HSCI and PCI</td>
</tr>
<tr>
<td>Welfare Food (England and Wales expenditure only)</td>
<td>RPI Food</td>
<td>UK</td>
<td>ONS</td>
</tr>
<tr>
<td>EEA (European Economic Area) treatment costs (England only expenditure)</td>
<td>ONS adjusted Health Services Cost Index : see Note 2</td>
<td>England</td>
<td>ONS analysis of HSCIC data</td>
</tr>
<tr>
<td>DH Administration non-pay costs (England only expenditure)</td>
<td>ONS adjusted Health Services Cost Index : see Note 2</td>
<td>England</td>
<td>ONS analysis of HSCIC data</td>
</tr>
</tbody>
</table>


**Note 2**: ONS adjusts the HSCI by subtracting some capital items from the index, and converting the index to a Paasche Price index. ONS converts the PCI to a Paasche Price index.

Income from patient charges is netted off expenditure, so that only the part of the service directly funded by Government is counted as publicly funded inputs.

A constant-price volume index of input is produced for each indirectly measured input type by deflating expenditure by an appropriate deflator, such that:
Where the notation is as above, including:
- \( \text{Ex}_{i,j,t} \) is the current price level of expenditure
- \( p_{i,j,t} \) is an appropriate deflator.

The volume of GP drugs is identical to that used in the output calculations.
The inputs components at a UK level are then aggregated together, using their respective expenditure shares in total goods and services expenditure to form a country-level, chain-linked Laspeyres volume index for goods and services inputs.

**Capital**

Data on capital consumption are based on the National Accounts estimates of healthcare capital consumption for the UK as a whole.

The following two series are extracted from UK National Accounts:
- capital consumption expenditure by Central Government on healthcare [A2BJ] in current prices; and
- capital consumption expenditure by Central Government on healthcare [CUET] in constant prices

The current price National Accounts figures are increased by an estimate for GP practice capital consumption for the UK. The GP capital consumption estimate is drawn from evidence from the annual GP Earnings and Expenses enquiry.

This new current price estimate for capital consumption of the publicly-funded UK healthcare system is divided by a derived deflator for capital consumption. The deflator is derived by dividing the original National Accounts data series - current price capital consumption – by the constant price capital consumption series.

**Calculating estimates of UK healthcare inputs**

The calculation of an aggregate estimate of UK Healthcare inputs involves drawing together data from the three different inputs components and using appropriate weights to aggregate them together. This calculation can be broken down into these steps:

1. Data on labour inputs for each country of the UK are aggregated into a UK chain-linked Laspeyres index using Public Expenditure Statistical Analysis (PESA) weights
2. Data on Goods and services inputs, where available, are aggregated into a UK chain-linked Laspeyres index, again using PESA weights.

3. Data on capital consumption is already at UK level, as the data is drawn directly from National Accounts.

The three UK components are aggregated together using overall expenditure weights from UK National Accounts for labour, net procurement and capital consumption.\(^7\)

To produce a UK level, chain-linked Laspeyres volume index of healthcare inputs, the detailed individual-input level indices (at UK level) are weighted by their share in aggregate healthcare expenditure, such that:

\[
N_t = N_{t-1} \cdot \left( \frac{\sum_{i} n_{i,t-1} \cdot E_{x_{i,t-1}}}{\sum_{i} E_{x_{i,t-1}}} + 1 \right) \tag{13}
\]

Where:

- \(i\) and \(t\) index input components and time respectively
- \(N_t\) is a chain-linked aggregate UK Laspeyres volume index of healthcare inputs
- \(n_{i,t}\) is an individual-input level volume index of healthcare inputs
- \(E_{x_{i,t}}\) is the UK level of current price expenditure on the input component
- UK healthcare inputs in the initial period, \(t=0\), is set equal to 100.

The result of this process is a UK level chain-linked Laspeyres volume index of healthcare inputs, which places proportionate weight on the magnitude of each healthcare input in each country.

5. Methodological revisions and the National Accounts

The estimates of healthcare quantity and output presented in ONS (2012a) include several methodological revisions compared to similar, earlier articles. These differences are outlined in this section, and covered in more detail in ONS (2012b).

The most significant change made to estimates of healthcare output is the inclusion of expenditure on Non-NHS Provision. Previous articles examining healthcare productivity (ONS 2011) (a) assumed that the output of this sector grew in line with the output in the rest of the health service and (b) included Non-NHS expenditure as an indirectly measured component of Goods & Services inputs. As expenditure in this sector has grown rapidly in recent years, ONS (2012a) revised these

\(^7\) An adjustment is made to these overall weights to take into account the fact that GP labour has been included within the ONS direct labour estimates, whereas in National Accounts Government expenditure on GPs is counted as net procurement. The weight for capital consumption is also adjusted to include GP capital consumption estimates.
assumptions, replacing them with the conventional National Accounts treatment for areas in which no direct output measures are available. In this new treatment, output in Non-NHS provision is assumed to grow in-line with deflated expenditure on inputs. This means that the treatment of Non-NHS provision is the same in both inputs and output.

Alongside changes to the treatment of Non-NHS Provision, ONS (2012a) incorporated a new treatment of Pharmacy Services. In contrast to the earlier treatment, ONS (2012a) deflated Pharmacy Services using country-specific information on total expenditure and prescription items dispensed, improving the estimation of pharmacy activity in each country.

Thirdly, the methodology supporting the calculation of aggregate inputs was altered so as to move the conversion from financial years to calendar years later in the process. As the source data used for estimating the volume of Goods & Services inputs is all provided on a financial year basis, the revised process completes the Laspeyres calculations on this basis before converting to calendar years through the application of a cubic spline. This replaces the previous process, which converted all source data to calendar years before the Laspeyres calculations were completed.

Finally, ONS conducted a thorough review of the healthcare output series between 2002-03 and 2010-11 to ensure consistency in methodological approach and data sources through time. This involved incorporating a range of data revisions and extending the use of Health and Social Care Information Centre Outpatient data. The combined effect of all of these changes was to raise healthcare output relative to inputs, with a correspondingly positive effect on health service productivity. For more details, see ONS (2012a, 2012b).

**Quantity, Quality and the National Accounts**

The estimates of healthcare quantity published in ONS (2012a) differ from those included in the National Accounts in three respects. Firstly, National Accounts estimates of healthcare volumes have historically excluded data from Scotland, but they are included in UK productivity articles. Inclusion of Scottish health output data is currently under review with a view to future incorporation into UK National Accounts.

Secondly, as set out in ONS (2012b), the most recent estimates of healthcare quantity presented in ONS (2012a) include data on Non-NHS provision for the first time. This area of expenditure is not currently included in the National Accounts. Thirdly, the estimates of healthcare output included in the National Accounts do not include an explicit adjustment for quality. Formally, the annual quantity of delivered healthcare series presented in ONS (2012a) is used to benchmark the more frequent, but less detailed Quarterly National Accounts series on an annual basis. Table 5 summarises these differences.
6. **Worked Examples**

In response to user requests for more detailed information about the mechanics of the underlying calculations which are carried out for ONS (2012a), ONS has produced a simplified spreadsheet model of the process which is published alongside this document. This model provides information about a fictional health service in which there are four output sectors (Hospital & Community Healthcare Services (HCHS), Family Health Services (FHS), GP Drugs and publicly-funded, Privately Provided Services (PPS)) and two inputs (Labour and Goods & Services), and demonstrates how the calculations of output, inputs and productivity are performed. As such, the

### Table 5: Differences in the Measurement of Healthcare Output: ONS (2012a) and the National Accounts

<table>
<thead>
<tr>
<th></th>
<th>ONS (2012a)</th>
<th>UK National Accounts</th>
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</thead>
<tbody>
<tr>
<td><strong>England</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HCHS</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>FHS</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>GP Drugs</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Non-NHS</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td><strong>Wales</strong></td>
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<td></td>
</tr>
<tr>
<td>HCHS</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>FHS</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>GP Drugs</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Non-NHS</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td><strong>Scotland</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HCHS</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>FHS</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>GP Drugs</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Non-NHS</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td><strong>Northern Ireland</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HCHS</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>FHS</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>GP Drugs</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Non-NHS</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td><strong>Quality Adjustment</strong></td>
<td>Y</td>
<td></td>
</tr>
</tbody>
</table>

*Notes: (1) n/a: Data not currently available. (2) Data from Scotland has not historically been included in estimates of healthcare output in the UK National Accounts.*
spreadsheet model retains many of the complexities of ONS (2012a), while the reduced number of dimensions makes the model more tractable. Quality Adjustment is also included.

The main objective of this worked example is to allow users to observe how health service developments feed into productivity. To this end, the example parallels ONS (2012c) and allows users to change the growth rates of key series – including the number of procedures in a variety of different healthcare sectors, the growth rate of inputs and the rate of change of quality – and observe how these changes affect the evolution of output, inputs and productivity. Users who are interested in the detailed calculation steps can follow these using the included worksheets. This section introduces the example’s simplifying assumptions, while the results of three customised scenarios devised using the accompanying spreadsheet are described in Appendix A.

At an aggregate level, changes in output and inputs have a largely predictable impact on productivity. For instance, if total healthcare inputs increase by 10% without a corresponding increase in total healthcare output, then productivity will fall. However, the precise impact of a specific change – a 10% increase in the number of nurses, for example – will depend on the input mix in a specific sector, and the relative size of the affected sector to the rest of the health service. Everything else being equal, changes which affect larger inputs or more substantial sectors will have a greater impact on health service aggregates than changes which affect smaller inputs or healthcare sectors.

To help illuminate these effects, the worked example includes four healthcare output sectors and two healthcare inputs. To more closely reflect reality, these sectors and inputs vary in their importance to the health service. These structural characteristics or assumptions influence the magnitude of the impact of user specified changes. These are set out in the ‘Assumptions’ worksheet of the model, and include:

- HCHS is the largest sector by output in the base year of the fictional example. HCHS accounts for 52% of total output, while FHS, GP Drugs and PPS Output account for 36%, 10% and 2% respectively. As a consequence, changes which affect HCHS output and inputs will have a correspondingly larger impact on health service aggregates than changes to other sectors.
- Within HCHS, there are four sub-sectors – Elective Inpatients, Non-elective Inpatients, Outpatients: First Attendance and Outpatients: Follow up – which account for 1%, 13%, 34% and 52% of the HCHS output total. As a result, changes which affect Outpatients: Follow Up will have a more significant impact on HCHS aggregates.
- The ratio of inputs to production varies across the three directly measured healthcare sectors. HCHS output as a whole uses Labour and Goods & Services in a ratio 85:15. For FHS the ratio is 52:48, while it is assumed that all GP Drugs inputs are Goods & Services. Consequently, changing the growth rates of a specific input in a specific sector will have a differentiated impact on aggregate input growth.
- Fourthly, it is assumed that quality changes are only relevant for HCHS and FHS activity. Neither GP Drugs nor PPS output are quality-adjusted, and in the case of the latter an indirect method of estimation is used.\(^8\)

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\(^8\) This involves deflating PPS expenditure by a given consumer prices index, which can be seen on the ‘PPS’ worksheet.
To allow users to judge the impact of their changes, a baseline scenario has been created in which healthcare output, inputs and productivity growth are fixed. This allows users to compare the results of their scenarios against an unchanging baseline. The specific assumptions incorporated in this baseline are:

- GP Drugs and all of the elements of HCHS and FHS experience activity growth of 2% per year. PPS grows by 4% per year in current price terms.
- The quality of HCHS and FHS services improves by 1% per year.
- All inputs components grow by 2% per year.

Finally, to simplify the model, it is assumed that unit input and output costs are fixed through time. These assumptions are designed to reflect several dimensions of heterogeneity which the healthcare system in the UK exhibits without over-complicating the calculation process.

This fictional, baseline scenario predicts (a) growing aggregate inputs, (b) rising healthcare output and (c) positive productivity growth. This arises as a consequence of the faster growth of quality adjusted output than of aggregate inputs. This baseline is invariant to the changes specified by the user and therefore provides an effective base case against which to judge a customised scenario. The results of three customised scenarios devised using the spreadsheet model are described in Appendix A.

7. User and stakeholder needs

ONS actively seeks feedback from users of its public service productivity statistics in order to inform its future work priorities. We are particularly interested in user views on the value of these statistics to inform policy debates and research projects within the academic and National Accounts fields. The updated Quality and Methodology Information (QMI) for the Healthcare productivity article (ONS 2012d) includes a section on user needs and perceptions.

The QMI outlines the various methods we have used to gain feedback from users about our statistics, including, (a) functional board meetings, (b) user workshops discussing the range of productivity estimates produced by ONS and (c) a user survey (via Survey Monkey) attached to the latest Healthcare productivity article. The results of the workshops in public service productivity measures are published in ONS (2012e). The results of the user feedback survey for Public Service Productivity Estimates: Healthcare 2010 are available at ONS (2012g).

In addition, ONS has produced a document containing a series of frequently asked questions that provides users with a short explanation of the key concepts relating to public service productivity (ONS 2012f), including how they relate to other issues such as ‘efficiency’ and ‘value for money’. This document also provides an overview of methods used to create the statistics and guidance on how they should be used.
8. Strengths and weaknesses of ONS methodology

The measurement of non-market output is a difficult task. Placing a value on a particular procedure, assessing the health gain of different healthcare activities and comparing the value of output in one part of the health service with that in another involves a range of assumptions, towards which there are a range of legitimate approaches. This section sets out the strengths and weaknesses of the methodological approach adopted in ONS (2012a), and highlights areas which ONS are looking develop for future publications.

The central strength of the existing methodology is its novelty. As far as we are aware, the estimates presented in ONS (2012a) are the only UK level estimates of healthcare output, inputs and productivity currently available. The approach is fairly comprehensive, accounting for changes in activity and expenditure across the publicly funded UK health service, including highly detailed information about many different types of activity, delivered in a variety of patient settings. The methodology follows practice elsewhere (ONS 2012c, for example) and offers clear information about the delivery of healthcare services in the UK, making it a valuable tool for policy-makers, academics and third-sector groups.

Four areas offer potential for future development through the improvement of geographic coverage and the improvement of data sources.

Geographic coverage

The first area of potential improvement is the different levels of health service coverage in different parts of the UK, as reflected in Tables 1 and 3. At present, only England provides output data on all four healthcare sectors. Wales do not provide data on FHS activity and neither Scotland nor Northern Ireland provides any data on the output of Non-NHS providers. ONS continues to work with data providers to ensure the highest possible degree of coverage. As more detailed information from appropriate sources becomes available, ONS will seek to incorporate it into estimates of output, inputs and productivity.

Non-NHS provision

While ONS (2012a) includes direct volume estimates of healthcare output and inputs for several healthcare sectors, Non-NHS provision is included using an indirect measurement approach. This involves the assumption that the level of expenditure on these services – once appropriately deflated – is a fair measure of the level of Non-NHS output produced. Data coverage can be improved through continuing to work with Scotland and Northern Ireland to provide expenditure data on non-NHS provision of services, funded by Government. ONS will also continue to be interested in improving its understanding of the kind of output supplied by non-NHS providers from information supplied by the Health Departments of the devolved administrations.
**GP activity**

The third area of future development concerns the measurement of GP activity in England. From 2014, ONS will hope to incorporate a new data source to estimate GP activity which replaces a survey contract that was discontinued in 2008-09.

**Timing & Sequencing**

Finally, ONS intends to produce more timely estimates of healthcare output, inputs and productivity and is planning to undertake work to explore how the sequencing of articles can be improved in the future.
Appendix A:

In response to user requests for more detailed information about the mechanics of the underlying calculations which are carried out for ONS (2012a), ONS has produced a simplified spreadsheet model of the process which is published alongside this document. This model provides information about a fictional health service in which there are four output sectors (Hospital & Community Healthcare Services (HCHS), Family Health Services (FHS), GP Drugs and publicly-funded, Privately Provided Services (PPS)) and two inputs (Labour and Goods & Services), and demonstrates how the calculations of output, inputs and productivity are performed. As such, the spreadsheet model retains many of the complexities of ONS (2012a), while the reduced number of dimensions makes the model more tractable. This section shows the results of three customised scenarios produced using this spreadsheet model.

Example 1: Increasing Labour inputs

To examine the effect of a change in the number of staff on healthcare productivity, the growth rate of Labour inputs in FHS was increased. Using the ‘Control Box’ worksheet, the annual growth rate of these Labour inputs was increased from 2% to 6%

The impact of this changes on aggregate inputs can be seen in the ‘IP – Summary’ worksheet. Raising the growth rate of Labour inputs relative to the baseline scenario increases aggregate inputs by 0.7 percentage points in 2003, by 1.5% in 2004 and by 7.8 percentage points by 2010. The growth of Total Labour inputs rises from an annual average rate of 2% to 3.3% between 2002 and 2010. Note that the magnitude of this change is smaller than the simple percentage changes would at first suggest. This is because (a) FHS represents only a third of total healthcare output in the base year and (b) the mix of FHS inputs is evenly split between Labour and Goods & Services. The levels of output in the scenario are unaffected by this change (see the ‘OP – Summary’ worksheet).

As the level of inputs in this scenario has risen without a corresponding increase in output, productivity is expected to decline. This can be verified on the ‘Productivity’ worksheet. Productivity declines from a base of 100 in 2002, to 99.8 in 2003, to 99.5 in 2004 and to 97.6 in 2010, compared to corresponding baseline productivity values of 100, 100.5, 101.0 and 104.1. The trebling of the growth rate of FHS Labour input reduces productivity by 6.5 percentage points between 2002 and 2010, compared to a baseline increase of 4.1 percentage points.

Example 2: Rising hospital activity

To examine the impact of increased activity in hospitals on aggregate healthcare output, inputs and productivity, the growth rate of the activity in the HCHS sector was increased using the ‘Control Box’ worksheet. The activity growth rates of Non-Elective Inpatients and both Outpatient Categories were doubled, from 2% per year to 4% per year, while the growth rate of activity in Elective Inpatients was increased from 2% to 8% per year.

The impact of these changes on aggregate output can be seen using the ‘OP – Summary’ worksheet. Comparing this scenario with the baseline, healthcare output in the scenario is 1.1 percentage points higher in 2003, 2.2% higher in 2004 and 11.1% higher in 2010. The annual
average growth rate of aggregate output increased from 2.5% per year to 3.6% per year. Examining HCHS output alone, the annual average growth rate of output increases to 5.1% in the scenario, from 3% in the baseline, resulting in a 21.8 percentage point difference in HCHS output in 2010. Note that while the increase in output in the scenario compared to the baseline is significant, it again is not as large as the initial percentage changes would suggest. This is due to the largest increases being concentrated in the smallest part of HCHS, and the dampening effect that the unchanged remaining 48% of healthcare output has on overall growth. The volume of inputs remains unchanged (see ‘IP – Summary’ worksheet).

As healthcare output has risen without a corresponding increase in inputs, the level of productivity must also increase. This can be verified in the ‘Productivity’ worksheet. Starting from a base of 100 in 1997, productivity in the baseline (scenario) rises to 100.5 (101.6) in 2003, to 101.0 (103.1) in 2004 and to 104.1 (113.6) in 2010.

**Example 3: Higher quality outcomes**

To examine the effect of a change in the quality of patient outcomes on output, inputs and productivity, the growth rate of quality in Non-Elective Inpatients is increased by 4% from 1% per year to 5% per year using the ‘Control Box’ worksheet.

The increase in the growth rate of quality has no impact on healthcare inputs (see ‘IP – Summary’ worksheet), but has a significant impact on the growth of quality adjusted healthcare output. This can be seen in the ‘OP – Summary’ worksheet. Comparing output in the scenario with output in the baseline, the former is 0.3 percentage points higher in 2003, 0.6 percentage points higher in 2004 and 2.7 percentage points higher in 2010. The annual average growth rate of Non-Elective Inpatient output rises from 3.0% per year to 7.0% per year. Note that a change in the quality of outcomes in just one part of the health service here lead to significant changes in the aggregate indices.

The effect of this change has a correspondingly positive impact on healthcare productivity. By increasing quality-adjusted healthcare output without raising the volume of inputs, productivity in the scenario (compared to the baseline) rises from 100.0 to 100.8 (100.5) in 2003, to 101.6 (101.0) in 2004 and to 106.4 (104.1) in 2010.
References:


12. ONS (2012g) Survey monkey results for Public Service Productivity Estimates: Healthcare 2010. Available at: