FEATURE

Kato Kimbugwe, Rhys Lewis
and Nicola James
Office for National Statistics

Labour inputs in public sector productivity: methods, issues and data

SUMMARY

This article provides an overview of the methodology currently used in the production of labour input measures, with a specific focus on how these affect estimates of public service productivity published by the UK Centre for the Measurement of Government Activity (UKCeMGA) in the Office for National Statistics (ONS). It reviews ongoing work to improve labour input measures within the context of both the literature and empirical work as a way of highlighting key conceptual and practical issues with existing methods and data. It provides an update of the new education direct labour input measure and an update on the implementation of the Atkinson review recommendations on the measurement of labour inputs to production.

Introduction

Total output of an economy or sector of the economy is determined partly by the quantity of factor inputs (labour, capital, etc) and partly by how these factors are used. Different sectors of the economy may achieve different volumes of total output using similar quantities of factor inputs because of the variations in productivity. Therefore productivity is a concept that relates output to a given input or inputs. In the UK, the Centre for the Measurement of Government Activity is tasked with measuring public service productivity. Essentially, this means measuring the effectiveness with which government produces and delivers services by measuring the relationship between outputs and the inputs (capital, labour, and intermediate inputs) used to produce them. In essence, this measures the productivity of government spending (a GDP expenditure approach) rather than government production (a GDP output approach).

Measures of both the output and inputs components of the productivity equation should ideally be adjusted for quality. In the case of output, this means an estimate of change in the quality of service. For inputs, this means measuring the changes or differences in the quality of the resources that are used in producing or delivering that service. Issues around how best to estimate the changes in the quality of outputs are not the focus of this paper¹. This article addresses the inputs component of the productivity equation, specifically measurement of labour as a subcomponent of the overall inputs measure. It discusses

how best to estimate the volume of different types of labour (direct or indirect) and, in each case, how best to account for changes in the quality of labour.

Labour in productivity estimation

Productivity is often expressed in terms of labour (labour productivity), frequently defined as output per person employed. This definition does not take into account the contribution of other factors such as capital in the production of that output. An alternative measure of productivity that relates output to both labour and capital inputs is Total Factor Productivity (TFP), sometimes referred to as Multifactor Productivity (MFP). Labour and capital are the most common components of multifactor productivity analysis although some productivity studies (Diewert and Lawrence 1999) have included additional variables such as land and inventories. Others have included intermediate inputs as a third variable in MFP measurement (US National Academy of Sciences 1979, and Gallop 1979 and 1981). They argued that the correct treatment of MFP variables depended on whether the task at hand was to measure MFP at a highly aggregate level or at the level of detailed industries.

At the highly aggregate level where interest is on final product, Gallop (1979) suggests an MFP measure that only accounts for capital and labour as the key inputs². Conversely, at detailed industry level, Gallop suggests that it would be a mistake to ignore intermediate inputs (that is, those purchased from other industries). At industry or sector level, the

key is to define output to include products or services delivered to other sectors while defining inputs to include intermediates purchased from other sectors. At the same time, within the industry or sector, intermediate transactions occurring between establishments should be excluded from both outputs and inputs, in line with National Accounts. Therefore gross output, defined as total services or products delivered adjusted for inventory change, should be compared to measures of capital, labour and intermediate inputs (Gallop 1981).

The current UKCeMGA approach to MFP measurement follows the Gallop interpretation by accounting for capital, labour, and intermediate input components in the MFP measure, given that the productivity work is undertaken at functional level – that is, Health, Education, etc. This approach is similar to what is known as the KLEMS approach which classifies inputs into capital (K), labour (L), energy (E), material inputs (M), and purchased services (S). Often the last three categories of inputs are aggregated to form a single ‘other input’ category commonly referred to as intermediate consumption. The advantage of using this type of MFP as a measure of productivity is that it incorporates the effects of changes in all three inputs, whether they are due to improved skills, more efficient capital usage, more efficient procurement or a change in the composition of labour, capital or intermediate inputs.

Labour input measures

There are two ways to measure labour inputs – direct and indirect. A **direct** measure involves counting the volume of inputs: the number of hours worked by different employees within a sector, accounting for their different skills. The **indirect** measure involves removing the effects of inflation from the compensation of employees’ expenditure by dividing the expenditure by a pay cost index. Ideally, using either method should result in the same estimate of labour input but in practice this is not the case due to a number of reasons – for example data availability and accuracy.

UKCeMGA’s experience in estimating public service productivity has shown that in many cases the variation in the results using either method is principally down to data availability, the quality of the data, and the degree of granularity of the data. In cases where both direct and indirect measures can be produced, a choice as to which measure is used in the final productivity calculation is based

on the quality and robustness of data. A review of labour input measures for public service areas in UK National Accounts and from UKCeMGA’s work on public sector productivity provides some examples of the problems faced with both methods and the need to improve these.

Issues arising from public sector productivity analysis

The 2007 Education Productivity article presented both an indirect and direct measure (ONS 2007). The direct measure used teacher numbers (full-time equivalents (FTE)) but it was thought this might fail to capture changes over time in actual hours worked, knowing that there had been deliberate expansion in support staff numbers to relieve pressures on teachers. Consequently the indirect measure was used in the productivity calculation. Since then, new data from the Office of Manpower Economics (OME) on teacher working hours has made it possible to produce a more robust direct labour input series, presented later in this article.

The National Accounts direct volume measure for defence labour inputs uses FTE employees multiplied by an average wage across the entire military defence workforce in the year 2000 (ONS 2008a). The drawback here is that it doesn’t account for skill: all MOD employees are treated as having the same level of skill given that an average wage is used. Secondly, by using weights fixed to the year 2000, this means that the estimates will not change to reflect the spending patterns in the given year (ONS 2008a).

For police, the current National Accounts indirect measure uses a basic deflator derived from police expenditure on labour, collected through the Subjective Analysis Returns (SAR), based on average pay increases with a base year at 2000 (ONS 2008b). This has a number of flaws given that it includes both volume and price changes and doesn’t account for skill. Therefore, it would be difficult to ascertain whether the change in the deflator is due to an increase in police numbers (volume change) or an increase in wages (price effects).

For social security administration (SSA), the 2006 productivity article highlighted the weaknesses of using a department specific pay deflator to deflate Department of Works and Pensions (DWP) component of labour expenditure and the Average Earnings Index (AEI) to deflate non-DWP labour expenditure for SSA (ONS 2006). Neither deflator accounts for changes in skill or experience of staff. The assumption in the DWP deflator is that the year-on-

year changes are due to price changes and not changes in skills mix. Simply put, an increase in the quality of the labour force represents a bigger volume input than if labour quality is unchanged.

The current health direct labour input measure splits employees into different professions, that is consultants, nurses, ambulance staff, and support staff, with FTE numbers for each category for the period 1995–2006 (ONS 2008d: 29). A Laspeyres index of the change in the volume of staff (by FTE) weighted by the average earnings of each category of staff is then calculated, which goes some way towards accounting for quality as it takes into consideration differences between staff categories/skills. Nevertheless, it may not fully account for changes in the quality of staff within each category if more highly qualified individuals are employed or current employees add to their skills set. There may also be salary differences between those employed by the NHS and agency staff. Furthermore, by using average earnings as weights, rather than total labour costs, it fails to account for changes in the relative cost of different staff – that is, dissimilar national insurance/pension contributions. Moreover, by using contracted hours and not actual hours worked, there is a possibility that hours actually worked by staff such as doctors, have changed in a way not reflected in formal contracted hours.

There is also an indirect measure of labour for health which splits current price labour expenditure (England only) into several streams; Hospital and Community Health Services (HCHS), General and Personal Medical Services (GPMS), and Department of Health (DH) administration with specific deflators to deflate these streams³. This approach differentiates between different types of labour input in hospitals, but does not take account of possible salary differences between those employed directly by NHS and agency staff. Similarly, the method is based on assumptions about the split between labour and non-labour costs in primary care; uses wages not total labour costs; and is based on England only data with proxies for the other countries.

A direct labour input measure

There are a number of options for calculating a direct labour input measure, each of which can be ranked along a continuum of conceptual correctness. The ranking, from lowest to highest is as follows.

- Employment count: a straightforward measure of labour input and usually the easiest to obtain, but it does have some

drawbacks: all workers are given the same weight regardless of whether they work full- or part-time.

- Full-time equivalents (FTEs): preferred to a straight count measure as it takes into account the mix of full-time and part-time employment. An assumption is made about the relative input of part-time workers to full-time: commonly, that a part-time worker has a weight of one half that of a full-time worker.
- Hours paid: improves on the FTE volume measure by not requiring an assumption about the relative input of part-time to full-time workers, but it does have some drawbacks: often workers are paid for a set number of hours, but it is common for workers to change the number of hours from week to week or work unpaid hours.
- Actual hours worked: a more accurate measure of labour volume than hours paid. However, it treats hours worked by all individuals as equal, regardless of their 'quality'.
- Quality-adjusted hours worked: the most accurate measure of labour volume is 'quality-adjusted' hours worked because differences among workers are explicitly recognised.

Constructing a direct labour input measure requires up-to-date data on the number of full-time equivalents or preferably actual hours worked, average earnings or specific information on compensation. A simple representation of a direct labour Laspeyres equation:

$$L_{t,t-1} = \sum_i w_{i,t-1} \left(\frac{h_{i,t}}{h_{i,t-1}} \right) \quad (1)$$

Where

$w_{i,t-1}$ is the share that each type of labour occupies in total labour compensation.
 $h_{i,t}$ represents the amount of actual hours worked in category i for year t .

From UKCeMGA's perspective, the selection of the appropriate direct input measure is dependent on the availability, coverage, and quality of the data available. In addition, a suitable time series of the sum of hours worked or the quality-adjusted measure of the hours worked is required. In the UK, there are a number of varied sources (both from surveys and directly from government departments) of this data. ONS (2009a) provides a detailed summary of the various data sources both within the ONS and externally. The impact of these data sources on the attainment of quality-adjusted direct labour inputs is addressed in the section on quality adjusting labour.

Indirect labour input measures

An indirect labour input measure is produced by deflating expenditure on labour compensation using an appropriate wage index. This removes the effects of inflation/ pay increases from expenditure and produces estimates of volume of labour inputs at constant prices, ideal for comparison of a direct volume of labour inputs over time. The simplest way of achieving this is to use a broad based deflator; however, a more accurate method would be to make use of a suite of deflators, specific to the components of labour expenditure – across sector, industry, job categories, etc.

Accounting for skill is important even in an indirect measure; otherwise, during deflation, it is automatically assumed that all year-on-year changes in price are due to inflation only. One of the *Atkinson Review* (2005) recommendations was to have sufficient disaggregation between types of labour to allow for changes in the input mix. That is, a shift towards more highly skilled workers at higher earnings, or the reverse. As a result, the quality of the indirect estimates of labour inputs depends on the level of data disaggregation of both the labour force and deflators. This enables the development of high quality deflators but this must be in conjunction with a high-level expenditure breakdown on which the deflators will be applied.

Constructing an indirect labour input measure requires expenditure on labour compensation by function (that is, Health) and a further breakdown by sub-function (Hospital services and Public health services), share of expenditure on staff categories by occupation in order to calculate the weights, and the average wage of each occupational category, in order to calculate deflators specific to these categories. A simple representation of how the health indirect labour deflator is calculated is given below:

$$\frac{\sum \exp_{it}}{\sum \left(\frac{\exp_{it}}{\text{def}_{it}} \right)} \quad (2)$$

Where:

exp – England expenditure on category i
 def – deflator specific to category i
 t – time
 i – occupational (sub-function) category

For UKCeMGA's purposes, a breakdown of public sector expenditure is available in the National Accounts or, where more disaggregated information is needed, departmental data is obtained (for example, teacher salary data from DCSF). Other

sources of information on deflators are: the Annual Survey of Hours and Earnings (ASHE), Monthly Wages and Salary Survey (MWSS), Labour Force Survey (LFS), and the Quarterly Public Sector Employees Survey (QPSES).

Comparing the two measures

The selection of the appropriate labour input measure is dependent on the availability of the requisite data for each method. Productivity analysts prefer direct measures as wage indexes (indirect methods) are viewed as less reliable (OECD 2001). However, the direct method requires detailed information on staff numbers, hours worked or hours paid, which may be difficult to obtain. The indirect approach is easier to calculate since no additional data is required if appropriate deflators are available. However, accurate deflators also depend on the availability of disaggregated data.

Whatever method is chosen, the key is to account for the heterogeneity of labour given that, over time, the composition of the labour force changes, which can be regarded as an increase or decrease in the average quality of labour input. For example, if a government department contracts out functions with relatively low labour cost such as security and cleaning staff, retaining highly skilled staff such as accountants, the average quality of employed staff has risen (with equivalent security services now forming part of intermediate consumption rather than labour). Either method should be sensitive to the possibility of such changes. Accounting for compositional changes of labour is important as it provides an accurate indication of the contribution of labour to production; and the comparison of the adjusted and unadjusted estimates of labour input illustrate how the compositional changes affect the productivity estimates.

Quality of labour inputs

The importance of accounting for quality within labour inputs has been extensively debated in the literature. Denison (1967) augmented labour input to reflect differences in the quality of labour by adjusting total employment for hours worked, age-sex composition, and level of education. Jorgenson and Griliches (1967) showed that a substantial fraction of the Solow residual could be explained by changes in the quality of labour inputs – growth accounting⁴. The US Bureau of Labour Statistics (1993) used a regression approach to identify the impact of particular sources of change on labour composition.

In recent times, the importance of labour quality has gained prominence given the widespread use of ICT capital and the increased investment in complimentary assets (including skills) to aid diffusion (O'Mahony et al 2005). O'Mahony and Vecchi (2005) argue that part of this complementary investment includes investment in labour force skills; therefore, an evaluation of labour quality is a prerequisite if we are to distinguish between returns to ICT capital and returns to labour input. Jorgenson et al (2005) further emphasise that investments in both ICT capital and education are key sources of growth at both economy and industry levels.

In addition, Fosgerau et al (2002) cite the growth in educational attainment across the developed world as a key driver in understanding and accounting for the quality of labour inputs. Others have argued that for accurate cross-country productivity growth comparisons to be made, it is imperative that labour quality is incorporated into the growth accounting framework (Melka and Nayman 2006).

Defining skills

The European System of Accounts (1995:10.54) defines the quantity of employee labour as 'an hour's work for a given type and level of skill'. This definition, however, does not specify what types and levels have to be distinguished – that is education level, type of job, level of compensation, grade, etc – each of which may produce a different estimate of the labour input. The challenge therefore is how to define skills and hence how they can be measured. Eurostat (2001) offers a possible definition:

'The skill of a labour input reflects the physical and mental ability that an employee brings to a particular job.'

There are two points of note with reference to this definition: (i) the definition of skill is specifically related to the job undertaken and (ii) the level of skill does not measure how much effort has been expended by a particular employee. Given the difficulty in defining a true measure of skill, a solution involves a combination of measures that could best approximate the definition. Consequently, the task for productivity analysts is to gauge the contribution to changes in aggregate output brought about by changes in human capital or the quality of labour inputs. This means accounting for differences in the quality of hours worked by different types of employees, and accounting for these separately when formulating productivity measures⁵.

As such, labour compositional changes show the growth in labour input that is not attributable to the growth in hours worked; that is, the growth in labour input as a result of an increase in the education or experience of the workforce. Therefore the growth in labour composition can be derived as the growth in labour input minus the growth in hours worked. Consequently, an increase in the quality of labour over time would mean that a quality-adjusted labour input would rise faster than an unadjusted measure of labour input.

Approaches to quality adjusting labour

From the literature there are different approaches to quality adjusting labour. The difference in approach is closely related to how skills are measured.

One option is to capture difference in labour input by looking at the differentiating characteristics of the labour force such as age, gender, class of worker, occupation or education and cross-classify labour input by industry – known as the Jorgenson approach.

The other option is to limit the number of differentiating characteristics so as to reduce the number of interaction effects between them. This is the approach adopted by the US Bureau of Labour Statistics (BLS) in which labour input is cross-classified by education and work experience.

Alternatively, we could assume a direct relationship between skills and occupations, rank occupations by skills intensity and then derive differentiated measures of labour input. This is the approach taken by OECD (1998) and Lavoie and Roy (1998) and has been adopted as the current UKCeMGA approach. ONS (2009a) provides a review of the BLS and Jorgenson approaches and hence the next section deals with the UKCeMGA approach.

The approach taken assumes a direct relationship between skill and occupation, and ranks occupations by their skill intensity. Information on the occupational distribution of hours worked is then used to derive measures of labour input. Labour expenditure (compensation) is used to weight hours worked. The weighting goes some way towards accounting for 'quality' in the labour inputs, based on the assumption that highly skilled workers will be paid more than unskilled workers.

It is assumed that under competitive market conditions, wages will reflect the marginal productivity of workers of different types since they are free to move between jobs in search of wages that reflect their productivity. However, many public

service occupations do not operate in a fully competitive market since they are employed by monopsony employers such as NHS hospitals whose budgets are constrained by public spending decisions and specific salary scales set by public sector Pay Review Bodies (PRB). As such, it can be argued that market forces may not have a significant influence of the salary scales adopted, although the PRB system does take some account of wider market factors.

The debate over which factors are most significant in determining wage rates is ongoing and is not the focus here. The next few sections focus on the importance of level of education and years of work experience as measures of the skills of a labour force.

Education and experience as a determinant of wage rates (or skills)

Human Capital theory shows that there is a positive relationship between wage levels and years of work experience (Reilly et al 2005). The age-earnings profile is concave, reflecting the concept of diminishing returns relative to work experience, and the profile is determined by employees calculating the costs and benefits of further investment in human capital. Therefore, an employee nearing retirement may opt to reduce their investments because the marginal benefits of further education are beginning to be outweighed by the marginal costs. To explain the relationship between wages and education attainment, Reilly et al (2005) offer the Screening Model (SM) and the Multi-period Implicit Contract Model (MICM) as alternatives to the Human Capital Model (HCM).

In the SM, productivity is determined by innate ability (which is proxied by education). The assumption here is that employers do not have perfect information about potential employees' abilities and thus use the level of education to screen the most able people into the various jobs and wage categories. This suggests that ability rather than education or training is the main determinant of the wage rate but, given that it is difficult to price this innate ability, a person's level of education offers a close approximation of this ability (skill).

In contrast, in the MICM it is assumed that the age-earnings profile is not an accurate representation of the relationship between wages, productivity or skills. Rather it partly reflects a deferred payment implicitly contained within the employment contract, whereby the employee agrees to take a wage lower than their value of marginal product early on in their career in order to receive a wage greater than the

value of their marginal product later on in their career. For example Lazear (1979) argues that in order to reduce labour turnover, firms prefer to pay lower wages in the beginning and higher wages later in a job spell. In contrast, Frank (1984) argues that a young worker might wish to hedge their bets by accepting employment under a less favourable pay scheme than could be achieved with full awareness of their own productivity.

Despite the competing models (SM, MICM or HCM), the Human Capital Model has been widely adopted in estimating labour inputs by a wide range of statistical organisations (US Bureau of Labour Statistics, Australian Bureau of Statistics, and Statistics New Zealand) and has been supported by empirical evidence in the literature. The main critique of this approach would be: how closely do wages truly reflect the quality of the labour input? Frank (1984) argues that wages depend on a number of characteristics: employee and firm characteristics, wage policies, and market in which the firm operates. Therefore, assuming competitive market conditions⁶, wages would be a good proxy for quality of labour, however, this assumption does not hold true in the real world:

- as indicated earlier, firms may follow strict pay formulae based on education, experience and length of tenure, even when there are apparently very wide differences in productivity among individual workers who are alike with respect to the characteristics specified in the pay formula
- in addition, it is costly for firms to measure individual productivity effectively enough for these differences to be reflected in wages
- since employees are more risk averse than firms, they are less willing to move around different employers in search of wages that reflect their marginal productivity
- moreover, frictions within the labour market can also mean that wages are not an accurate reflection of an employee's productivity⁷

Despite these shortcomings, level of education or qualification attained and the numbers of years of work experience are still the best and most widely used measures to estimate the quality of labour inputs.

Accounting for quality in a direct labour measure

Accounting for quality in direct labour methods involves a direct measurement of

the quantity of labour using either actual hours worked, hours paid, or full-time equivalent number of employees broken down by type of employee. The next step is to find a method that reflects the skill levels of employees, so that the labour input data can be weighted appropriately and changes in the mix of skills over time are reflected as a volume change. Eurostat (2001) recommends the Wage Rate (WR) method as a way of constructing a direct labour quality-adjusted index. The method defines the price/volume decomposition in such a way that if a price change is not specified in the wage rate change for a certain category, it will end up in the volume component (Eurostat 2001). The method is ideally suited to industries or sectors of the economy where there are collective bargaining agreements that set common wage rates for large groups of employees. The method assumes that the collective wage increases give an indication of the actual changes in the price of labour, while all other wage increases are related to performance and hence are included in the volume component.

Accounting for quality in an indirect labour measure

For wage indices to offer some level of quality adjustment they would have to meet some criteria: they should be broken down in sufficient detail to provide a deflator for groups of staff of homogenous skill. This presents some difficulty, given the structure of the labour market. Eurostat (2001) recommends the Average Wage (AW) method as a way in which an indirect labour quality-adjusted index can be constructed. The starting point is an exhaustive set of data on numbers of employees and their salaries, in a detailed breakdown of grades and activities. The average wage increase per employee is determined for each of the detailed categories of employees, so that the wages of each category can be deflated separately. The breakdown into price and volume is implicit in the classification of grades, activities, etc, and the detail of those classifications. Shifts between the categories are reflected in the volume component, while wage increases within categories are included in the price component (Eurostat 2001). Consequently, the coverage of the volume component is increased when a more detailed stratification is used. The method is much more data-intensive than the WR method, and is applicable to deflating the wages and salaries of government employees (Eurostat 2001).

The next section outlines the new

education direct labour input measure made possible by the acquisition of new data from the OME Teacher Workload Survey.

Measuring the quantity of labour inputs in Education

Recent government policies and reforms have been aimed at reducing unpaid overtime worked by teachers by increasing support staff⁸. The direct method was published in the Education Public Service Productivity article but not used given that it did not take account of actual hours worked since there was no reliable survey data (ONS 2007). This was of particular concern due to rapid growth in the number of support staff from the late 1990s onwards, a change which was thought likely to have been at least partly offset by a reduction in teachers' working hours as indicated in **Figure 1** and **Figure 2**. Support staff numbers are estimated to have risen by 229.4 per cent between 1996 and 2007 while average teachers' working hours increased from 51.5 hours to 52.9 hours during the period 1996 to 2000 then fell to 50.4 hours in 2007, a fall of 2.1 per cent over the whole period.

Revised direct labour measure for education inputs

The revised direct measure addresses the hours issue by adjusting teaching staff numbers by their actual working hours using data from the OME survey, and shows that an offsetting effect did in fact occur: between 1996 and 2007 support staff numbers more than doubled while the average teacher worked around 2 per cent fewer hours per week. In chained volume terms, the revised direct measure of education labour input growth over this period falls from 24.1 per cent to 22.5 per cent once teachers' working hours are taken into account.

The revised measure also incorporates two further methodological improvements. Firstly, it uses regional full-time equivalent staff data for teachers for England, Scotland, Wales and Northern Ireland and full-time equivalent support staff data for England, Scotland and Wales, broken down by type of institution and teacher level where possible; the method previously presented covered England and Scotland only and aggregated by type of institution only. Secondly, it uses lower-level salary data to weight region-specific salary data which is then used to weight support staff, whereas the previous measure used UK figures. As indicated earlier, salary data is used in the weighting of staff categories to account for skill level. ONS (2009a) provides a detailed outline of the various data sources used in the production of the new measure.

Figure 1
Index of Teachers and support staff numbers^{1,2} in the UK

Notes:

- 1 Academic year basis
- 2 Northern Ireland figures are estimated

Source: Department for Children Schools & Families, Scottish Government, Wales Assembly Government, Department of Education Northern Ireland

Figure 2
Average teachers' working hours for England and Wales

Source: Office for Manpower Economics

Revised direct measure versus published indirect measure

Using the revised direct measure, it is estimated that volume of education labour input in the UK increased by 22.5 per cent over the period 1996 to 2007, an average of 1.9 per cent per year. This compares with the indirect measure of education labour which had growth of 26.2 per cent, an average of 2.1 per cent per year, for the same period – **Figure 3**.

Conceptually, an indirect and a direct measure should provide identical results if the same data sources are used. However:

- the direct measure shows lower growth than the indirect measure as it uses actual teachers' working hours for England and Wales, rather than paid hours worked. Actual working hours fell by 2.1 per cent between 1996 and 2007
- the direct measure accounts for skill level by using a finer breakdown of teaching staff salary data than the indirect measure, which uses average full-time equivalent staff remuneration to deflate expenditure on teachers
- the indirect measure for support staff does not take into account the

different categories of support staff for each country as the composite ASHE deflator is based on England support staff categories only

Revised direct labour versus previously proposed direct measure

The direct labour measure, outlined in 2007, used data spanning from 1996 to 2006. Over this period, the volume of direct labour on the revised method increased by 21.7 per cent for the period 1996 to 2006

compared to growth of 24.0 per cent on the previous measure (**Figure 4**). Around half of the difference is attributable to the inclusion of teachers' working hours, with the remainder resulting from the use of more detailed staff number and salary data and their conversion from academic to calendar years where appropriate.

In summary, the revised direct labour measure addresses the main concerns with the previous method, by taking account of actual teachers' working hours, by using more detailed data on staff numbers and salaries, and by broadening coverage to a UK-wide basis. However, a number of measurement issues remain unaddressed:

- The OME survey only covers England and Wales with no equivalent survey conducted in Scotland or Northern Ireland; therefore the measures for these countries are based on full-time equivalent staff numbers only
- Using average salary to account for skill level may not truly reflect the level of skill as the assumption made is that higher wages reflect higher skills, which may not be completely accurate within the publicly funded education sector
- As there are no data for support staff numbers in Northern Ireland, Wales is used as a proxy. However, the two education systems are different and there could be over- or underestimation for support staff for Northern Ireland
- For Scotland, a consistent time series showing the breakdown between support staff categories was not available for full-time equivalent staff numbers

Conclusion and Next Steps

UKCeMGA is taking forward other work to address some of the issues highlighted in this article. The Defence Scoping Paper outlines the proposed changes to improving

Figure 3
Comparison of indirect and revised direct measure of labour input for Education

Source: Office for National Statistics

Figure 4
Comparison of revised and previous direct labour measures for Education

Index numbers (1996 = 100)
 United Kingdom¹

Note:

1 Previous direct labour measure only covers England and Scotland.

Source: Office for National Statistics

the current direct and indirect labour input measures. The proposed direct measures will break down FTE staff into 'service and civilian personnel by rank/grade, weighted by wage; or service personnel by trade, weighted by Job Evaluation Scores, and civilian personnel weighted by wage' (ONS 2008a). The proposed indirect measure will split defence labour expenditure into service and civilian personnel, and these will be further broken down by rank or grade respectively for the service or civilian personnel then deflated using rank- or grade-specific pay indices (ONS 2008a). In both cases, the proposed changes offer a significant improvement from the National Accounts measure outlined in the preceding sections of this article.

The proposed improvements to the police labour input measure are mainly focused on the improvement to the method of deflation. The ONS (2009b) publication on police inputs outlines the changes proposed. There are two possible deflators: one based on OME average pay data, and the other based on average earnings from the ASHE. A direct measure is also presented, using data on police service strengths FTEs from the Home Office (HO) together with the new data from the OME on the average pay of police forces in England and Wales. Therefore, it is now possible to estimate a new direct labour inputs measure.

Development work on healthcare labour inputs in the future will include work on increasing the number of categories of labour, quality adjusting categories of labour and increasing coverage by obtaining data from Scotland and Northern Ireland. Quality adjusting labour categories would necessitate not only having data on variables such as experience but also

estimating the marginal impact of these variables on labour quality.

This article has outlined how labour inputs in productivity analysis can be measured, the various data sources for each method and a way in which measures of labour quality can be incorporated. The choice between the direct or indirect measures of labour and the quality of labour input is dictated by the availability of data to support either measure. The ideal requires data on total number of hours, disaggregated by the skill level composition of labour. Labour force categories should be distinguished when making appropriate adjustments for quality differences in the labour input. Alternatively, where a direct measure is not available, a detailed breakdown of labour compensation expenditure by category and the use of relevant deflators to adjust the expenditure in the specified categories thus providing a quality-adjusted indirect labour input measure.

Notes

- 1 This is not to say that the issues and challenges in measuring outputs are not important. These are dealt with by various UKCeMGA publications which can be found on our website.
- 2 At a highly aggregate level with a focus on final output; GDP estimation would exclude intermediate inputs in order to avoid double counting.
- 3 Overall DH Pay Cost Index to deflate expenditure on HCHS pay; NHS administration component of DH Pay Cost Index to deflate expenditure on DH administration pay; and a General & Personal Medical Services (GPMS) index constructed from the GP

Earnings and Expense Enquiry survey to deflate GPMS.

- 4 The Solow residual is a number describing empirical productivity growth in an economy from year to year and decade to decade.
- 5 For example, one hour worked by a new employee is not going to be of the same quality as one hour worked by someone with years of experience in the job (unless perhaps the new employee has significantly higher relevant qualifications). There might also be a change in the composition of the labour force over time - more qualified workers might be employed or existing workers might increase their skill by gaining more qualifications. If higher skilled employees are employed, then total number of FTE workers or hours worked would not increase, but in volume terms the actual labour inputs have increased.
- 6 Which assumes that: (i) workers are homogeneous, (ii) firms have no buying power, (iii) there are no trade unions, (iv) the productivity of each worker can be clearly measured, (v) the supply of labour is perfectly elastic, etc.
- 7 Other factors in play include:
 - Geography - limits employees' willingness to travel in search of a wage that reflects a person's productivity
 - Efficiency wages - an employer might pay an employee a wage above their equilibrium level as an extra incentive to work hard. The worker that is paid in excess may not be different to any other worker with the same ability and human

capital investment who earns an equilibrium wage. The payment is an inducement to work more efficiently

- The pervasiveness of unions affects wages. Union workers earn approximately 20 per cent higher wages than comparable non-union workers, according to studies by Hirsch and Macpherson (2002), and Pierce (1999).

- 8 For example, 'Raising Standards and Tackling Workload: a National Agreement', introduced by DfES in 2003.

CONTACT

✉ elmr@ons.gsi.gov.uk

REFERENCES

- Atkinson T (2005) *Atkinson Review: Final Report*, Palgrave Macmillan: Basingstoke.
- BLS (1993) 'Labour Composition and U.S. Productivity Growth, 1948–90', *Bulletin* 2426, U.S. Department of Labour – Bureau of Labour Statistics.
- Denison E F (1967) *Why Growth Rates Differ*, The Brookings Institution: Washington D.C.
- Diewert E and Lawrence D (1999) 'Measuring new Zealand's Productivity', *Treasury Working Paper No 99/5*, March.
- ESA (1995) *European System of Accounts*, Chapter 11: 'Population and Labour Inputs', available at: <http://circa.europa.eu/irc/dsis/nfaccount/info/data/esa95/en/een00463.htm>
- Eurostat (2001) *Handbook on Price and Volume Measures in National Accounts*, Eurostat: Luxembourg.
- Frank R H (1984) 'Are Workers Paid Their Marginal Products?', *The American Economic Review*, Vol 74, No.4, 549–571.
- Fosgerau M, Jensen H and Sorensen A (2002) 'Measuring Educational Heterogeneity and Labour Quality: A note', *Review of Income and Wealth*, Vol 48, No 2, 251–259.
- Gallop F M (1979), 'Accounting for Intermediate Input: The Link between Sectoral and Aggregate Measures of Productivity' in *Measurement and Interpretation of Productivity*, National Academy of Sciences: Washington D.C., pp 318–333
- Gallop F M (1981) 'Growth Accounting in an Open Economy', *Boston College Department of Economics, Working Paper*, March.
- Hirsch B T and Macpherson D A (2002) *Union Membership and Earnings Data Book: Compilations from the Current Population Survey*, Bureau of National Affairs: Washington D.C.
- Jorgensen D W and Griliches Z (1967) 'The Explanation of Productivity Change', *Review of Economic Studies*, Vol. 34, No. 3, 249–283
- Jorgenson D, Ho M S and Stiroh K J (2005) 'Growth of US Industries and Investments in Information Technology and Higher Education', in Corrado C, Haltiwanger J, and Sichel D (eds.) *Measuring Capital in a New Economy*, University of Chicago Press: Chicago.
- Lazear E P (1979) 'Why is there Mandatory Retirement?', *Journal of Political Economy*, Vol 87, 1261–84.
- Lavoie M and Roy R (1998) *Employment in the Knowledge-Based Economy: A Growth Accounting Exercise for Canada*, Applied Research Branch, Human Resources Development Canada, R-98-8E.
- Melka J and Nayman L (2006) 'Growth Accounting and Labour Quality in France, 1982–2001', in Mas M and Schreyer P (eds.), *Growth, Capital and New Technologies*, Foundation BBVA.
- National Academy of Sciences (1979) *Measurement and Interpretation of Productivity*, National Academy of Sciences: Washington D.C.
- OECD (1998) *The OECD Jobs Strategy - Technology, Productivity and Job Creation: Best Policy Practices*, Paris: OECD: Paris, available at: www.oecd.org/dataoecd/39/28/2759012.pdf
- OECD (2001) *Measuring Productivity: Measurement of Aggregate and Industry Level Productivity Growth*, OECD: Paris, available at: www.oecd.org/dataoecd/59/29/2352458.pdf
- O'Mahony M, Robinson C and Vecchi M (2005): Heterogeneity of the Labour Input: Methodological Issues in Constructing Labour Quality Measures. Paper presented at EUKLEMS consortium meeting, Helsinki, 9–11 June 2005, available at: [www.euklems.net/meetings/CM_Helsinki/omahony_et_al_\(2005\).pdf](http://www.euklems.net/meetings/CM_Helsinki/omahony_et_al_(2005).pdf)
- O'Mahony M and Vecchi M (2005) 'Quantifying the Impact of ICT on Output Growth: A Heterogeneous Dynamic Panel Approach', *Economica*, Vol 72, No 288, 615–633.
- ONS (2006) *Public Service Productivity: Social Security Administration*, UK Centre for the Measurement of Government Activity, available at: www.statistics.gov.uk/articles/nojournal/1596.pdf
- ONS (2007) *Public Service Productivity: Education*, UK Centre for the Measurement of Government Activity, available at: www.ons.gov.uk/about-statistics/ukcemga/publicationshome/publications/archive/public-service-productivity--education.pdf
- ONS (2008a) *Scoping Paper on Possible Improvements to Measurement of Defence in the UK National Accounts*, UK Centre for the Measurement of Government Activity, available at: www.statistics.gov.uk/articles/nojournal/Defence08v1.pdf
- ONS (2008b) *Criminal Justice System: Scoping Document*, UK Centre for the Measurement of Government Activity, available at: www.statistics.gov.uk/articles/nojournal/CriminalJusticeSystem_190308.pdf
- ONS (2008d) *Public Service Productivity: Healthcare*, UK Centre for the Measurement of Government Activity, available at: www.statistics.gov.uk/articles/nojournal/HealthCare_290108.pdf
- OME (2008) *Teachers Workloads Dairy Survey*, a report produced for The School Teachers' Review Body by The Office of Manpower Economics, available at: www.ome.uk.com/downloads/2008%20Teachers%20Report%20FINAL.pdf
- ONS (2009a) *Labour Inputs in Public Sector Productivity: Methods Issues and Data*, UK Centre for the Measurement of Government Activity, available at: www.statistics.gov.uk/articles/nojournal/Labour-Inputs-Article.pdf
- ONS (2009b) *Public Service Output, Input and Productivity: Measuring Police Inputs*, (UK Centre for the Measurement of Government Activity), available at: www.ons.gov.uk/about-statistics/ukcemga/publications-home/publications/index.html
- Pierce B (1999) 'Compensation Inequality', *Department of Labour, Working Paper No. 323*, Office of Compensation and Working Conditions.
- Reilly R, Milne W and Zhao S (2005) 'Quality Adjusted Labour Inputs', *ABS Research Paper No 1351.0.55.010*, (November) Australian Bureau of Statistics.