Assessing productivity in the delivery of health services in Australia: Some experimental estimates

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Paper presented to the
Australian Bureau of Statistics-Productivity Commission
Productivity Perspectives 2007 Conference

Marque Hotel, Canberra

17 December 2007

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The views expressed in this paper are those of the authors and do not necessarily reflect those of the Productivity Commission. This paper draws on a number of studies undertaken by the Productivity Commission and other researchers as well as presenting experimental estimates of health industry productivity. The authors would like to thank Mike Woods, Paul Gretton, Jonathan Pincus, Dean Parham, John Salerian and Ben Dolman for comments and Tim Murray, Jyothi Gali, John Salerian, Tony Simovski and Julie Novak for assistance.

1 Introduction

This paper explores the availability and suitability of Australian health data for measuring health productivity. It draws on a range of earlier studies and presents results from experimental research on the productivity of Australian state and territory public hospital systems between 1996-97 and 2004-05. Measuring productivity in health is a difficult exercise and, accordingly, the results should be treated with some caution. The paper is structured as follows. Section 2 discusses some of the broader issues involved in measuring productivity in health services delivery. Section 3 provides an overview of health services delivery in Australia. Sections 4, 5 and 6, respectively, explore productivity at three levels within the health system:

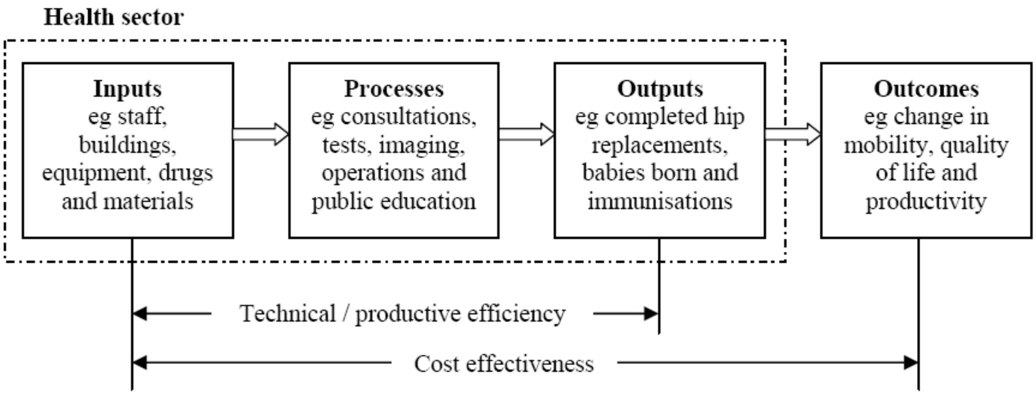
- health and community services (the ‘health’ system in aggregate);
- public hospitals (the health service provider level); and
- diagnostic categories related to hip replacement surgery (the procedural level).

Section 7 offers some suggestions for improving the suitability of Australian data for measuring productivity in the delivery of health services. Section 8 draws the main points made in the paper together.

2 Measuring productivity in health services delivery

The provision of health industry services involves the use of physical and intellectual resources (inputs) to produce goods and services (outputs) (figure 1). Its inputs consist of the health workforce (staff and their skills), buildings, land, technology, medical supplies, food, bed linen, office supplies, utilities, etc that are used to produce its outputs. The outputs of the health sector are numerous and vary substantially in character encompassing consultative and procedural services delivered in a range of community and institutional settings. They include general practitioner consultations, acute care treatment (such as hip replacements, cataract operations, organ transplants and oncology treatments), immunisations, staff training and scientific research. These outputs bestow benefits upon individuals and society (outcomes).

Figure 1 **Relationship between inputs, outputs and outcomes**



Source: Productivity Commission (2005, p. 370).

The demand for health services is derived from the desire of individuals for good health and the associated benefits in terms of quality of life and income earning capacity that good health can bring. The demand for health industry services contributes to the total demand for all goods and services (including pharmaceuticals) used for the purpose of achieving health outcomes.

The character and mix of inputs, processes and outputs, and the outcomes from the healthcare goods and services provided, varies substantially over time with the introduction of new or improved products, technological innovation affecting the delivery of products and changes in ways of working, as well as with broader influences such as relative prices and income levels.

Productivity is the quantity of goods and services produced by the health sector per unit of input (box 1). As such, it incorporates the technical efficiency with which inputs are turned into outputs. Technical efficiency can be measured as the extent to which the same output can be produced using fewer inputs (input-orientated) or the extent to which output can be increased using the same inputs (output-orientated).[1] The remainder of the paper focuses on input-orientated technical change to simplify matters. That is, the extent to which resources can be freed up for use in other activities without compromising output levels. Such a measure of technical change nonetheless provides an indication of the extent to which governments and society are able to increase the output of the health sector given existing health outlays.

[1] Estimates of technical efficiency are typically derived quantitatively using a sample of countries or states and territories. To the extent that the sample used does not include world's best practice, the potential gains may be higher than indicated.

Box 1 **Productivity and technical and economic efficiency in standard production processes**

Productivity is the *quantity* of goods and services produced per *unit* of input. It incorporates the technical efficiency with which inputs are turned into outputs.

A production function denotes the relationship between units of output and inputs. If there is a single output, Y, and a vector of inputs ($X_1, X_2, X_3, \ldots$), the corresponding production function can be denoted as $Y = f\left(X_1, X_2, X_3, \ldots\right)$. This single output example can be extended to include multiple outputs.

Productivity is commonly measured as Y/X. If X is a single input such as labour (capital), the result is a partial measure of average productivity such as labour (capital) productivity. However, if X is an index of labour and capital inputs (all inputs), the result is a measure of multi factor productivity (total factor productivity).

Technical efficiency is the degree to which the same output can be produced using fewer inputs (input-orientated) or the extent to which output can be increased using the same inputs (output-orientated) *given* existing technology.

Technical efficiency is a necessary condition for productive efficiency (producing output at the least cost), allocative efficiency (maximising social welfare at a point in time), dynamic efficiency (maximising social welfare over time) and cost effectiveness (minimising the cost of producing a given outcome).

Source: Based on Coelli et al. (2005) and Productivity Commission (2005, p. 371).

Quality is an integral part of healthcare and, as such, should be recognised and taken into account in productivity measurement; otherwise improvements in output quality may result in declines in *measured* productivity (box 2). At a basic level, quality encompasses two key, but distinct, dimensions: length of life (mortality); and quality of life (morbidity). A range of factors may contribute to these overarching measures, such as:

- survival rates;
- the duration and intensity of pain;
- the degree of patient mobility;
- the number, nature and severity of complications;
- waiting time length; and
- the nature of patient care received.

Box 2 Measuring quality in healthcare

Many factors bring about changes in output and input quality.

For example, research may lead to a better understanding of illness that leads to the development of more effective drugs, treatments and technology or the redesign of existing systems and processes. Likewise, better education and on the job training may translate into a more 'effective' health workforce. Quality may also vary with resource inputs and the competing demands being placed on the health workforce.

Some aspects of quality are measurable against objective or pre-defined standards (eg average waiting times, infection rates, babies delivered without complications and unsuccessful separations). Surveys can elicit important aspects of quality care such as cleanliness and courtesy from the perspective of patients. Accreditation of health facilities and staff qualifications by external organisations may also be indirect indicators of input quality.

Measures of quality can be incorporated into assessments of productivity in various ways. Ideally, the quality of outputs and inputs should be recognised explicitly, either by treating quality as a component of output or input in its own right (along the lines of the performance indicators of quality used by the NHPC 2004 and SCRGSP 2006) or by using quality-adjusted measures of output and inputs. Quality can also be incorporated implicitly by adjusting the weights used to aggregate outputs and inputs.

However, not all aspects of quality in healthcare are easy to measure. The impact of illness and the resulting treatment on patient wellbeing (morbidity), for example, is difficult to measure, as is the contemporaneous skill of medical staff in operations. As a result, it would be difficult to incorporate all aspects of quality into any assessment of health sector productivity. Nevertheless, the inclusion of soundly based and unbiased quality indicators would add valuable information to measures of the productivity of health services provision.

Source: Productivity Commission (2005, p. 385).

Data relating to quality are available for measures such as hospital and bed accreditation, mortality, waiting times, unplanned re-admissions, surgical site infections and patient surveys for most or all jurisdictions. However, not all aspects of quality are covered. For example, in the case of hip replacements, objective measures of the resulting changes in patient mobility do not appear to be available nor do details on the complications arising during surgery. This may be because the data are not collected or, perhaps, not published.

An alternative to aggregating individual quality measures is to use broader overarching measures of quality. However, there are few, if any, overarching measures of quality available and those that come close, such as life expectancy, are a function of more than just the quality of treatment or care received (eg they are also influenced by public health and lifestyle choices). Thus, the measures used need to be linked to the treatment received. Even then, care needs to be exercised in using such measures, as other factors may give rise to the observed changes in quality (eg changes in lifestyle) or may not be within the control of the health system (eg the probabilistic nature of many illnesses mean that adverse events will occur regardless of the quality of care received).

There is an issue as to what the appropriate counterfactual should be for measuring changes in quality in the context of health. Where collected, the available data typically indicate changes in quality over time — before and after medical intervention. However, such measures do not take into account what otherwise would have occurred. A more appropriate counterfactual against which to assess changes in quality would be against what would otherwise have happened if the medical intervention had not occurred. Thus, a deterioration in a patient's quality of life may, nevertheless, represent an improvement in quality, if the alternative were that they would have died (Atkinson Review 2005). But such a counterfactual for measuring changes in quality is effectively untestable in an objective manner. There is also an important time dimension to quality that needs to be taken into account (eg survival rates typically vary over time).

Ideally, suitably measured changes in quality should be taken into account in productivity measurement. There are a number of different options available.

- One approach would be to incorporate quality into a quality-adjusted output measure. This would require individual measures of quality to be drawn together into a single measure in a sensible and objective manner, even though the measures themselves are expressed in different metrics.
- A second option for incorporating quality into productivity analysis would be to treat quality as an additional output in its own right. Such an approach would avoid the implicit value-judgements needed to weight the output and quality changes to form quality-adjusted output measures.
- A third approach would be to dispense with activity measures of health outputs, such as separations, in productivity analysis, and instead use measures of the ensuing health outcomes. This would be analogous to viewing government and private expenditure on health as procuring a certain level of health outcomes (eg a certain improvement in quality of life).

Thus, while being a central factor in the delivery of health services, the absence of suitable metrics means that summarising the effects of service quality is seldom incorporated into measures of health productivity *in practice* using any of the three approaches possible.

3 An overview of health services delivery in Australia

A number of different definitions of what constitutes health services are used in Australia. Prior to the recent introduction of ANZSIC 2006 (ABS Cat. no. 1292.0), the Australian Bureau of Statistics (ABS) defined ‘health services’ (ANZSIC subdivision 86) on a production basis to include: hospitals and nursing homes (ANZSIC group 861); medical and dental services (862); other health services (863); and veterinary services (864). The ABS definition included animal as well as human health services. The Australian Institute of Health and Welfare (AIHW) — the main publisher of national health data in Australia — uses the ABS definition (excluding veterinary services), but also uses other definitions (typically based on purpose of expenditure or educational qualification). For example, some AIHW definitions of health include expenditure on medicines and pharmaceuticals. Reflecting its production rather than consumption focus, the ABS classifies medicines and pharmaceuticals as part of the ‘other chemical products’ industry. Consequently, taken on face value, statistics from different sources may not be strictly comparable.

While recognising that the ABS definition of health services includes animal health services that operate under a very different set of institutional and regulatory arrangements to human health services, this paper adopts, insofar as possible, the ABS definition of the health services to enable comparability with other industries in the Australian economy.[2]

Health services had an estimated value-added output of $51 billion (4.9 per cent of GDP) in 2006-07 and employed almost 650 000 people in 2006 (ABS Cat. no. 2068.0).[3] It is highly labour intensive, with compensation of employees accounting for 69 per cent of Australian production of health services in 2001-02 (ABS Cat. no. 5209.0.55.001).

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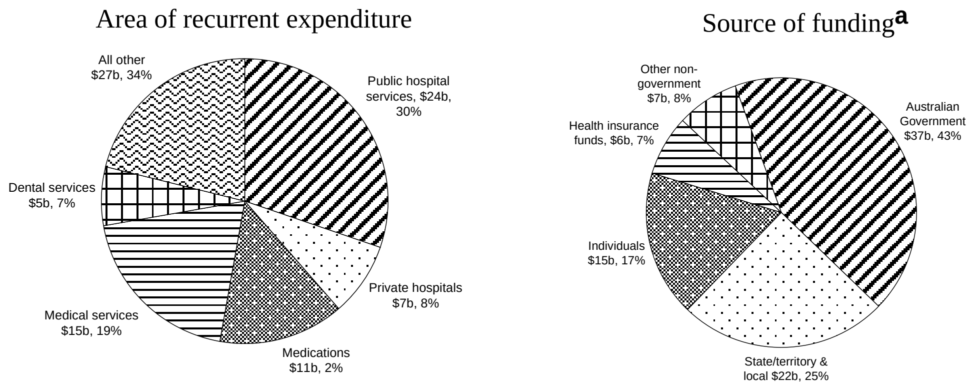
[2] Veterinary services accounted for approximately 2 per cent of the output of health services in 1996-97 (ABS 2001, *Australian National Accounts: Input-Output Tables (Product Details)*, Cat. no. 5215.0).

[3] Health services gross value added was estimated by applying the share of health services in health and community services in 2001-02 (84.1 per cent) to the gross value-added of health and community services in 2006-07 ($61.1 billion) (ABS 2006b and 2007b).

Total expenditure on health services was almost $87 billion in 2005-06 (AIHW 2007a, p. ix). Of this, recurrent expenditure accounted for 93 per cent with capital expenditure and consumption accounting for the remainder. The single largest item of recurrent expenditure was on public hospitals — $24 billion, or 30 per cent of the total (figure 2). The Australian Government funded 43 per cent of total expenditure on health services in 2005-06 (figure 2), and the states and territories collectively funded 25 per cent.

Figure 2 **Australian health expenditure and funding, 2005-06**
Current prices



[a] Source of funding also includes capital expenditure and consumption.

Sources: Based on AIHW (2007a, pp. 21 & 118).

4 Health and community services productivity

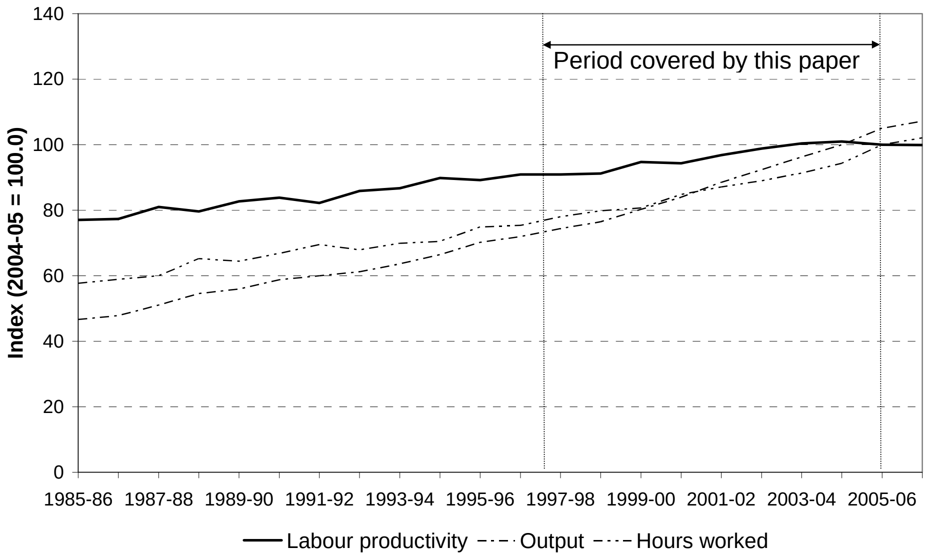
Although ABS labour productivity estimates are not available for health services or for the components of health services such as public hospitals, they are available for the broader 'health and community services' sector, within which health services accounted for 84 per cent of the output in 2001-02 (ABS Cat. no. 5209.0.55.001).

The ABS measure of labour productivity in health and community services — gross value added per hour worked — grew at an average rate of 1.2 per cent per year since 1985-86 (figure 3).[4] While positive, this growth rate is lower than the 1.6 per cent average across all industries. The 1.2 per cent growth rate for health and community services is a consequence of the 4.0 per cent growth in GVA exceeding the 2.8 per cent growth in hours worked.

[4] To ensure comparability with other industries, the ABS defines the output of health and community services in terms of a chain volume measure of gross value added (GVA) It is a quantity (as opposed to value) measure of output and nets valuation effects from changes in the value of GVA.

Comparable data for public hospitals — discussed in section 5 of this paper — is available from another source over the shorter period 1996-97 to 2004-05. Over this shorter period, the ABS measures of health and community services output, hours worked and labour productivity grew at a slightly lower rate than over the period 1985-86 to 2004-05 (3.7 per cent, 2.5 per cent and 1.1 per cent, respectively).

Figure 3 **Health and community services labour productivity**[a]
1985-86 to 2006-07



a Output: GVA (chain volume measure). Labour productivity: output per hour worked

Source: ABS (*Australian System of National Accounts, 2006-07*, Cat. no. 5204.0).

The ABS measure of 'labour productivity' indicates changes in GVA per hour worked and, as such, reflects the contribution of all factors of production and not just labour. For example, an increase in output from capital deepening — an increase in the capital intensity of production — would show up as an increase in *measured* labour productivity even though labour is not any more productive per hour worked. Because some of the ABS estimates of outputs and inputs *within* the health sector are not independently derived, the ABS classifies the health services in its 'non-market' sector. The ABS does not measure capital services in the non-market sector.[5] Consequently, the ABS series, as presented, do not allow measured changes in labour productivity for health and community services to be decomposed into its constituent parts such as capital deepening and multifactor productivity growth.

5 The ABS publishes estimates of a related concept, the level of capital stock, for the health and community services industry.

The ABS does not explicitly adjust health outputs in the Australian National Accounts for changes in quality over time. In a much broader UK review, the Atkinson Review (2005) discussed the measurement of government output and productivity of health in the UK National Accounts. The Review noted that the various dimensions of quality in health are relevant for the National Accounts and that the UK Office of National Statistics (ONS) 'should give priority to work on quality adjustments'. To this end, the Review stated that adopting a more detailed classification of outputs would help in identifying changes in quality, but tempered this somewhat by calling for further research to find a robust basis for aggregating (weighting) the different dimensions of quality. In a note of caution it went on to say that 'quality adjustment of government output is a particularly challenging area, given the intrinsic difficulty and the relatively limited experience — both in the United Kingdom and in other countries — with such adjustments'. It recommended that 'a relatively high threshold should be set for their [quality adjustments] introduction into the National Accounts' (Atkinson Review 2005, pp. 91–2, Chapter 8).

A number of studies go further than the ABS labour productivity estimates and use quantitative techniques such as data envelopment analysis (DEA) and stochastic frontier analysis (SFA) to estimate the extent to which the productivity of the entire Australian health system could be improved relative to the health system in other countries (table 1 at the end of this paper). The results of these studies depend on the sample of countries chosen, the prevailing regulatory and institutional environments in operation across the countries, the estimation techniques and variables used, and the time periods chosen.

Notwithstanding the scope for difference between studies, all but one suggest that the Australian health system operates close to the identified best practice frontier, with implied inefficiency gaps — the maximum extent to which, based on the countries included in the sample, inputs could be reduced while still producing the same level of output — of up to 14 per cent (table 1). The arithmetic mean of these gaps is 8 per cent and the geometric mean is 6 per cent.[6] The one outlier is a 2005 study by Vasanthakumar that estimates an implied inefficiency gap of 33 per cent.

[6] The geometric or harmonic mean — the nth root of the product of the implied inefficiency gaps — is less influenced by outliers than the arithmetic mean (or 'average').

However, these studies are potentially subject to limitations that may affect the applicability of their findings to assessments of the efficiency and effectiveness of the health system today or in the future. Some potential limitations arising from the use of historical data to assess productivity potential were raised by the Productivity Commission in the context of its assessment of the potential for national reform to improve health sector productivity (box 3). These potential limitations in the use of historical data for policy analysis would also apply to the current paper.

Box 3 Use of historical data to evaluate productivity potential

The Commission analysed the potential for the proposed National Reform Agenda (NRA) to increase the effectiveness of the health system in achieving health outcomes (PC 2006).

With respect to the use of quantitative techniques based on historical data to assess reform potential, the Commission noted that:

> … the available indicators have significant limitations. In particular, they are based on (sometimes dated) historical information and do not isolate the effects of policy choices (eg achievement of equity goals in the regional provision of services) from efficiency and other influences. The indicators are also based on an examination of the industry *in situ*, are not 'forward looking', and do not fully take account of the potential for change, as NRA seeks to do. For example, they do not take account of the potential benefits of health workforce reform or of reform of funding arrangements. (PC 2006, p. XL)

Source: Based on Productivity Commission (2005, p. 385).

5 Public hospital productivity

Public hospitals are considered here as they constitute the single largest item of recurrent expenditure on health, accounting for around 30 per cent of health expenditure activity in 2005-06 (figure 2).

In attempting to estimate public hospital productivity, the measure of output used needs to be estimated, as the ABS does not publish GVA for activities below the level of health services.

The most widely used output measure for public hospitals in Australia is the 'separation' (a completed episode of patient care).[7] To account for differences in complexity and resource use across procedures, the number of separations for each procedure is typically weighted up using average cost to get 'casemix-adjusted separations'. Separations and casemix-adjusted separations are activity measures and, as such, differ conceptually from conventional economic measures of output — the quantity of goods and services used by consumers or as inputs to industry that are purchased in the marketplace. Basic data on separations are also not adjusted for changes in output quality over time (although technological change may result in new procedures). This is equivalent to assuming that the quality of each diagnostic procedure is constant over time.

Public hospitals also produce other outputs. For example, teaching hospitals undertake on-the-job training for the future health workforce and conduct medical and scientific research that should be taken into account in assessing their output and productivity. Data on such outputs are not readily available and are not typically taken into account in productivity measurement.

Aggregate data indicate that labour productivity in Australian public hospitals declined by 2 per cent between 1996-97 and 2004-05. This differs from the aggregate result published by the ABS for health and community services (section 4). The difference arises because the ABS measure of output for health and community services (GVA) grew by substantially more over the period than did public hospital casemix-adjusted separations (39 per cent and 19 per cent, respectively). This suggests that other components of the sector were growing at rates above the sector average.

The statistically estimated gap in productivity between observed public hospital productivity and that assessed to be feasible based on the performance of other public hospitals provides an indicator of the scope for improvement of the productivity of hospital service delivery.

[7] In Australia, hospital procedures, or separations, are classified into diagnosis related groups (DRGs). The number of DRGs covered varies from year to year in line with revisions to the Australian Refined-Diagnosis Related Groups (AR-DRGs). The 2004-05 collection covered 664 diagnosis related groups (AR-DRG version 5.0).

There have been earlier empirical studies on the efficiency of individual public hospitals across a range of states in Australia (table 2). The implied inefficiency estimates, and hence scope for improvement, range from 3 to 89 per cent, with an arithmetic mean of 25 per cent and a geometric mean of 18 per cent. In the absence of productivity improvements in the non-public hospital components of the health and community services sector, the geometric mean for individual public hospitals implies a 5 per cent improvement in the delivery of health services, which compares to the 6 per cent from cross-country studies (discussed in section 4).

Furthermore, these empirical studies enable the implied inefficiency gaps for public hospitals to be reported for different measures of productivity. The studies indicate an arithmetic mean of 4 per cent for labour productivity, 27 per cent for multi-factor productivity (MFP) (labour and capital only) and 28 per cent for total factor productivity (TFP).

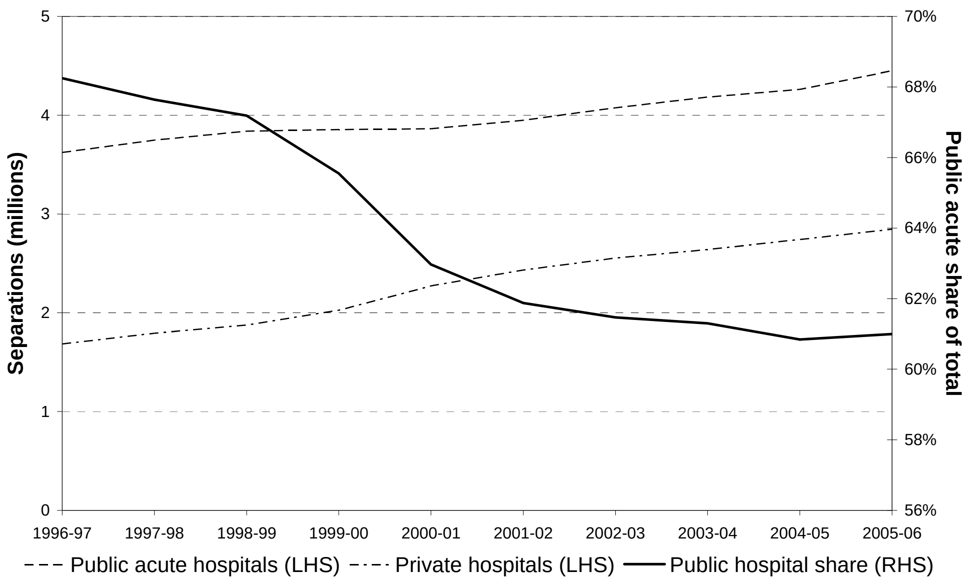
There appears to be only one somewhat dated Australian study of private hospitals that could be used to derive comparative estimates for all hospitals (table 2). Notwithstanding the dated nature of this study, its estimates of the implied inefficiency gaps for private hospitals are slightly higher than those for public hospitals. That is, the available estimates suggest that public hospitals undertake more separations per unit of input than do private hospitals. This result is consistent with a finding of a review of the international literature (Hollingsworth 2003). However, such comparisons are confounded by the different regulatory and institutional environments under which public and private hospitals operate. In particular:

- there are scope and coverage differences in the analyses;
- as they operate as healthcare providers of last resort, public hospitals are less able to influence the level and mix of patients than private hospitals;
- public hospitals and private hospitals do not necessarily have the same mix of activities, for example, in relation to the incidence of more complex, cutting-edge and infrequent procedures. Differences in services mix would be reflected in differences in costs associated with use of more specialised and expensive equipment, lower levels of throughput and capital utilisation and longer surgical times and stays in hospital;
- public hospitals generally undertake more on-the-job medical training and research than do private hospitals; and
- private ‘for profit’ hospitals face commercial incentives which are not the focus of public hospital decision making.

Accordingly, considerable caution is required in making comparisons between activity levels and particularly hospitals.

The reduction in the public hospital share of total separations (figure 4) has implications for the extent to which the inefficiency gaps identified for public hospitals can be generalised to the whole hospital system. While explaining the differences is complex, it would be so that if separations per unit of input were higher (lower) in private hospitals, the productivity with which overall hospital procedures are delivered in Australia would be higher (lower) than indicated for public hospitals. The implied inefficiency gap would differ accordingly.[8]

Figure 4 Public acute and private hospital separations[a]
1996-97 to 2005-06



[a] Public acute hospitals do not include public psychiatric hospitals.

Source: AIHW (2007a).

Overall, the available estimates drawn from these studies suggest that the scope for productivity improvements are generally higher for public and private hospitals in Australia (table 2) than for the Australian health system as a whole (table 1). Because the studies are not integrated, it is difficult to assess the implications of the differences for assessing the scope for productivity improvement across the Australian health system and the factors that would contribute to any such improvement.

8 There is an issue as to whether the mix of outputs being delivered by public and private hospitals is socially optimal.

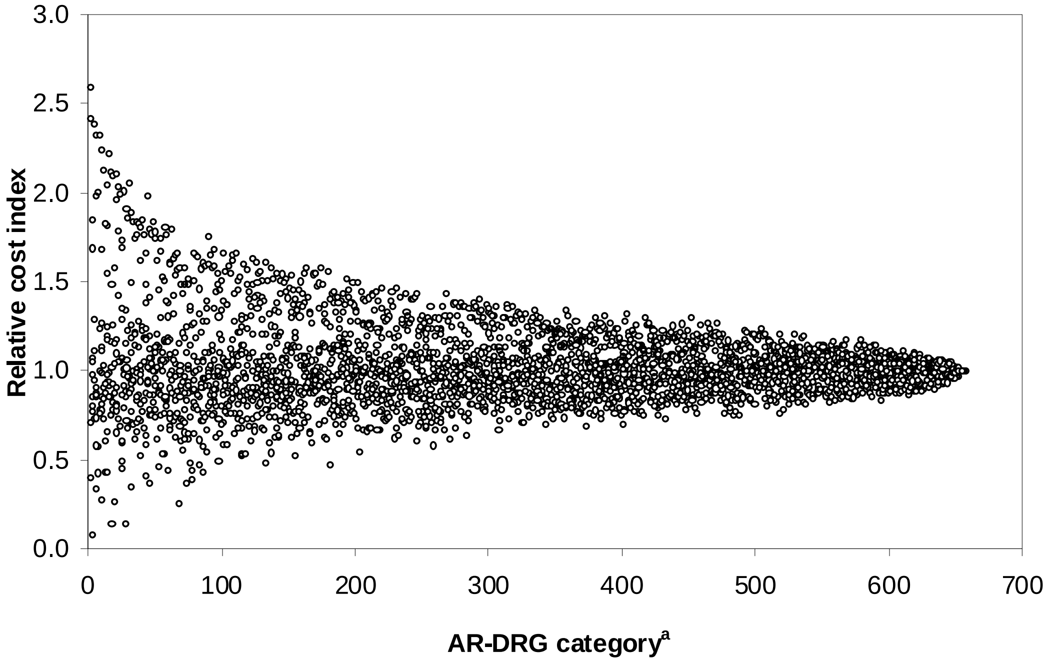
Productivity estimates for the public hospital system as a whole

To tell us more about the productivity of the public hospital system as a whole, and to test whether there are differences across Australian states and territories, experimental productivity estimates are derived from data for the period 1996-97 to 2004-05.

National public hospital cost data indicate substantial variation across states and territories in the average cost of each procedure over the 650 odd diagnosis related groups in 2003-04 (figure 5). These differences in average cost for the same procedure are suggestive of differences in public hospital productivity across states and territories.

Figure 5 **Variation in average relative cost of public hospital outputs by procedure and state, ranked by decreasing variation in average costs**[a]

New South Wales, Victoria, Queensland, South Australia and Western Australia, 2003-04



a Medical treatment categories are sorted in descending order of the total variation in the relative cost index of each AR–DRG. Excludes 10 DRGs for which cost data was not available for two or more jurisdictions

Source: Productivity Commission (2006, p. 179).

To test whether there are productivity differences across state and territory public hospital systems, this paper undertakes some experimental productivity estimates from 1996-97 to 2004-05. The estimates are derived econometrically from a three input stochastic production function — with labour, capital services and medical supplies as inputs — estimated using SFA.

Two variants of the model are estimated. The first variant consists of one output (casemix-adjusted separations) and three inputs (labour, capital services and medical supplies). If i denotes the state or territory and t denotes the time period, the function estimated is of the form:

$$\ln Q_{it} = \beta_0 + \beta_1 \ln L_{it} + \beta_2 \ln K_{it} + \beta_3 \ln S_{it} + v_{it} - u_{it}$$

Where:

Q_{it} casemix-adjusted separations (output);

L_{it} full-time equivalent staff (input);

K_{it} real capital services (input);

S_{it} real medical supplies (input);

v_{it} an unobserved symmetric random error for state or territory i; and

u_{it} an unobserved random variable for state or territory i.

An advantage of SFA over rival techniques such as DEA is that it does not attribute all of the observed differences between states and territories to differences in technical efficiency. Instead, SFA allows for the observed differences to also reflect measurement error. SFA uses actual data on outputs and inputs to estimate a common stochastic production frontier for all states and territories. The resulting difference between the estimated frontier and the actual data gives an estimate of the extent of technical inefficiency in each state or territory. The non-negative measure of technical inefficiency is zero if the state or territory lies on the estimated frontier and has a positive value if technical inefficiency exists. The resulting parameter indicates the extent to which inputs can be minimised to produce the existing level of output (or output increased using the existing level of inputs).

On the basis that v_{it} and u_{it} are both independent and identically-distributed (except that $u_{it} \geq 0$), technical efficiency in state or territory i can be expressed as $e^{-u_{it}}$. The estimation of u_{it} requires assumptions about the distribution of v_{it} and u_{it} (such as a half-normal distribution). In estimation, the technical efficiency score may vary with time (time varying) or remain fixed through time (time invariant ie $u_{it} = u_i$).

Output and input data

As discussed, productivity analysis should ideally take into account changes in output quality. In the absence of an all encompassing measure of output quality, the second variant of the model estimated uses a measure of quality-adjusted output — in which the output of the first model (casemix-adjusted separations) is multiplied by the ratio of the growth in state and territory life expectancy at birth relative to that in 1996-97 — to (crudely) proxy for changes in the quality of services provided by public hospitals. The inputs used are those in the first variant of the model estimated.

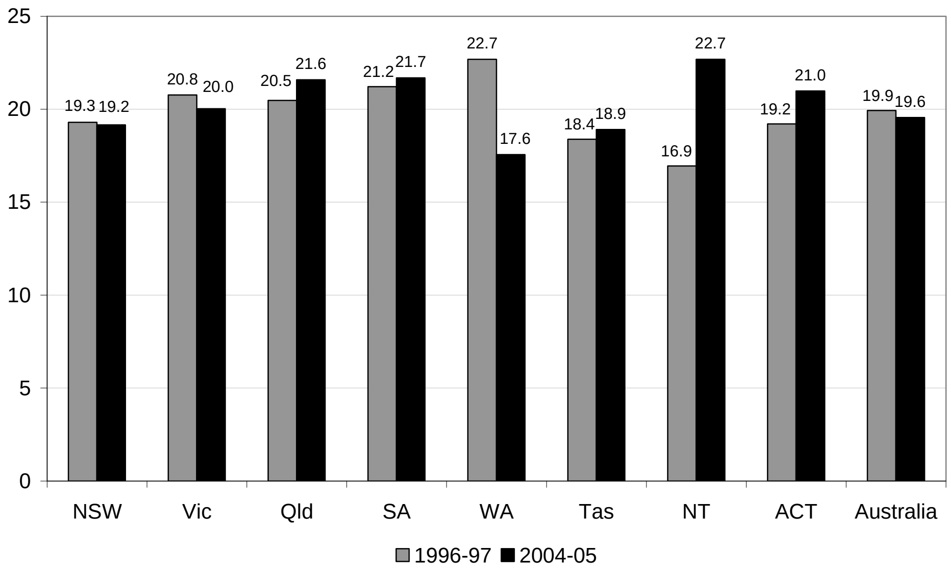
Labour is measured as full-time equivalent employment in persons. Real capital services covers buildings and equipment less interest payments, but not land, and is measured as depreciation plus an 8 per cent opportunity cost of the funds employed (based on the asset value) deflated by a state, territory and local government gross fixed capital formation price index. Real medical supplies is measured as nominal expenditure on medical supplies and drug supplies deflated by final household consumption expenditure on medicines, aids and appliances. All variables are expressed per 1000 residents to account for differences in size between jurisdictions. All data are sourced from the AIHW (2007a, 2007b), the *Report on Government Services* (SCRGSP 2006) and the ABS (2006c). These data do not cover all of the inputs used by public hospitals and, as a result, the sum of the estimated coefficients should not be interpreted as an indication of increasing, constant or decreasing returns to scale.

What the data indicate

The data indicate clear differences in the average *level* of labour productivity in public hospitals across states and territories (figure 6). In 1996-97, labour productivity was highest in Western Australia with 23 casemix-adjusted separations per FTE employee and lowest in the Northern Territory with 17 casemix-adjusted separations per FTE employee. By 2004-05, the Northern Territory had the highest labour productivity at 23 casemix-adjusted separations per FTE employee and Western Australia the lowest at 18 casemix-adjusted separations per FTE employee.

Figure 6 **Public hospital labour productivity**

Casemix-adjusted separations per FTE staff member, 1996-97 and 2004-05



Source: Estimates based on AIHW (2007a).

The Northern Territory recorded the highest *growth* in labour productivity between 1996-97 and 2004-05 (34 per cent), reflecting a 50 per cent growth in casemix-adjusted separations and a 12 per cent increase in FTE employment (figure 6). In contrast, measured labour productivity declined in Western Australia by 23 per cent, reflecting a 35 per cent increase in FTE employment and an estimated 4 per cent increase in output. States with higher initial *levels* of productivity generally grew more slowly than did those with lower productivity levels, suggesting a degree of level convergence towards 'best practice'. This appears to apply most strongly to the Northern Territory, Queensland and the Australian Capital Territory, but also, to a lesser degree, to South Australia and Tasmania. However, it does not apply to Western Australia. A number of possible reasons for this could include data as well as institutional and operating differences.

While the results illustrate underlying statistical differences, further analysis would be required to identify the state-specific and broad health system influences underlying the observed differences.

Despite these broad trends and recognising the necessary qualifications, there has been some change in the relative productivity of public hospital sectors across jurisdictions. Because the aggregate data are built up from component procedural information, relative changes in component outputs and inputs are likely to be important.

Against this background, this paper uses SFA to take into account these detailed changes to explore, on an experimental basis, the productivity 'gaps' between public hospital sectors in each state.

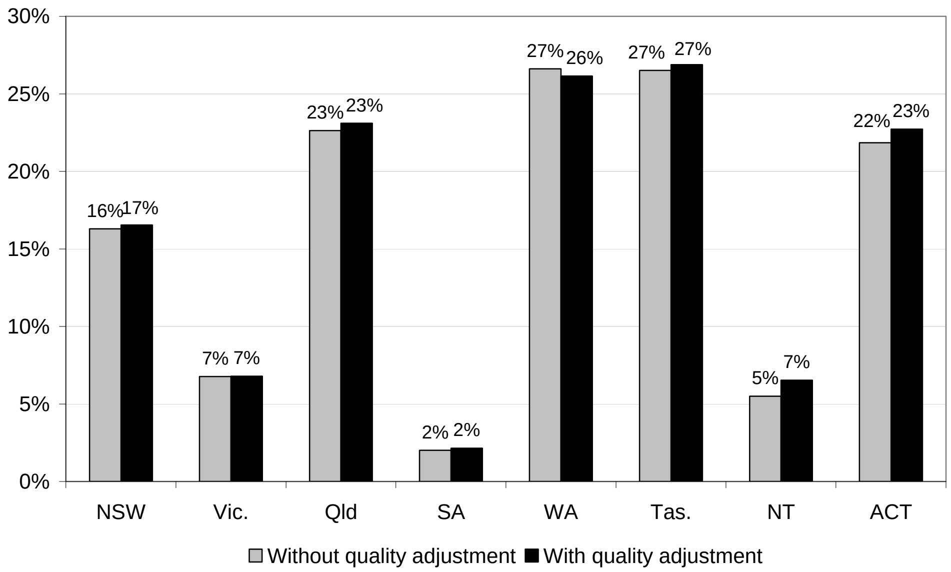
Table 4 presents the SFA results for the two variants of the model estimated, while table 5 presents the technical efficiency scores and the implied inefficiency gaps by state for the time invariant model. Finally, table 6 presents the implied inefficiency gaps by state for the first variant of the model for each year in the series examined (time varying model).

As noted earlier, the first variant of the model uses casemix-adjusted separations as its measure of output. The experimental results from the time invariant version of this model estimated over the period 1996-97 to 2004-05 indicate substantial variation across state and territory public hospital systems (table 3 and figure 7). The estimated slope coefficients are all positive and statistically significant (table 4). The experimental results indicate:

- The first group consists of South Australia, the Northern Territory and Victoria, which lie closest to the estimated frontier. The implied inefficiency gaps for these states are 2, 5 and 7 per cent, respectively.
- The second group consists of New South Wales with an implied inefficiency gap of 16 per cent.
- The third group consists of the remaining states — in order, the Australian Capital Territory, Queensland, Tasmania and Western Australia — with implied inefficiency gaps of between 22 and 27 per cent.

Figure 7 **Implied inefficiency gaps by state and territory**[a]

Time invariant, 1996-97 to 2004-05



a With quality adjustment involves multiplying output (casemix-adjusted separations) by the ratio of the growth in state and territory life expectancy at birth relative to that in 1996-97.

The arithmetic mean across all states and territories is 16 per cent and the geometric mean is 12 per cent. That is, the experimental analysis taken at face value suggests that the existing level of output undertaken across all states and territories could be produced using approximately 10 per cent fewer inputs (or output could be increase by roughly 10 per cent using the same inputs).[9] These results fall towards the lower end of those from other Australian studies (table 2) and in the middle of those for the health system as a whole (table 1).

Given that SFA is based on levels data, the ranking of the states and territories are more closely aligned to productivity levels than growth rates (table 3).

[9] A 10 per cent measure of input-orientated technical inefficiency may not be equivalent to a 10 per cent increase in output using the same inputs, as the relationship between input- and output-orientated technical efficiency is, in theory, asymmetric and will depend on the degree of curvature in the estimated production frontier.

The second variant of the model indicates that, in this instance, adjusting output for quality, as proxied by changes in life expectancy, generally makes little difference other than changing slightly the magnitude of the implied inefficiency gaps (table 5). The quality adjustment increases the implied inefficiency gap in all jurisdictions, except in Western Australia, where it fell slightly. This reflects two competing influences. First, as life expectancy rose in all jurisdictions over the period under consideration, the quality adjustment increased the level of output in all jurisdictions and was proportionately highest in the Northern Territory. Had the estimated coefficients remained unchanged, this increase in output would have translated into lower implied inefficiency gaps. However, the non-uniform output adjustments across jurisdictions have implications for the modelling of the production frontier more generally. An increase in the level of output produced from the existing input mix should increase the coefficient on each input. This does indeed occur. However, the non-uniform output adjustments also result in some rotation of the stochastic frontier, which means that each coefficient does not increase uniformly. The coefficient on real medical supplies increases by proportionately more than do those on capital and labour. Consequently, the adjustment also effectively 'penalises' those states such as the Northern Territory with higher real medical supplies use. The SFA results indicate the net effect of these two opposing influences is a higher implied inefficiency gap for all jurisdictions other than Western Australia.

The experimental results for the time varying model indicate a progressive, but statistically insignificant, decline in measured productivity across all states in each year from 1996-97 to 2004-05 (table 6).

The results presented here are experimental and need to be treated with caution. First, it is noted that the capital measures derived from the available data differ significantly between jurisdictions. These differences contribute to the reliability of the productivity measures and, accordingly, the potential for productivity improvement. Presenting data in this framework provides a new opportunity to examine the information in a broader economic context.

Second, there are state and territory differences that may affect productivity in public hospital systems that should be taken into account in specifying the SFA model. Possible examples include: area, population density and differences in demographic profiles, including the share of indigenous population and age distributions. This may result in omitted variable bias and the omission of these environmental variables may mean that the unobserved symmetric random error term (v_{it}) does not meet the required statistical properties (such as being random with a mean of zero).

Third, as noted earlier, changes in output quality should be taken into account. Quality is an integral part of healthcare and needs to be recognised as such; otherwise improvements in output quality may result in declines in *measured* productivity. Notwithstanding the attempt to adjust for quality in this study, further research is needed on how best to do this in a sensible and objective manner taking into account relevant dimensions (such as the length and quality of life). Additional data on output quality may need to be collected.

6 Hip replacement and revision productivity

Conceptually, measures of health productivity should also be capable of being applied to individual procedures in order to assess the actual or potential productivity benefits of reform. This was examined for this paper in the context of hip replacement and revision surgery.

Broadly, hip replacement surgery involves replacing either the head of the femur (the ball) and/or the socket with artificial components (prostheses). Hip revision surgery involves follow-up surgery to repair an artificial hip joint that has been damaged or loosened or the site has become infected. Revision surgery is a partial indicator of an adverse outcome associated with hip replacement surgery, albeit an indicator with a possibly significant time lag.

In the AR-DRG system that is used to classify hospital outputs in Australia, hip surgery is covered by three diagnosis related groups (DRGs):

- hip replacements without catastrophic or severe complications and comorbidity (I03C);
- a composite output consisting of hip replacements with catastrophic or severe complications and comorbidity and hip revisions without catastrophic or severe complications and comorbidity (I03B); and
- hip revisions with catastrophic or severe complications and comorbidity (I03A).

The average complexity and cost of hip revision surgery is higher than for hip replacement surgery (ie the average cost of I03A was almost $29 500 in 2004-05 compared to just over $14 000 for I03C) (Department of Health and Ageing 2006). As would be expected, the average cost for a given procedure also tends to be higher if major complications arise during surgery (ie the average cost of just over $17 700 for I03B is higher than that of I03C, and the average cost of I03A is higher than that of I03B). This suggests that one way of improving productivity is to reduce the need for revision surgery and to reduce complications during surgery.

A third data source is needed to assess productivity for individual procedures as neither the ABS or AIHW sources used in the analysis of the health system and public hospital systems, respectively, contain information on input use by procedure.

Two alternative data sources were investigated to assess their suitability for use in productivity measurement:

- the National Joint Replacement Registry (NJRR), which is maintained by the Australian Orthopaedic Association (AOA); and
- the National Hospital Cost Data Collection (NHCDC), which is compiled by the Australian Government Department of Health and Ageing from state and territory administrative data.

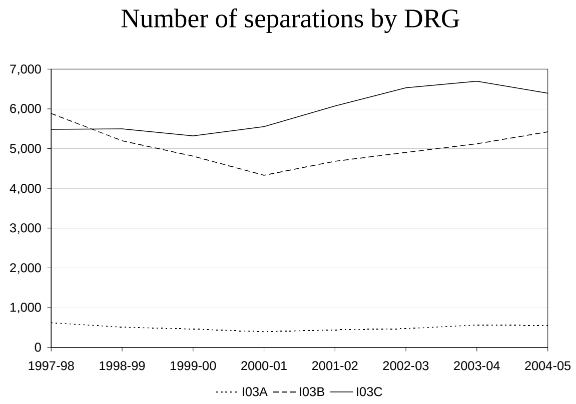
The NJRR is a unit record dataset with detailed technical information on the type of hip surgery undertaken, the parts used and patient information. It also has some information on sentinel or adverse events such as mortality and the incidence of revision surgery. However, while containing an excellent coverage of hip replacement and revision surgery in Australia since it commenced on 1 September 1999, the registry has no information on the inputs used (labour, capital, etc) other than on the prostheses and method of affixing the prosthesis. It also does not have any objective or subjective measures of the effects of surgery on patient quality of life (morbidity) to supplement the information collected on mortality. Also, its focus on hip and knee replacement and revision surgery means that it cannot be used more widely to assess other procedures. Thus, while being a rich source of information on hip (and knee) replacement and revision surgery in Australia, alone it is unsuited to measuring *productivity* either for hip (and knee) replacement and revision surgery or more widely.

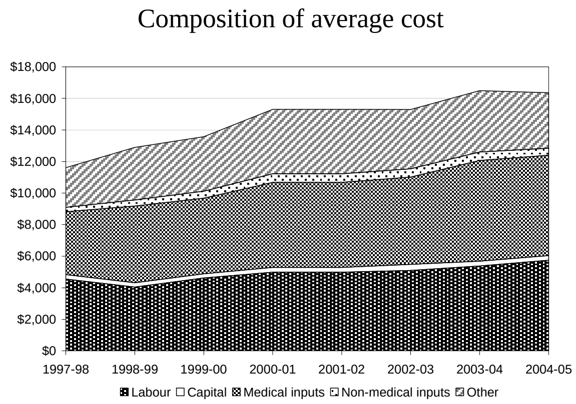
The NHCDC provides annual state-level data on the number and average cost structure of hundreds of individual procedures undertaken in public hospitals since 1996-97. The collection also covered private hospitals up to 2002-03. The collection provides for each procedure: the cost weight, the standard error, the number of separations undertaken, the number of days spent in hospital, the average length of stay and the average cost in aggregate and broken down into 27 cost groupings (termed ‘cost buckets’) (figure 8).[10]

[10] Of the 27 cost buckets, 22 are accounted for by 11 activities that are broken down into direct costs and overheads. Aggregating direct costs and overheads for these 11 activities gives 16 ‘aggregated’ cost buckets.

Figure 8 **Number of separations and composition of average costs of hip replacement and revision surgery**

Public hospitals, all states and territories, 1996-97 to 2004-05





Source: Department of Health and Ageing (2006).

This NHCDC dataset initially appeared promising for productivity measurement as it covered all procedures undertaken in public hospitals, including hip replacements, and the individual ‘cost buckets’ appeared to cover labour costs (ward medical, ward nursing, non-clinical salaries and on-costs), capital (depreciation), medical inputs (pathology, imaging, allied health, pharmacy, supplies and prostheses) and non-medical inputs (hotel). The collection also included the average cost of critical care, operating rooms, emergency departments and specialist procedure suites used.

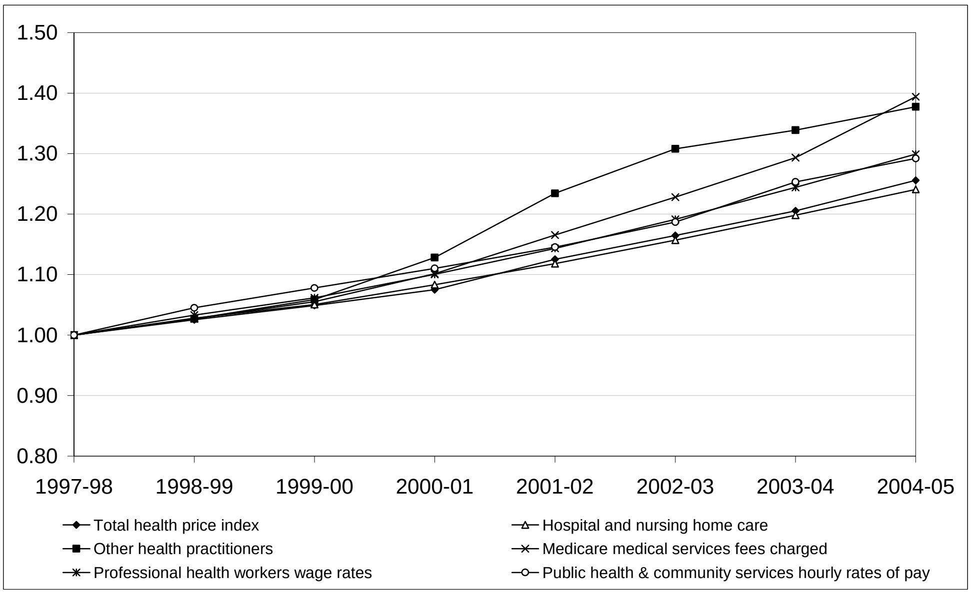
However, closer inspection revealed that the cost buckets were not as homogenous as they first appeared. Most of the ‘non-labour’ cost buckets, for example, operating rooms for hip replacements, also appeared to include significant labour costs. This reflects the labour intensive nature of the health services industry in Australia. Furthermore, many cost buckets also did not appear homogeneous in the non-labour inputs either. This resulted in multicollinearity between many of the cost buckets that made it difficult to identify econometrically the contribution of the individual cost buckets. This lack of cost bucket homogeneity was subsequently borne out in the instructions issued for submitting hospital costing data to the Commonwealth (Department of Health and Ageing 2003, pp. 33–41).

The NHCDC also proved unsatisfactory for productivity measurement for a number of other reasons.

First, the NHCDC only contains value information on the inputs used. In theory, price deflators could be used for each cost bucket to derive real (quantity) measures of input use. Such price deflators do not exist at the procedural level. The use of aggregate deflators may mask material differences across procedures. Moreover, testing of aggregate deflators indicates that the resulting quantity measures are sensitive to the choice of deflator used, thereby introducing the potential for misattributing the measurement error as changes in productivity. To illustrate the effect of this, there is a 15 per cent difference in the growth of six possible deflators that could be used to estimate the quantity of labour inputs used between 1997-98 and 2004-05 — the AIHW's health price index, hospital and nursing home care index, other health practitioners index, the Medicare medical services fees charged index and the professional health workers wage rates index, and the ABS's public health and community services hourly rates of pay index (figure 9). Thus, depending on which index is adopted, real labour inputs may have risen by up to 5 per cent or fallen by as much as 7 per cent over the same period.

Figure 9 **Selected health-related price deflators, Australia**[a]

1997-98 to 2004-05, Index 1996-97 = 100.0



Source: AIHW (2007b, p. 159).

Second, there was substantial variation in the level and composition of costs for individual procedures across states. While these cost differences may be the consequence of productivity differences across states and territories, they may also reflect differences in the way individual expenses are recorded in the various states and territories.

Third, there are major problems with the capital data. Depreciation is not collected at all for Victoria and the relativities across the remaining states and territories suggest that capital may not be measured in a uniform manner.

Fourth, the shared cost nature of many inputs (termed 'joint costs' in economics) such as ward medical and ward nursing suggest that their allocation in the NHCDC across procedures may be arbitrary and not the consequence of underlying changes in actual resource use.

Fifth, the NHCDC does not contain information on output quality. While data from other sources such as the AIHW could be used to tell a complementary story, the apparent absence of data on output quality by procedure is likely to be an issue in measuring productivity at the procedural level.

Consequently, the attempt to measure productivity at the procedural level was unsuccessful and the results have not been presented, at this stage.

7 Improving health productivity measures

In its review of *Australia's Health Workforce,* the Productivity Commission looked in general terms at ways of improving the measurement of health productivity in Australia (PC 2005, pp. 383–7).

A concern in that policy focused exercise was that biases in estimated productivity could provide adverse incentives to decision makers and service providers using that information to guide decision making and could potentially distort decisions. For example, not adjusting output measures for changes in quality could lead to the judgement that a lowering of costs per unit of output is solely attributable to an improvement in 'efficiency'. Similarly, an increase in the incidence of 'separations' due to greater specialisation in health functions and an associated higher level of 'intra-industry trade' could lead to a judgement that output per unit of input has increased. Such biases should be avoided as far as practicable, or data qualified as appropriate.

It was considered that, to be capable of evolving over time with changes in technology and ways of working, the estimates need to be based on an information system that includes quality changes and a disaggregation of outputs and inputs that would enable sources of change to be identified and subjected to credibility checks. The omission of quality adjustments in the current series and the omission of capital services and material inputs from the ABS estimates are significant impediments to satisfying this requirement.

Overall, it was found that currently available information does not support the full assessment of health sector productivity and hence the efficiency of health service provision. It was also considered that it would be possible to improve the relevance and reliability of measures of health sector outputs and inputs and fill this information gap.

As a first step towards developing robust and 'cost effective' productivity measures in the health workforce and the health sector more generally, the Commission (p. 383) considered that measures to support the quantification and evaluation of the productive contribution of the health sector to national output and the wellbeing of the community should:

- be based on independent measures of outputs from, and inputs to, the health sector;
- allow for quality differences between outputs and inputs and the incremental contribution of changes in quality to outputs and inputs;
- be comprehensive and inclusive of preventative, curative and management health services;
- be measurable and capable of being applied consistently across different health sector activities and aggregated to broad sectoral indicators of performance;
- maintain an output focus and avoid concentrating on component care processes, procedures and ancillary services;
- avoid creating adverse incentives for health workers, or for administrative or ancillary staff;
- be capable of evolving over time as medical technology, ways of working and outputs change;
- avoid unnecessary compliance costs for service providers and governments; and
- be compiled in a clear and transparent manner according to methods that are made available for evaluation.

To this end, some particular improvements that would help improve the suitability of Australian health data for use in productivity analysis include:

- defining multifactor productivity for the health and community services sector as a whole;
- developing output and input measures that support the measurement of this concept and enable the estimation of productivity at all levels within and across the health system (to enable productivity performance to be examined for individual activities and compared across activities);

- collecting data on homogenous inputs (eg separating labour and capital services);
- estimating capital services nationally and across jurisdictions for key activities and the sector in total;
- collecting information that provides a basis for adjusting output and input measures for changes in quality;
- collecting cost data for private hospitals that is comparable to that for public hospitals (including direct costs incurred by, or on behalf of, patients such as additional surgeon and anaesthetist fees and the cost of prostheses); and
- splitting composite DRGs into their constituent parts (eg in the case of hips, splitting I03B into: hip replacements with catastrophic or severe complications and co-morbidities; and hip revisions without catastrophic or severe complications and co-morbidities).

Improved health data needs to be supported by further research on how to incorporate quality into productivity measurement in a sensible and objective manner that recognises the different dimensions to quality (such as the quantity and quality of life), and on measuring productivity in the non-market sector.

8 Summing up

This paper extends previous studies analysing the productivity of the health sector. The earlier studies tended to examine individual segments of the public hospital system, whereas this study attempts to look at the public hospital system as a whole. It also adds experimental estimates of the effects of a 'quality' adjustment on productivity measurement. In so doing, it raises a number of practical considerations that differentiate productivity measurement in health from productivity measurement in more traditional goods-producing industries.

On the surface of it, the available data indicate significant differences in the level and growth of productivity across state jurisdictions in Australia, with the possibility of a degree of convergence in level terms.

The experimental results in this paper also suggest that there is scope to improve productivity in public hospitals. If the *observed* differences in productivity reflect productivity potential, productivity improvements in the order of 10 per cent may be achievable in *aggregate* for Australian public hospitals. This estimate falls within a range of possibilities suggested by previous studies.

Despite anecdotal data indicating a wide dispersion in the average cost of individual procedures across jurisdictions, an illustrative study of hip surgery suggests that the available data are not well equipped to delineate the productivity differences between service providers. Moreover, the data do not appear sufficiently robust to assess the scope for productivity improvements at the individual treatment level.

Table 1 Estimates of inefficiency in Australia's health system

Study	*Estimation method*[a]	*Technical efficiency score of Australia*	*Implied inefficiency*[b]
			%
WHO (2000)	Global rankings based on composite index	Overall index of 0.88	14
Evans et al. (2001)	Regression estimation	Less than 0.94	6
Gravelle et al. (2003)	SFA	Around 0.91	10
Greene (2003)	SFA	0.99	1
Afonso & Aubyn (2005)	FDH and DEA	0.92	9
Kumbhakar (2004)	SFA	0.94	6
Vasanthakumar (2005)	DEA	0.75	33

a The estimation methods referred to in this table refer to data envelopment analysis (DEA), stochastic frontier analysis (SFA) and free disposal hull (FDH). **b** The inferred inefficiency score in the source has been expressed as a share of the technical efficiency score to indicate the potential for improvement.

Source: Productivity Commission (2006, p. 174).

Table 2 Estimates of inefficiency in Australian studies of public and private hospitals

Study	*Sample*	*Factor inputs*[a]	*Estimation technique*[bc]		*Implied inefficiency*[d]
Public hospitals					
SCRCSSP (1997)	109 public hospitals (Victoria) (1994-95)	MFP (labour, other)	DEA	Model 1	23%
		MFP (labour, other)	DEA	Model 2	12%
		MFP (labour, other)	DEA	Model 3	49%
		MFP (labour, other)	DEA	Model 4	11%
		MFP (labour, other)	DEA	Model 5	89%
Yong & Harris (1999)	35 public hospitals (Victoria) (1994-95)	Labour	SFA	Model 1	3%
		Labour	SFA	Model 2	5%
Wang & Mahmood (2000a)	112 public hospitals (NSW) (1997-98)	TFP	DEA	Model 1	25%
		TFP	DEA	Model 2	37%
Wang & Mahmood (2000b)	114 public hospitals (NSW) (1997-98)	MFP (labour, capital)	SFA	Model 1	10%
		MFP (labour, capital)	SFA	Model 2	12%
Mortimer (2002)	38 public hospitals (Victoria) (1993)	MFP (labour, capital)	DEA	Model 1	19%
		MFP (labour, capital)	SFA	Model 2	20%
Paul (2002)	223 public hospitals (NSW) (1995-96)	TFP	SFA	Model 1	35%
Mangano (2003)	116 public hospitals (Victoria) (1992-93 to 1995-96)	TFP	SFA	Model 1	33%
Queensland Department of Health (2004)	74 public hospitals (Qld) (2000-01 to 2002-03)	TFP	DEA	Model 1	9%
Private hospitals					
Webster, Kennedy & Johnson (1998)	301 private hospitals (Australia) (1991-92 to 1994-95)	TFP	DEA	Model 1	37%
		TFP	SFA	Model 2	35%
		TFP	SFA	Model 3	22%

[a] Measurements for total factor productivity (TFP) include all inputs (labour, capital and other inputs); multi-factor productivity (MFP) generally refers to labour and capital. However, the term MFP is used here to also describe the studies which include labour and other non-capital inputs as the factors of production. [b] The estimation techniques referred to in this table are data envelopment analysis (DEA) and stochastic frontier analysis (SFA). [c] Some of the empirical studies use various estimation methods and sensitivity analysis by changing model specifications such as inputs/outputs and analysis of the size and location of hospitals. For simplicity, various modelling results have been represented as model 1, 2 etc. [d] The inferred inefficiency score in the source has been expressed as a share of the technical efficiency score to indicate the potential for improvement.

Sources: Productivity Commission (2006, p. 172).

Table 3 Rankings of public hospital productivity by state and territory

1996-97 to 2004-05

	Labour productivity[a]			
State	*Level 1996-97*	*Level 2004-05*	*Growth rate 1996-97 to 2004-05*	*SFA*[b]
NSW	5	6	6	4
Vic.	3	5	7	3
Qld	4	3	3	6
SA	2	2	5	1
WA	1	8	8	7
Tas.	7	7	4	8
NT	8	1	1	2
ACT	6	4	2	5

1 is the most efficient and 8 the least efficient. [a] Casemix-adjusted separations per FTE staff member. [b] Ranking of the technical efficiency scores estimated using SFA.

Table 4 Estimated stochastic production function for state and territory public hospital systems

Time invariant, 1996-97 to 2004-05

Variable	*First variant*[a]		*Second variant*[b]	
	Coefficient[c]	z-statistic	Coefficient[c]	z-statistic
Constant	-1.28***	-4.78	-1.12***	-4.05
Labour	0.18**	2.06	0.18**	2.00
Capital	0.06**	2.18	0.06**	2.06
Medical supplies	0.18***	4.85	0.24***	6.10
No. of observations	72		72	
Maximum likelihood	111.49		109.19	

*** significant at 1 per cent. ** significant at 5 per cent. * significant at 10 per cent. [a] Output measured as casemix-adjusted separations. [b] Output measured by an index of state and territory life expectancy at birth relative to that in 1996-97 multiplied by casemix-adjusted separations to proxy for changes in quality-adjusted output. [c] As the variables included do not cover all of the inputs used, the sum of the estimated coefficients should not be interpreted as an indication of increasing, constant or decreasing returns to scale in the provision of health services by public hospitals.

Source: Estimates based on AIHW (2007a, 2007b), SCRGSP (2006) and ABS (2006c).

Table 5 **Implied inefficiency gaps by state**

Time invariant, 1996-97 to 2004-05

	NSW	*Vic.*	*Qld*	*SA*	*WA*	*Tas.*	*NT*	*ACT*	*Ave*
First variant[a]									
Technical efficiency score	0.86	0.94	0.82	0.98	0.79	0.79	0.95	0.82	0.87
Implied inefficiency gap	16%	7%	23%	2%	27%	27%	5%	22%	15%
Second variant[b]									
Technical efficiency score	0.86	0.94	0.81	0.98	0.79	0.79	0.94	0.81	0.87
Implied inefficiency gap	17%	7%	23%	2%	26%	27%	7%	23%	16%

a Using casemix-adjusted separations as output. **b** Using an index of state and territory life expectancy at birth relative to that in 1996-97 multiplied by casemix-adjusted separations as output (a proxy for quality-adjusted output).

Source: Estimates based on AIHW (2007a, 2007b), SCRGSP (2006) and ABS (2006c).

Table 6 **Implied inefficiency gaps by state and year**[a]

Time varying, 1996-97 to 2004-05

Year	*NSW*	*Vic.*	*QLD*	*SA*	*WA*	*Tas.*	*NT*	*ACT*	*Average*
1996-97	14%	6%	20%	1%	23%	23%	4%	19%	13%
1997-98	15%	6%	20%	1%	24%	24%	4%	20%	14%
1998-99	15%	6%	21%	1%	24%	25%	5%	20%	14%
1999-00	16%	6%	22%	1%	25%	25%	5%	21%	14%
2000-01	16%	6%	22%	1%	26%	26%	5%	21%	15%
2001-02	16%	6%	23%	1%	27%	27%	5%	22%	15%
2002-03	17%	7%	23%	2%	27%	28%	5%	22%	15%
2003-04	17%	7%	24%	2%	28%	28%	5%	23%	16%
2004-05	18%	7%	25%	2%	29%	29%	5%	24%	16%
Average	16%	6%	22%	1%	26%	26%	5%	21%	15%

a Using casemix-adjusted separations as output.

Source: Estimates based on AIHW (2007a, 2007b), SCRGSP (2006) and ABS (2006c).

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