3 Data used in this analysis

Key points

- The Commission obtained the permission of state and territory health departments, and private hospital owners to access data of public and private hospitals for the years 2003-04 to 2006-07.
  - There were 343 public, 99 private and 17 public contract acute overnight hospitals that contributed 1806 observations to the dataset.
- The dataset captures virtually all public acute hospitals, and approximately 42 per cent of all private hospitals in Australia.
  - The Commission weighted the known private hospital observations to compensate for the under-representation of not-for-profit hospitals in the dataset.
- The dataset provides a rich picture of the patient activity within hospitals:
  - medical separations comprise 78 per cent of public hospital inpatient activity and 42 per cent of private hospital inpatient activity
  - public hospitals provide significantly more outpatient services including emergency departments, pathology and radiology, mental and alcohol services, and allied health and dental services
  - private hospitals serve relatively more patients from major cities, whereas the patients for public hospitals are largely from outside major cities
  - private hospitals serve patients from relatively more socioeconomically advantaged communities
  - the comorbidity of patients is highest for public contract hospitals, followed by public and private hospitals.
- There are, however, some limitations with the data:
  - non-admitted occasions of care are not casemix adjusted
  - public hospitals do not adequately report the depreciation and other costs of land, buildings, plant and equipment
  - medical staff and medical staff costs were excluded because data were not available for doctors exercising their rights of private practice in public and private hospitals
  - public and private hospitals counted hospital beds differently.

The Commission accessed data from a number of databases to create a unique dataset on the care provided and the facilities available in public and private acute

hospitals from 2003-04 to 2006-07. Details of data sources, and the processes by which consent was obtained to access those data sources, are provided in section 3.1. The variables used in the analysis are described in section 3.2. A description of the hospitals used in the sample, and their representativeness of the population of Australian hospitals, is discussed in section 3.3.

3.1 The Commission's dataset

For this study, the Commission treated hospital establishments (and in some instances, campuses) as the principal subject of measurement. In doing so, it was assumed that decisions made to use 'inputs' (such as nurses, administration and clerical staff, medications, and technologies) to produce a range of 'outputs' (such as medical and surgical procedures, emergency department episodes of care) occurred at the hospital level.

Acute overnight-stay hospitals were the focus of this analysis. Psychiatric hospitals, free-standing day hospitals and sub-acute and non-acute facilities were considered to be sufficiently different from these hospitals to exclude them from the analysis, because they generally offer a more limited range of services compared to acute overnight hospitals. Likewise, free-standing day hospitals often focus on a small number of procedures at the exclusion of many other activities undertaken by acute hospitals which have overnight stays.

Data sources

Data on public hospital establishments were drawn from the National Public Hospital Establishments Database (NPHED) held by the Australian Institute of Health and Welfare (AIHW). The NPHED contains information on public hospital staffing levels, expenditure, revenues and other hospital characteristics, including bed numbers and geographical location.

Data on private hospital establishments were drawn from the Private Health Establishments Collection (PHEC) held by the Australian Bureau of Statistics (ABS). The collection is drawn from a census of private hospitals (acute and psychiatric) and free-standing day facilities (ABS 2008a). It includes information about private hospital staffing, finances, patients, facilities (such as beds or special units) and activities (such as days of hospitalisation provided and bed occupancy rates).

Patient-level data on morbidity for both public and private hospitals were drawn from the National Hospital Morbidity Database (NHMD) held by the AIHW. In Australian hospitals:

> … the medical notes, laboratory reports and other relevant information are integrated into an individual patient's ongoing medical record and 'coded' after the patient is discharged, transferred or dies. Trained medical coders assign codes for principal and other diagnoses, procedures, and other events to a coded electronic summary of that admission. This coded record then goes into a hospital database which eventually populates, via state, territory or private hospital ownership chain aggregation, a national data collection called the NHMD. (ACSQHC 2009, p. 82)

Although the PHEC contains some patient data, the Commission does not regard these data to be useful for this study because they are not patient-level, and therefore are not casemix-adjusted and do not include the necessary details of patient morbidity.

Accessing hospital data

The Commission obtained the consent of the state and territory health departments for the AIHW to release public hospital morbidity and establishment data to the ABS for the years 2003-04 to 2006-07.

The Commission also obtained consent from 130 for-profit and not-for-profit private hospitals to use their hospital-level morbidity data in this study. After consent was obtained, state and territory health departments provided information that allowed the private hospital patient morbidity data held by the AIHW to be matched with the establishment-level data held by the ABS.

After the AIHW undertook some preliminary analysis to prepare the morbidity and public hospital establishment data, the empirical analysis was undertaken at the ABS under direction from the Commission. The latter arrangement was to facilitate access to the private hospital information held by the ABS, and from the perspective of both data providers, to protect the identity and commercial-in-confidence arrangements of hospitals and hospital groups.

This data access arrangement, however, meant that the analysis was considerably delayed and restrictions were imposed on the analytical results that could be reported (PC 2009). The Commission considered these delays and restrictions to be greater than what would be reasonably expected to address legitimate privacy and confidentiality issues. Making these data more accessible to a range of users could drive improvements in health care, especially as competitive markets have only a

limited role in the health sector. It could also encourage future improvements in data collections (PC 2009).

Assembling the data

The first step in assembling the dataset was to group the patient-level morbidity data by hospital. The morbidity data were then aggregated to create hospital-level patient variables (for example, the total number of casemix-adjusted separations of endocrine, nutritional and metabolic diseases and disorders).

A number of modifications to the dataset were made in order to adjust for reporting inconsistencies. Many Victorian hospitals operate as part of a hospital network. This meant, however, that some data items were reported at the network level while others were reported at the hospital level. Similarly, a single observation was reported for all Tasmanian public hospitals and another observation was provided for all Tasmanian private hospitals. To overcome these problems, grouped data were apportioned to the hospital (establishment) level on the basis of casemix-adjusted separations. Binary variables denoting the state and territory of the hospital and whether the hospital belonged to a hospital network were introduced to account for possible biases that might arise from this process.

Other adjustments were required to remove invalid data, such as hospitals that were recorded as incurring negative costs, or having no staff, beds or deaths in a given year. While it is feasible that some acute hospitals did not experience any deaths, some of the 'zero deaths' were found to have occurred in medium and large hospitals. It was concluded that these were missing values that were inadvertently classified as zero deaths. Ninety-six observations in total with erroneous data were removed from the dataset.

From time to time, hospitals open, merge or close down, or change from public to private ownership and vice versa. For instance, the Mersey Community Hospital was categorised as a private hospital until 2003-04 and a public hospital from 2004-05 to the end of October 2007 (AIHW 2009a). Because of such changes, some hospitals were not included in the dataset for some of the years in the period 2003-04 to 2006-07.

The requirement to maintain the confidentiality of hospitals and hospital groups meant that the two-step modelling process with the ABS resulted in noticeable delays. Due to these delays, the Commission chose to model the data as a pool rather than a panel, even though the data spanned multiple years.

Scope of the dataset

The dataset excludes the number and cost of medical staff, because data were not available for doctors exercising their rights of private practice in public and private hospitals. As a result, the dataset is limited to hospital nursing, diagnostic, allied health, administrative and ancillary staff. This scope is consistent with the scope of the multivariate analysis reported in PC (2009).

The 343 public hospitals covered in this dataset cover virtually all public hospitals in Australia. Even though the AIHW noted that there were 768 public hospitals in 2007-08 (AIHW 2009a), many of these are sub-acute, non-acute and psychiatric facilities (AIHW 2009a).

The Commission re-classified some public hospitals as 'public contract' hospitals. These are hospitals managed by non-government entities to provide public hospital services. They are either contracted or, if they are deemed to be public health organisations (as under the *Health Services Act 1997* (NSW)), subsidised. The Commission identified 17 such hospitals operated by for-profit and not-for-profit organisations. The Commission made this distinction to test whether there are differences in the effect of ownership or management structure on the performance of public hospitals.

The final dataset consists of 1806 observations comprising:

- public hospitals — 343 hospitals contributing 1354 observations
- private hospitals — 99 hospitals contributing 389 observations
- public contract hospitals — 17 hospitals contributing 63 observations.

3.2 Variables used in this study

The variables used in this study are grouped into:

- costs
- volume of outputs
- quality and patient safety
- volume of inputs and input prices
- patient characteristics
- hospital roles and functions, and incentives
- other factors (table 3.1).

The following discussion defines these variables and posits the expected relationships in the estimation of technical and cost efficiency.

Costs

Hospital costs, ideally, should reflect the costs of all inputs used in the provision of hospital services. This would include the operating expenditures (the costs of nursing and other health service staff, clerical and administration, hotel services, and medical, surgical and pharmaceutical supplies) and capital costs (the costs associated with the operation of land, buildings and equipment). Public hospitals pose a challenge in this regard, since funding and accounting systems have rarely accounted for the depreciation and opportunity cost of capital. In contrast, private hospitals tend to record capital costs.

Consistent with other studies, hospital costs are limited to operating expenditures to ensure a consistency of measurement between public and private hospitals. This estimate will inflate the costs of some private hospital owners who occasionally enter into leasing arrangements for land and buildings and thereby incur leasing costs (operating expenditures) and not interest and depreciation costs.

Total operating expenditure, however, does not include any medical costs. Public hospitals routinely collect data on the medical costs of doctors who are employees of the hospital. They typically do not collect data on the charges of visiting medical officers or those exercising their rights of private practice in private practice. While some private hospitals employ salaried doctors, the majority of doctors are self-employed and charge patients separately. Data on medical charges to private health insurers are, in principle, available from the Commonwealth's *Hospital Casemix Protocol* dataset. However, given the delays in obtaining other hospital-related data for this study, the Commission did not collect these data for this study.

Hospital operating costs were deflated using the ABS *Hospital Cost Index* (ABS 2008c). In the analysis, hospital costs were converted to natural logarithms and mean centred.[1]

[1] Mean centering is the process by which the mean of a vector of variables is subtracted from every component of the vector.

Table 3.1 **Description and summary statistics of variables used in the analysis, 2003-04 to 2006-07**

Variable	*Description*	*Mean*	*Std. dev.*	*Median*	*5th percentile*	*95th percentile*
Costs						
Total operating expenditure	Total operating exp. constant prices ($'000s)	54 924	89 051	17 081	2 218	260 627
Outputs — admitted patients						
Number of separations	Total number of separations	11 791	15 020	5 878	411	47 079
Casemix-adjusted separations						
Total number	Total number of separations	12 385	17 163	5 372	344	50 731
MDC 1 separations[a]	No. of seps. for MDC 1	822	1 616	213	20	3 932
Acute separations	No. of seps. for MDCs 2–13, 16–18, 21 and 22	9 370	13 393	3 767	223	40 011
Pregnancy and neonate separations	No. of seps. for MDCs 14,15	1 194	2 510	208	–	5 454
Mental and alcohol separations	No. of seps. for MDCs 19, 20	492	910	79	1	2 559
Other separations	No. of seps. for MDC 23	507	832	170	10	2 096
Separations by principal diagnosis chapter						
Procedures on the nervous system	Percentage of procedures	2.0	1.5	1.8	0.1	4.9
Procedures on the endocrine system	Percentage of procedures	7.6	5.3	6.9	1.1	15.5
Procedures on the eye and adnexa	Percentage of procedures	0.9	0.8	0.8	0.1	2.2
Procedures on the ear and mastoid process	Percentage of procedures	2.6	1.6	2.3	0.6	5.5
Procedures on nose, mouth and pharynx	Percentage of procedures	4.8	4.9	4.0	–	12.3
Dental services	Percentage of procedures	2.4	1.5	2.2	0.7	4.9
Procedures on the respiratory system	Percentage of procedures	1.4	3.0	0.4	–	6.3
Procedures on the cardiovascular system	Percentage of procedures	0.6	0.8	0.4	–	1.9
Proc. on blood and blood-forming organs	Percentage of procedures	8.9	5.7	8.3	0.7	18.7
Procedures on digestive system	Percentage of procedures	8.4	4.6	7.9	1.4	16.5
Procedures on urinary system	Percentage of procedures	9.8	4.4	9.4	2.8	16.9
Procedures on male genital organs	Percentage of procedures	2.5	1.8	2.0	0.6	6.4

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Table 3.1 (continued)

Variable	*Description*	*Mean*	*Std. dev.*	*Median*	*5th percentile*	*95th percentile*
Gynaecological procedures	Percentage of procedures	7.6	7.4	5.4	1.6	21.2
Obstetric procedures	Percentage of procedures	5.2	2.7	4.7	2.0	10.0
Procedures on musculoskeletal system	Percentage of procedures	6.9	8.1	6.3	–	18.4
Dermatological and plastic procedures	Percentage of procedures	1.1	3.1	0.3	–	4.0
Procedures on the breast	Percentage of procedures	0.4	1.8	0.2	–	0.8
Radiation oncology procedures	Percentage of procedures	5.6	3.4	5.0	1.3	11.8
Non-invasive, cognitive and other proc. nec	Percentage of procedures	9.0	4.9	8.5	1.8	17.3
Imaging services	Percentage of procedures	12.1	13.6	8.4	2.5	33.1
Separations by Major Diagnostic Category						
Eye diseases and disorders	Percentage of casemix-adjusted separations	1.6	3.4	0.6	–	6.6
Ear, nose, mouth and throat diseases and dis'd	Percentage of casemix-adjusted separations	3.7	3.5	3.0	0.2	9.1
Respiratory diseases and disorders	Percentage of casemix-adjusted separations	8.8	4.8	8.4	0.6	17.2
Circulatory diseases and disorders	Percentage of casemix-adjusted separations	9.2	6.6	8.4	0.3	19.2
Digestive diseases and disorders	Percentage of casemix-adjusted separations	10.0	4.1	9.9	1.3	16.6
Hepatobiliary and pancreatic diseases and dis'd	Percentage of casemix-adjusted separations	2.5	1.3	2.6	0.2	4.6
Musculoskeletal and connective tissue diseases and disorders	Percentage of casemix-adjusted separations	12.9	9.0	10.8	3.3	28.1
Skin, subcutaneous tissue and breast diseases and disorders	Percentage of casemix-adjusted separations	4.9	2.8	4.4	1.3	10.4
Endocrine, nutrition. & metab. diseases and dis'd	Percentage of casemix-adjusted separations	2.3	1.5	2.1	0.5	5.0
Kidney and urinary tract diseases & disorders	Percentage of casemix-adjusted separations	4.4	3.1	3.8	0.5	9.3
Male reproductive diseases and disorders	Percentage of casemix-adjusted separations	1.2	1.2	0.9	–	3.5
Female reproductive diseases and disorders	Percentage of casemix-adjusted separations	3.1	3.4	2.3	–	9.6
Pregnancy, childbirth and the puerperium	Percentage of casemix-adjusted separations	7.2	8.0	6.4	–	19.0
Newborns and other neonates	Percentage of casemix-adjusted separations	1.6	3.9	0.6	–	5.4
Diseases and disorders of blood, blood forming organs, immunological disorders	Percentage of casemix-adjusted separations	0.9	0.8	0.8	0.1	2.1
Neoplastic disorders	Percentage of casemix-adjusted separations	2.1	3.2	1.3	–	6.1
Infectious and parasitic diseases	Percentage of casemix-adjusted separations	1.9	1.2	1.8	0.2	4.0
Mental diseases and disorders	Percentage of casemix-adjusted separations	4.0	4.1	3.3	–	10.5

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Table 3.1 (continued)

Variable	*Description*	*Mean*	*Std. dev.*	*Median*	*5th percentile*	*95th percentile*
Drug and alcohol related diseases	Percentage of casemix-adjusted separations	0.7	1.7	0.4	–	2.0
Injuries, poisoning and effects of drugs	Percentage of casemix-adjusted separations	2.4	1.8	2.2	0.3	5.5
Burns	Percentage of casemix-adjusted separations	0.2	0.3	0.1	–	0.7
Factors influencing health status	Percentage of casemix-adjusted separations	6.4	11.4	4.1	0.7	15.9
Top 5 MDCs	Percent of casemix-adjusted seps. accounted by the five most common MDCs	58.6	12.9	56.1	47.8	81.4
Average length of admitted patient stay						
Medical DRG	Days	3.83	2.55	3.42	1.58	6.85
Surgical DRG	Days	3.07	5.14	2.32	–	6.60
Other DRG	Days	1.41	2.38	1.18	–	3.08
Medical and surgical cases						
Medical DRG	Per cent of total separations	69.8	22.0	72.7	27.1	100.0
Surgical and other DRG	Per cent of total separations	30.2	22.0	27.3	–	72.9
Other aspects of inpatient activity						
Emergency department (ED) ratio	Ratio of emergency department services to total inpatient separations	2.29	2.78	1.62	–	7.36
Admissions transferring from another hospital	Per cent of all admissions	4.8	7.5	3.1	0.4	13.1
Patient separations transferring to another hospital	Per cent of all separations	7.1	6.0	5.6	0.7	17.8
Outputs — non-admitted patient services						
Accident and emergency services	Number of occasions of service	12 841	15 824	5 707	–	46 696
Allied health and dental services	Number of occasions of service	9 195	21 034	1 151	–	41 774
Mental and alcohol services	Number of occasions of service	5 005	18 202	–	–	34 772
Dialysis and endoscopy services	Number of occasions of service	174	1 476	–	–	430
District nursing and outreach services	Number of occasions of service	9 729	25 548	617	–	54 002
Pathology and radiology services	Number of occasions of service	21 540	56 460	1 003	–	111 662
Other outpatient services	Number of occasions of service	20 158	48 672	1 599	–	114 006

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Table 3.1 (continued)

Variable	*Description*	*Mean*	*Std. dev.*	*Median*	*5th percentile*	*95th percentile*
Hospital inputs						
Nursing staff	Number of full-time equivalent salaried staff	219	326	77	13	970
Diagnostic and allied health staff	Number of full-time equivalent salaried staff	63	138	8	–	360
Other staff	Number of full-time equivalent salaried staff	146	239	49	8	681
Available beds	Total number	125	150	68	10	474
Staffed beds	Total number	124	157	62	8	499
Drug costs	$'000s	2 749	6 213	497	33	14 786
Other hospital costs	$'000s	8 792	12 431	3 646	397	37 517
Medical and surgical supplies cost	$'000s	4 979	9 394	1 117	49	24 178
Input prices						
Nursing staff	Annual, $ (incl. on-costs and super.)	77 771	3 835	77 824	72 518	86 383
Diagnostic and allied health staff	Annual, $ (incl. on-costs and super.)	67 986	7 904	69 014	53 321	81 792
Other staff	Annual, $ (incl. on-costs and super.)	54 396	3 008	54 892	48 547	59 583
Hospital quality						
In-hospital mortality rate	Per cent of total separations	1.28	0.96	1.17	0.14	2.81
Patient characteristics						
Female patients	Per cent of total separations	53.5	7.3	53.3	42.9	63.2
Aged less than 1 year (but not newborn)	Per cent of total separations	2.0	3.0	1.4	–	6.6
Aged 1–4 years	Per cent of total separations	2.8	4.5	2.1	–	7.1
Aged 5–19 years	Per cent of total separations	3.9	5.1	3.3	0.1	8.5
Aged 20–59 years	Per cent of total separations	45.0	12.5	45.1	26.2	65.6
Aged 60–69 years	Per cent of total separations	14.0	4.9	14.3	5.1	21.1
Aged 70+ years	Per cent of total separations	29.0	13.2	28.7	4.8	51.8
SEIFA 1 (most disadvantaged)	Per cent of total separations	34.3	35.7	16.5	1.0	96.6
SEIFA 2	Per cent of total separations	24.4	29.4	11.9	0.7	90.2
SEIFA 3	Per cent of total separations	17.8	23.7	8.4	0.4	77.9
SEIFA 4	Per cent of total separations	13.1	19.1	2.7	0.2	49.9
SEIFA 5 (most advantaged)	Per cent of total separations	10.4	19.7	0.9	0.1	62.3
Charlson score 0 (no comorbidities)	Per cent of total separations	73.2	12.9	75.7	49.4	90.2
Charlson score 1 (fewest comorbidities)	Per cent of total separations	9.6	4.6	8.8	3.0	18.3

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Table 3.1 (continued)

Variable	*Description*	*Mean*	*Std. dev.*	*Median*	*5th percentile*	*95th percentile*
Charlson score 2	Per cent of total separations	10.7	10.1	6.7	2.2	31.5
Charlson score 3	Per cent of total separations	1.7	1.4	1.5	0.3	3.7
Charlson score 4	Per cent of total separations	1.3	2.4	0.7	–	4.2
Charlson score 5	Per cent of total separations	3.0	4.3	1.8	0.3	9.3
Charlson score 6 or higher (most comorbidities)	Per cent of total separations	0.5	0.5	0.4	–	1.3
Average Charlson score	Average score for all separations	0.57	0.38	0.48	0.11	1.24
Hospital roles and functions						
Located in major city	Dummy variable (1=yes; 0=otherwise)	0.387	0.487	–	–	1
Located in inner regional	Dummy variable (1=yes; 0=otherwise)	0.313	0.464	–	–	1
Located in outer regional	Dummy variable (1=yes; 0=otherwise)	0.210	0.407	–	–	1
Located in remote	Dummy variable (1=yes; 0=otherwise)	0.043	0.203	–	–	–
Located in very remote	Dummy variable (1=yes; 0=otherwise)	0.047	0.211	–	–	–
Teaching hospital	Dummy variable (1=yes; 0=otherwise)	0.201	0.401	–	–	1
Member of a hospital network	Dummy variable (1=yes; 0=otherwise)	0.920	0.290	–	–	1
Evans and Walker Index 1	Index of complexity of work	0.59	0.51	0.43	0.04	1.63
Evans and Walker Index 2	Index of complexity of work, adj. for size	0.52	0.40	0.42	0.04	1.29
Public patients	Per cent of total separations	65.4	35.4	81.4	–	96.7
Palliative-care unit	Dummy variable (1=yes; 0=otherwise)	0.13	0.34	–	–	1
High-level intensive-care unit	Dummy variable (1=yes; 0=otherwise)	0.21	0.41	–	–	1
Residential care unit	Dummy variable (1=yes; 0=otherwise)	0.02	0.41	–	–	1
Domiciliary unit	Dummy variable (1=yes; 0=otherwise)	0.46	0.50	–	–	1
Rehabilitation unit	Dummy variable (1=yes; 0=otherwise)	0.25	0.43	–	–	1
Neonatal intensive care unit	Dummy variable (1=yes; 0=otherwise)	0.06	0.23	–	–	1
Cardiac care unit	Dummy variable (1=yes; 0=otherwise)	0.10	0.29	–	–	1
Obstetrics unit	Dummy variable (1=yes; 0=otherwise)	0.55	0.50	1	–	1
Other factors						
Very large hospital	Dummy variable (1=yes; 0=otherwise)	0.197	0.398	–	–	1
Large hospital	Dummy variable (1=yes; 0=otherwise)	0.154	0.362	–	–	1
Medium hospital	Dummy variable (1=yes; 0=otherwise)	0.163	0.370	–	–	1
Small and very small hospital	Dummy variable (1=yes; 0=otherwise)	0.485	0.500	–	–	1

a MDC Major diagnostic category. – Nil or rounded to zero.

Source: Productivity Commission estimates based on unpublished ABS and AIHW data.

Outputs

Hospitals are complex entities that provide a varied range of services. In addition to acute inpatient care, many hospitals provide some sort of outpatient services or emergency departments. This provides a strong argument for hospitals to be modelled as multi-input multi-output firms (Butler 1995).

Inpatient services

There is a wide variation in the type and severity of acute inpatient care provided by different hospitals. To account for this variation, the Melbourne Institute of Applied Economic and Social Research (cited in PC 2009) suggested that it would be reasonable to model inpatient activity at the major diagnostic category (MDC) level (box 3.1).

However, separately specifying all 23 MDCs would result in a large number of variables that would reduce the interpretability of the results, particularly when more complex functional forms such as the translog are considered. Therefore, the categories of inpatient outputs used in this study are:

- normalising variable — casemix-adjusted separations for MDC 1 (diseases and disorders of the nervous system)[2]
- acute separations — casemix-adjusted separations for MDCs 2 to 13, 16 to 18, 21 and 22
- pregnancy and neonate separations — casemix-adjusted separations for MDCs 14 and 15
- mental and alcohol separations — casemix-adjusted separations for MDCs 19 and 20
- other separations — casemix-adjusted separations for MDC 23.

MDC 1 served as the normalising output variable in the output-oriented distance function as it had the lowest count of zero observations (that is, the fewest number of hospitals not offering that service) and therefore minimised the effects of the adjustments that needed to be made for zero observations. It was also included in both the cost and input-oriented distance functions as its own output.

2 The normalising variable was inverted in the output distance function. This has the effect of reversing the signs of the coefficients of the output distance function.

Box 3.1 Major Diagnostic Categories and the Australian Refined Diagnosis-Related Group system

The Australian Refined Diagnosis-Related Group (AR-DRG) system categorises separations according to the patient's condition and the hospital resources expected to be used. The system provides a way to record the number and type of separations administered by a hospital in relation to the resources required.

Version 5.1 of the classification system defines 665 individual AR-DRGs. Each separation is assigned to an AR-DRG mainly on the basis of the medical diagnosis or surgical procedure involved, but also according to a patient's age, length of stay, mode of separation, the level of clinical complexity and the existence of complicating diagnoses or procedures.

Individual AR-DRGs are grouped under 23 Major Diagnostic Categories (MDCs) that are mostly defined by body system or disease type:

- MDC 1 — Diseases and disorders of the nervous system
- MDC 2 — Diseases and disorders of the eye
- MDC 3 — Diseases and disorders of the ear, nose, mouth and throat
- MDC 4 — Diseases and disorders of the respiratory system
- MDC 5 — Diseases and disorders of the circulatory system
- MDC 6 — Diseases and disorders of the digestive system
- MDC 7 — Diseases and disorders of the hepatobiliary system and pancreas
- MDC 8 — Diseases and disorders of the musculoskeletal system and connective tissue
- MDC 9 — Diseases and disorders of the skin, subcutaneous tissue and breast
- MDC 10 — Endocrine, nutritional and metabolic diseases and disorders
- MDC 11 — Diseases and disorders of the kidney and urinary tract
- MDC 12 — Diseases and disorders of the male reproductive system
- MDC 13 — Diseases and disorders of the female reproductive system
- MDC 14 — Pregnancy, childbirth and the puerperium
- MDC 15 — Newborns and other neonates
- MDC 16 — Diseases and disorders of the blood and blood forming organs and immunological disorders

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Box 3.1 (continued)

- MDC 17 — Neoplastic disorders (haematological and solid neoplasms)
- MDC 18 — Infectious and parasitic diseases
- MDC 19 — Mental diseases and disorders
- MDC 20 — Alcohol or drug use and alcohol or drug induced organic mental disorders
- MDC 21 — Injuries, poisoning and toxic effects of drugs
- MDC 22 — Burns
- MDC 23 — Factors influencing health status and other contacts with health services.

Within each MDC, individual AR-DRGs are assigned to a 'surgical', 'medical' or 'other' partition on the basis of the type of treatment involved. A separation is classified as surgical if it includes an operating-room procedure, medical if it does not include any type of procedure, and other if it includes a procedure performed outside of an operating room (such as dental extractions and colonoscopies). In this context, a procedure is defined as a clinical intervention that carries a procedural or anaesthetic risk, and/or requires specialised training, facilities or equipment available only in an acute-care setting.

Sources: AIHW (2009a); DOHA (2004).

Pregnancy and neonate MDCs were kept separate from the majority of acute care separations, as pregnancy separations do not generally involve acute illness. Similarly, mental and alcohol separations were also kept separate because these MDCs do not contain any diagnoses requiring surgical treatment, and therefore require a different mix of hospital resources to other acute diagnoses.

Casemix-adjusted data were based on public hospital cost weights supplied by the AIHW. As is common practice, all input and output variables terms are specified in natural logarithms except shares and binary variables, so that the measures represent proportional values rather than absolute levels.[3] All logarithmic variables were mean centred.

[3] Where a natural number was reported as zero, its value was set to the natural logarithm of one. Additional adjustments were made, as per Battese (1996), which are outlined in appendix C.

Non-admitted occasions of service

There is no national casemix classification for outpatient services, so there is a greater need to provide a detailed level of aggregation of these hospital activities than for admitted patient care. The output categories used were:

- accident and emergency services — number of accident and emergency department presentations or visits
- allied health and other services — number of occasions of service for allied health, dental and other outpatient services
- mental and alcohol services — number of mental, alcohol and psychiatric outpatient services
- dialysis and endoscopy — number of non-admitted occasions of service for dialysis and endoscopy[4]
- diagnostic services — number of pathology and radiology services provided to non-admitted patients
- outreach services — number of community services, district nursing and other outreach services
- pharmaceutical services — the number of visits to the hospital's pharmacy.

Other output variables

A number of other variables were used to describe in greater detail the differences in the types of services provided by hospitals. These included:

- emergency ratio
- proportion of patients treated with surgical and other procedures.

Emergency ratio — the number of accident and emergency visits divided by the number of casemix-adjusted separations — is used as a surrogate for data on the proportion of inpatients that were admitted through emergency department, and is intended as a measure of the acuity of a hospital's workload. Ideally, the preferred measure should be the proportion of patients that were admitted as emergency cases — whether through an emergency department or not. However, this is not collected consistently at a national level.

4 Some jurisdictions admit patients who are undergoing dialysis or endoscopy, while other jurisdictions commonly perform these procedures as non-admitted services. Dialysis and endoscopy are grouped together to account for these different admission practices.

Proportion of patients treated with surgical and other procedures describes the extent to which a hospital specialises in surgical and other diagnosis-related group (DRG) cases (box 3.1). Some private hospitals seek to maximise their productivity by specialising in elective surgery procedures. Since medical DRG cases have a greater likelihood of being unplanned, they tend to be inherently more difficult for hospitals to manage. Ideally, this variable should be defined in terms of elective surgery, since some surgical and other procedures captured by this variable will be emergency in nature.

Two other variables which were used in the estimation of hospital-standardised mortality ratios (HSMRs) included the proportion of patients that were transferred from another hospital, and the proportion of patients discharged that were transferred to another hospital. These were included in that analysis to account for the activities of surgical specialisation that is thought to occur among hospitals.

Expected signs of the coefficients

In the output-oriented distance function, the coefficient of each output is expected to be negatively signed, reflecting that as a hospital's outputs increase for a given set of inputs, so does its productivity (and therefore efficiency). In the input-oriented distance function, outputs are expected to be positively signed, reflecting that as a hospital's outputs increase for a given set of inputs, and a decline in resource intensity (which is equivalent to an increase in productivity). In the cost function, each of the output variables is expected to be positively related with costs — that is, increases in outputs are associated with increases to total operating costs.

The variable describing the proportion of patients who undergo surgical and other procedures is expected to be negatively related with costs (since surgical and other procedures are thought to be less expensive than medical cases), positively related in the output distance function, and negatively related with the input-oriented distance function.

Hospital quality

The HSMR is used as a measure of the quality and effectiveness of hospital services (the process of risk-adjustment is described in chapters 2 and 4). Its sign is expected to differ with each of the models:

- Output-oriented distance function — if the coefficient of the HSMR variable is negatively signed, hospitals with higher than expected HSMRs (worse quality) are associated with lower productivity and therefore worse efficiency.

- Input-oriented distance function — if the coefficient of the HSMR variable is positively signed, hospitals with higher than expected HSMRs are associated with a increased resource intensity and therefore worse efficiency.
- Cost function — if the HSMR is negatively correlated with costs, then hospitals can only achieve improvements to mortality outcomes with increases to costs. If however, it is positively correlated with costs, this suggests that improvements in mortality outcomes will lead to reductions in costs.

Inputs

Following common practice, inputs into the production of hospital services included:

- nursing staff — number of full-time equivalent nursing staff
- diagnostic and allied staff — number of full-time equivalent diagnostic (pathology and radiology) and allied health staff
- other staff — number of full-time equivalent domestic, administration and other staff
- medical and surgical supplies — constant price expenditure on medical and surgical supplies used
- pharmaceutical supplies — constant price expenditure on pharmaceuticals
- other inputs — constant price expenditure on other hospital inputs, such as administration and clerical services, housekeeping, and repairs and maintenance
- beds — number of beds in the hospital (as a proxy for hospital capital).

As noted, the number of doctors exercising their rights of private practice in public and private hospitals is not known. Hence the number of medical staff has been excluded from the analysis. This exclusion is equivalent to assuming that each hospital employs its doctors in a fixed proportion to its other inputs over time — that is, it does not substitute between doctors and other inputs. The extent to which this is the case, however, is unknown. Otherwise, all efficiency scores derived from the analysis can be interpreted as the efficiency of the hospital, and not specifically of the hospital and its medical workforce.

Medical and surgical, pharmaceutical and other input supplies were each deflated by their respective components from ABS *Hospital Cost Index* (ABS 2008c).

The number of beds is used as the normalising variable in the input-oriented distance function. This variable was inverted in the input-oriented distance function, which has the effect of reversing the signs of the coefficients of that function.

Some limits to using beds as a measure of capital

The number of beds presents two challenges as a measure of capital. First, public and private hospitals do not define the number of beds in the same manner. Public hospitals report the number of *staffed beds* (AIHW 2009), which is defined as the number of beds for which staff are on hand to attend to a patient. At any point in time, a staffed bed may be occupied or unoccupied with a patient (AHRQ nd). In contrast, private hospitals report to the ABS the number of *total available beds* (ABS 2007), which generally means the number of beds that are physically set up and ready for use even if they are not staffed (AHRQ nd).

The different definitions mean that, on average, private hospitals report more beds than if they had to comply with the staff beds definition. This in turn means that, in the absence of any data adjustment, private hospitals would appear to be less productive or more resource intensive — and therefore less efficient — than public hospitals.

The Commission estimates that there are approximately 4 to 5 per cent more available beds in the private sector than there are staffed beds, and public contract hospitals maintain approximately 3 to 4 per cent more available beds than staffed beds (appendix C).

To ensure that the number of beds in the two sectors are comparably measured, the Commission estimated the number of staffed beds for private hospitals. The method is outlined in appendix C.

The other challenge is that the count of beds is not an ideal measure of the usage of capital in a hospital over time or between hospitals. Ideally, capital measures should be disaggregated into the main categories of hospital activity — such as the number of ICU beds, non-acute beds, palliative care beds, the number of sameday chairs, the number of operating theatres. As these data were not available, differences in the capital of hospitals were captured with variables that reflected the roles and functions of hospitals — such as the presence of palliative care units, rather than the number of palliative care beds, for example. The variables which reflect differences in hospital roles and functions are discussed below.

Expected signs of the coefficients

The sign of the coefficient of each input is expected to differ according to the model being estimated, so that for the:

- output-oriented distance function — each input is expected to be positively signed, indicating that increases in the use of an input reduces productivity and therefore efficiency
- input-oriented distance function — each input is expected to be negatively signed, indicating that increases in the use of an input increases resource intensity (for a given level of output), and therefore reduces efficiency
- cost function — each input is expected to be positively correlated with total operating expenditure, since increasing input use typically increases overall costs.

Input prices

Input prices are used in estimating the cost function. The five input prices that were considered are:

- wages and salaries of nursing staff
- wages and salaries of diagnostic and allied health staff
- wages and salaries of other staff (including administration and clerical, and hotel staff)
- price index for medical and surgical supplies
- price index for pharmaceutical supplies.

Wages and salaries were set to be equal across each broad hospital sector within each state or territory. Wages and salaries included superannuation and other on-costs and were deflated by the wages and salaries index of the ABS *Hospital Cost Index* (ABS 2008c).

The calculation of wage rates in this way is intended to reflect the possibility that there exists a unique market for hospital staff within each jurisdiction and hospital sector.

The average price of medical and surgical supplies and pharmaceutical supplies was drawn from the price indices for medical and surgical supplies and pharmaceutical supplies from the ABS *Hospital Cost Index* (ABS 2008c). These indices are national, so this assumes that there is single market (and market price) for these inputs.

Input prices are expected to be positively correlated with costs, since increases in input prices contribute to increased total operating expenditures.

Patient-risk characteristics

Patient-risk characteristics used in the HSMR and efficiency analyses included:

- age
- gender
- socioeconomic status — based on the *Socio-economic Index for Areas — Index of Relative Disadvantage and Advantage* (SEIFA index) (ABS 2008b)
- remoteness of residence — based on the *Australian Standard Geographic Classification — Remoteness Area* (ASGC-RA) (ABS 2005)
- distribution of the Charlson index of comorbidity (Charlson et al. 1987).[5]

Unlike PC (2009), patient Indigenous status was not used as a variable because of concerns regarding the reliability of estimates of Indigenous status (AIHW 2010).

At least some patient-risk characteristic variables are expected to be statistically significant because private hospital separations were casemix-adjusted using public hospital cost weights and both private and public hospital outpatient services were not casemix-adjusted.

Expected signs of the coefficients

Patient-risk characteristics can influence hospital costs, outputs and the use of inputs. Patient groups with more complex needs are expected, for the:

- output-oriented distance function — to be negatively signed indicating that they reduce a hospital's productivity
- input-oriented distance function — to be positively signed indicating that they increase a hospital's resource use

5 The Charlson index (Charlson et al. 1987) is an odds-ratio of the risk of mortality within one year. Thus a Charlson score of 6 indicates a 6:1 (or 86 per cent) chance of the patient dying within one year. The Charlson index for this study was prepared using patient morbidity data, based on codes from the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Australian Modification — ICD-10-AM (Quan et al. 2005; Sundarajan et al. 2004). The Commission considered using the Multipurpose Australian Comorbidity Scoring System (Preen et al. 2006) but chose not to use this approach because the data available for this study were neither linked between different hospitals nor within the same hospital over time.

- cost function — to be positively correlated with costs.

The signs and statistical significance of each of the patient-risk characteristic variables will depend in part upon their interaction with other patient-risk characteristic variables, including the default variable of a group of common variables. For example, the coefficient of the Charlson comorbidity score of 6 will depend upon the influence of the default Charlson score (such as patients with a score of 0).

Hospital roles and functions, and incentives

To account for differences between hospitals in the services they provide, the resources they use and the patients they treat, a number of other variables were included in the analysis:

- hospital remoteness
- specialist units
- teaching status
- proportion of patients that are public
- Evans and Walker indices of complexity.

Hospital remoteness is defined by ASGC-RA (ABS 2005). A hospital is classified as being in a major city, inner regional, outer regional, remote or very remote area. In parts of this analysis, the latter four areas are grouped as 'outside major cities'. Hospitals in more remote communities of Australia are thought to operate a lower levels of capacity.

Specialist hospital units are six variables that describe whether a hospital maintains particular facilities. These variables are used to augment existing data on the number of hospital beds as a measure of hospital capital.

Teaching status as included to indicate whether a hospital is a teaching hospital affiliated with universities providing undergraduate medical education. However, the available data did not allow the Commission to measure the intensity of the teaching effort. The variable therefore represents all declared university affiliations, irrespective of the hospital resources involved. Data were not available from the ABS or AIHW on the status of nursing education of hospitals.

Proportion of patients who are treated as public patients is a proxy measure for the different incentives faced by hospitals when treating public and non-public patients. Non-public patients include patients who are funded by private health insurance,

Department of Veterans' Affairs, third-party motor vehicle accident insurance and workers' compensation funds, and patients who are self-funding.

The *Evans and Walker information indices* are measures of the relative complexity of work undertaken by hospitals. Evans and Walker (1972) put forward a relationship between the complexity of work undertaken by a hospital and the information the hospital learns from undertaking that work. By establishing a link between complexity and information gain, the authors were able to adapt information indices as proxies for the complexity of hospital services.

In general, the amount of information a hospital learns from an admission is inversely related to the likelihood of that case occurring within the system and the likelihood of that hospital treating that particular case. If an event is almost certain to take place, such as a routine case from which the hospitals learn little, the hospital attracts a relatively low index of information gain and therefore complexity (Butler 1988a). In contrast, cases that are rarer and provide more information gain are classified as more complex. A mathematical exposition of the Evans and Walker indices is given in appendix C.

Expected signs of the coefficients

The coefficients of the hospital remoteness variables will depend on their relative degree of remoteness. Hospitals that operate in more remote locations are thought to operate at lower levels of capacity. The coefficients for more remote hospitals in the output-distance function are expected to be negatively signed, and positively signed in the input-distance and cost functions.

Level III intensive care units (ICUs) are expensive to operate relative to most other hospital wards and are expected to be negatively signed in the output distance function, and positively signed in the input-distance and cost functions. Though the other five variables are less capital intensive and more labour intensive, their effect on costs and distance functions is unclear.

To the extent that the financial incentives encourage hospitals to treat public and non-public patients differently (for example, public patients share common wards rather than private rooms), this variable is expected to be positively signed in the output-oriented distance function and negatively signed in the input-distance and cost functions.

The sign of the teaching status of a hospital may is unclear. If a teaching hospital's productivity is lower because of the lower productivity of medical trainee staff, then the coefficient in the output-oriented distance function should be negative. If

teaching functions are more resource intensive, then the input-oriented and cost functions will have positively signed coefficients. Care must be exercised when interpreting this variable as the number of medical staff and medial costs are not included in the distance and cost functions.

Finally, both of the Evans and Walker indices are expected to be positively with costs — as hospital complexity increases so do hospital costs. The first Evans and Walker index, which as an absolute measure of complexity, is expected to be negatively signed in the output-oriented distance function, since this reflects the effect that the complexity of a hospital's workload has on decreasing its productivity. It is also expected to be positively signed in the input-oriented and cost functions because of the effect that increased complexity has on resource use.

It is unclear what the sign will be for the second Evans and Walker index, since this measure of complexity recognises that larger hospitals are expected to be able to address more complex procedures.

Other variables

Another possible determinant is the policy and regulatory environment in which hospitals operate. These are factors outside the control of hospitals and need to be included in any assessment of hospital performance. Since data on policy and regulatory environments are not available, a set of proxy variables were used. These are binary variables for each state and territory. For example, the New South Wales binary variable took on a value of '1' if a hospital was located in that state, and '0' if not. A variable was not defined for Queensland, because it was used as the reference category.

Reporting categories

Summary statistics, including efficiency scores, are reported for the various reporting categories, including public hospitals, private hospitals (including for-profit and not-for-profit), and public contract hospitals.

Data are also reported according to hospital size. Hospital size is based on number of casemix-adjusted separations per year, in which:

- very large refers to 20 001 or more casemix-adjusted separations per year
- large is defined as 10 001 to 20 000 casemix-adjusted separations per year
- medium is defined as 5001 to 10 000 casemix-adjusted separations per year

- small is defined as 2001 to 5000 casemix-adjusted separations per year
- very small is defined as 2000 or fewer casemix-adjusted separations per year.

Where relevant, data are reported according to a hospital's remoteness: whether a hospital is in a major city, or outside a major city (including inner regional, outer regional, remote and very remote).

3.3 Profile of hospitals in the sample

As noted above, the Commission's dataset includes 1806 observations, with 1354 public acute hospital observations, 389 private hospital observations and 63 public contract hospital observations (table 3.2).

Table 3.2 **Observations in the sample, by hospital location, size and year, 2003-04 to 2006-07**[a,b]

	Public	*Private*			*Public contract*	*Total*
		All private	*For-profit*	*Not-for-profit*		
By size						
Very large	252	87	52	35	17	356
Large	155	85	68	17	39	279
Medium	167	np	np	np	np	295
Small	222	np	np	np	np	295
Very small	558	np	np	np	np	581
By remoteness						
Major city	356	288	np	np	55	699
Inner regional	472	np	np	np	np	566
Outer regional	364	np	np	np	np	379
Remote	78	–	–	–	–	78
Very remote	84	–	–	–	–	84
By year						
2003-04	328	98	np	np	15	441
2004-05	343	99	np	np	16	458
2005-06	341	96	np	np	15	452
2006-07	342	96	np	np	17	455
All hospitals	1354	389	295	94	63	1806

a Sample refers to all the acute overnight hospitals included in the Commission's multivariate analysis. **b** Hospital location is defined by the Australia Standard Geographical Classification — Remoteness Structure (ABS 2005). Hospital size is defined by number of casemix-adjusted separations per year, where *Very large* refers to 20 001 or more casemix-adjusted separations; *Large* is defined as 10 001 to 20 000 casemix-adjusted separations per year; *Medium* is defined as 5001 to 10 000 casemix-adjusted separations per year; *Small* is defined as 2001 to 5000 casemix-adjusted separations per year; and *Very small* is defined as 2000 or fewer casemix-adjusted separations per year. **np** Not published because of ABS confidentiality concerns. – Nil.

Source: Productivity Commission estimates based on unpublished ABS and AIHW data.

Representativeness of the sample

Ideally, the data should be representative of all Australian hospitals. Data for public hospitals were representative, as virtually all public acute overnight hospitals were included in the study.

However, private sector data may not be representative of the private hospital sector for two reasons. First, there is an under-representation of not-for-profit hospitals. They comprise approximately 43 per cent of the total number of private hospitals in Australia (AIHW 2009a), yet comprise only 15 per cent of the Commission's private hospital dataset. The Commission's dataset was also relatively under-represented in terms of smaller private hospitals — many of which are not-for-profit hospitals. For example, only about 33 per cent of hospital separations from small and very small private hospitals (outside major cities) were represented in the sample (table 3.3).

Table 3.3 **Profile of private acute hospitals in the sample[a,b,c]**

	Private separations[d]		*Private beds*		*Private hospitals*	
	Number in sample	*Share of total*	*Number in sample*	*Share of total*	*Number in sample*	*Share of total*
	no.	%	no.	%	no.	%
Major cities						
Very large	575 058	71	4 890	67	18	75
Large	351 804	62	3 079	61	25	63
Medium	173 188	56	1 671	59	23	53
Small and very small	53 894	34	1 079	40	20	28
Outside major cities						
Large and very large	94 061	42	855	42	6	43
Medium	65 351	59	787	65	10	63
Small and very small	25 809	33	335	27	8	15
Total	**1 339 165**	**59**	**12 696**	**57**	**110**	**42**

[a] Sample refers to all the acute overnight hospitals included in the Commission's analysis. [b] Hospital location is defined by the Australia Standard Geographical Classification — Remoteness Structure (ABS 2005). [c] Hospital size is defined by number of casemix-adjusted separations per year, where *Very large* refers to 20 001 or more casemix-adjusted separations; *Large* is defined as 10 001 to 20 000 casemix-adjusted separations per year; *Medium* is defined as 5001 to 10 000 casemix-adjusted separations per year; *Small* is defined as 2001 to 5000 casemix-adjusted separations per year; and *Very small* is defined as 2000 or fewer casemix-adjusted separations per year. [d] All separations (not casemix-adjusted).

Source: Productivity Commission estimates based on unpublished ABS and AIHW data.

Second, the nature of the for-profit and not-for-profit hospitals in the sample may differ from those in the community. The private hospitals in the dataset were not drawn as a random sample and it is possible that those hospitals that agreed to participate may be different in ways that affects their efficiency compared to those

that did not agree to be included in the study. In particular, if the factors that affect hospital efficiency also affect the likelihood that a hospital agreed to participate in the study, the efficiency estimates may be biased.

To address the first of these issues, sampling weights were applied to the private hospital observations. The weights were designed to capture the extent to which hospitals of different sizes and from different locations are represented in the private sector sample. Specifically, observations from hospitals of different sizes and locations were weighted by the inverse of the share of separations from hospitals of that size and location that were included in the Commission's sample. For example, 62 per cent of separations from large hospitals in major cities are included in the sample (table 3.3). Therefore, observations for this hospital category are assigned a sampling weight of (1/0.62 = 1.613). The weights were based on non-casemix-adjusted separations, because casemix-adjusted data are unavailable for hospitals outside of the sample.

The Commission considered potential methods to overcome the issue of non-random selection using methods analogous to the Heckman correction procedure (Heckman 1976). This procedure would involve modelling the likelihood that a hospital chose to participate in the study, before computing the efficiency scores. The Commission did not employ this method because there were insufficient data about the hospitals outside the sample which would be needed to model their likelihood of participation, and that it was not clear that the technique was sufficiently developed for use with stochastic frontier analysis. As a result, the analysis proceeded without this additional sampling correction.

The Commission's approach means that the efficiency scores should be less biased by the under-representation of different sizes or locations, though it does not control for the possibility that hospitals with different efficiencies may also have a different likelihood of participating in the study.

Profile of sample hospitals

Hospital and patient characteristics, as well as the outputs, inputs and partial productivity measures of hospitals are summarised in tables 3.4 and 3.5. These characteristics are based on the Commission's sample and are not population estimates.

Establishment characteristics

Under the Australian Revised Diagnosis Related Groups (AR-DRG) classification system, each episode of hospital care is classified as being medical, surgical or other. Surgical procedures are invasive in nature and take place in an operating theatre, while other procedures, while also surgical in nature, take place within the doctors' suites or rooms. Medical separations comprise 78 per cent of inpatient activity in public hospitals, but around 42 per cent of separations from private hospitals in the sample. The average share of medical separations for public contract hospitals, at 64 per cent, is larger than for private hospitals but smaller than for public hospitals.

Over half of the separations from large and very large public hospitals are same-day separations. The share of same-day separations is lowest in small and very small public hospitals (35 per cent).

Proportionally more private hospitals in the sample are reported to be teaching hospitals than is the case for public hospitals. However, three-quarters of very large public hospitals are teaching hospitals compared to 48 per cent of very large private hospitals.

Very large, large and medium public hospitals are more likely to have palliative-care units, rehabilitation units and high-level intensive-care units than private hospitals of the same size. Public contract hospitals were most likely to have such palliative-care and high level intensive care units than public hospitals.

Patient-risk characteristics

The patients who had the most comorbidities (Charlson score of 6 or more) collectively constitute a larger share of patients in private hospitals than in public hospitals, on average. Public contract hospitals treated patients with the most comorbidities (based on the average Charlson score).

Patients from the most disadvantaged socio-economic areas constituted a larger share of patients in public hospitals than in private hospitals. This differential is particularly apparent in the small and very small size category. With respect to patients' socio-economic status, public contract hospitals treat a similar patient profile to private hospitals. This may reflect the catchment populations of public contract hospitals, which tend to be located in areas of comparative socio-economic advantage.

Table 3.4 **Profile of sample hospitals, by establishment and patient characteristics[a]**

	All hospital sizes			*Very large*		*Large*		*Medium*		*Small & very small*	
	Public	Private	Public contract	Public	Private	Public	Private	Public	Private	Public	Private
Establishment characteristics											
Teaching hospital (%)	17.8	24.2	44.4	75.8	48.3	24.5	25.9	4.2	16.0	0.6	10.9
Member of network (%)	12.0	–	6.3	22.2	–	15.5	–	19.8	–	6.4	–
Medical DRGs (%)	77.9	42.3	63.8	73.1	44.0	70.4	33.8	66.1	41.6	83.5	49.6
Surgical and other DRGs (%)	22.1	57.7	36.2	26.9	56.0	29.6	66.2	33.9	58.4	16.5	50.4
Public patient (%)	83.4	1.0	75.4	84.6	2.8	85.0	0.6	85.7	0.5	82.2	0.4
Non-public patient (%)	16.6	99.0	24.6	15.4	97.2	15.0	99.4	14.3	99.5	17.8	99.6
Same-day separations (%)	40.9	52.7	47.0	48.8	50.1	47.6	49.9	49.3	56.3	35.2	52.8
Emerg. to admissions ratio	3.0	0.1	1.2	1.0	0.3	1.7	0.1	2.2	0.0	4.0	0.0
Admissions from other hospital (%)	8.6	2.1	5.0	4.9	1.8	6.6	2.2	7.4	1.7	10.5	2.6
Evans and Walker Index 1	0.6	0.6	0.9	1.4	1.2	0.9	0.8	0.6	0.4	0.2	0.2
Evans and Walker Index 2	0.5	0.5	0.8	1.1	1.0	0.8	0.7	0.6	0.4	0.2	0.2
Palliative-care unit (%)	14.5	4.9	36.5	21.0	8.0	14.2	5.9	14.4	–	12.6	7.6
High-level ICU (%)	19.9	19.3	44.4	77.4	55.2	34.2	20.0	13.2	4.8	–	4.3
Rehabilitation unit (%)	26.0	21.9	23.8	58.7	27.6	60.0	9.4	43.1	20.0	5.0	30.4
Patient characteristics (% of patients)											
Female	53.1	54.5	55.5	52.0	51.7	54.8	54.4	54.5	56.5	52.8	54.3
Aged less than 1 year	2.2	1.1	2.9	3.1	0.6	3.7	0.7	1.9	1.5	1.8	1.5
Aged 1-4 years	3.2	1.4	3.4	3.6	1.1	4.6	1.1	2.3	1.2	3.0	2.2
Aged 5-19 years	4.4	2.1	4.3	4.6	1.6	5.5	1.9	3.3	2.0	4.4	3.1
Aged 20-59 years	44.6	45.9	49.0	44.8	45.9	45.1	51.5	45.0	45.5	44.4	41.1
Aged 60-69 years	13.3	16.3	13.1	13.7	18.0	12.7	16.8	14.9	15.9	13.0	15.0
Aged 70+ years	28.8	30.7	24.2	26.9	30.8	25.1	25.3	29.4	31.5	30.0	34.5
From major city	25.9	67.3	77.8	71.4	84.2	50.8	68.4	33.9	61.1	4.6	58.5
From inner regional	34.2	24.9	15.5	19.6	11.3	36.5	20.4	31.2	31.7	39.1	32.7
From outer regional	27.8	7.1	6.3	7.6	3.6	9.3	10.2	30.9	6.6	37.3	8.2

(Continued next page)

Table 3.4 (continued)

	All hospital sizes			*Very large*		*Large*		*Medium*		*Small & very small*	
	Public	Private	Public contract	Public	Private	Public	Private	Public	Private	Public	Private
From remote	5.8	0.5	0.3	0.7	0.6	1.7	0.6	3.1	0.4	8.9	0.6
From very remote	6.3	0.2	0.1	0.7	0.2	1.7	0.4	0.9	0.2	10.1	0.1
SEIFA 1 (most disadvantaged)	40.5	15.2	18.4	21.3	11.6	28.0	13.8	35.3	15.0	50.3	20.1
SEIFA 2	27.5	14.7	18.2	21.7	12.7	25.1	13.8	27.1	17.2	30.0	13.8
SEIFA 3	16.1	23.3	19.6	23.2	19.0	16.8	29.4	18.8	20.8	13.1	25.2
SEIFA 4	9.7	23.4	23.4	18.1	26.3	14.9	25.2	13.5	23.5	5.1	19.0
SEIFA 5 (most advantaged)	6.2	23.4	20.4	15.7	30.4	15.2	17.9	5.4	23.4	1.5	21.9
Charlson score 0	72.0	77.8	70.8	67.3	71.0	72.1	80.0	72.0	80.6	73.4	78.4
Charlson score 1	10.59	6.36	8.02	8.46	6.47	8.15	6.12	9.56	5.79	11.99	7.27
Charlson score 2	11.06	9.00	13.57	16.08	12.81	12.73	7.66	10.81	8.62	9.16	7.16
Charlson score 3	1.86	1.36	1.62	2.04	1.33	1.63	0.98	2.01	1.17	1.82	1.99
Charlson score 4	1.49	0.47	1.18	1.69	0.71	1.42	0.31	2.16	0.41	1.30	0.49
Charlson score 5	2.50	4.65	3.90	3.58	7.26	3.41	4.57	2.80	3.12	1.90	4.35
Charlson score 6 or more	0.53	0.34	0.87	0.80	0.47	0.53	0.36	0.63	0.25	0.42	0.31
Average Charlson score	0.58	0.54	0.70	0.75	0.77	0.62	0.49	0.63	0.42	0.50	0.51
Quality and patient safety											
Mortality rate (%)	1.48	0.54	1.40	1.22	0.70	1.12	0.48	1.17	0.47	1.71	0.53
MRSA 1 (per 10 000 seps)[b]	10.65	4.13	7.61	16.41	4.52	4.07	3.20	14.49	4.07	7.90	4.69
MRSA 2 (per 10 000 seps)[c]	9.36	4.65	11.58	11.96	5.81	3.39	4.24	10.29	3.39	8.13	5.67
VRE (per 10 000 seps)[d]	0.428	0.136	0.112	0.340	0.071	0.015	0.045	2.761	0.015	0.018	0.444
Adverse event rate (%)[e]	3.74	4.39	4.69	5.46	5.56	4.61	4.44	4.42	3.44	2.87	4.54
Number of observations	**1354**	**389**	**63**	**252**	**87**	**155**	**85**	**167**	**np**	**780**	**np**

[a] Sample refers to all the acute hospitals included in the Commission's multivariate analysis. Data disaggregated by size excludes public contract hospitals due to confidentiality requirements. Private hospital data disaggregated by size refers to both for-profit and not-for-profit hospitals. – Nil or rounded to zero. [b] Defined as the number of cases in which *staphylococcus aureus* (ICD-10-AM B95.6) is the cause of disease and which is *Methicillin* resistant (ICD-10-AM BZ06.32). [c] Defined as the number of cases in which *staphylococcus aureus* (ICD-10-AM B95.6) is the cause of disease and which is resistant to multiple antibiotics (ICD-10-AM Z06.8). [d] Defined as the number of cases in which *streptococcus group D* (ICD-10-AM B95.2) is the cause of disease and which is *Vancomycin* resistant (ICD-10-AM Z06.41). [e] Defined as the number of separations with ICD-10-AM Y92.22 place of occurrence code. **np** Not published due to ABS confidentiality concerns.

Source: Productivity Commission estimates based on unpublished ABS and AIHW data

Table 3.5 **Profile of sample hospitals, by output, input and partial productivity measures[a]**

	All hospital sizes			*Very large*		*Large*		*Medium*		*Small & very small*	
	Public	Private	Public contract	Public	Private	Public	Private	Public	Private	Public	Private
Output— admitted patients (number)											
Total separations	11 312.4	12 408.0	18 261.5	39 855.8	27 211.4	15 847.0	13 657.1	8 132.1	7 687.7	1 870.6	3 668.6
Casemix-adj. separations	11 747.1	13 397.8	19 842.7	44 351.3	31 697.9	15 095.3	14 756.0	7 267.4	7 125.0	1 507.3	3 360.4
MDC 1 separations	896.2	478.2	1 347.2	3 642.7	1 434.6	855.8	354.3	448.6	169.0	112.6	108.4
Acute separations	9 432.3	11 609.1	15 460.9	32 575.5	27 595.1	10 646.9	12 391.8	5 097.7	5 449.0	1 087.8	2 451.7
Preg. & neonate seps.	1 265.0	844.7	1 824.9	4 570.1	1 484.3	2 162.4	1 242.1	671.3	673.4	146.0	105.4
Mental and alc. seps.	577.7	149.3	755.3	2 146.0	269.0	721.0	150.0	432.2	145.2	73.7	41.0
Other separations	468.6	650.4	454.3	1 404.7	926.0	705.7	308.5	617.6	688.4	87.1	654.0
Output — non-admitted patients (number)											
Accident and emergency	15 318.7	2 633.2	22 628.9	41 053.1	9 925.5	24 900.1	1 815.9	15 620.7	51.6	5 035.8	–
Allied health and dental	11 529.6	600.0	12 092.6	39 191.3	692.4	15 679.7	29.9	9 041.1	1 151.5	2 037.4	290.1
Mental & alcohol services	5 883.8	12.1	16 960.1	21 748.2	30.3	9 316.0	–	4 680.4	10.8	333.9	8.1
Dialysis and endoscopy	118.1	381.4	101.6	585.9	1 642.1	35.4	56.3	22.5	5.8	3.9	–
Dist. nurs. and outreach	5 271.8	20.5	5 314.4	14 301.6	61.1	6 253.5	21.8	5 428.5	6.5	4 946.1	–
Pathology and radiology	26 262.3	3 611.3	30 749.6	106 901.6	15 933.1	31 461.7	67.6	10 759.5	71.0	2 495.7	43.4
Pharmacy	5 729.3	..	5 605.2	21 052.2	..	7 569.3	..	3 202.0	..	663.6	..
Other outpatients	25 332.1	289.0	31 635.4	103 191.1	286.7	29 027.6	396.3	11 201.2	399.2	2 468.8	42.4

(Continued next page)

Table 3.5 (continued)

	All hospital sizes			*Very large*		*Large*		*Medium*		*Small & very small*	
	Public	Private	Public contract	Public	Private	Public	Private	Public	Private	Public	Private
Inputs											
Nursing staff (no.)	233.8	147.5	338.3	874.3	357.4	288.8	157.1	143.4	77.6	35.2	35.3
Diag. & allied health staff (no.)	76.0	8.1	114.5	310.6	21.4	88.4	4.6	36.2	4.8	6.2	3.2
Other non-medical staff (no.)	161.9	76.8	241.0	597.5	195.7	193.4	74.8	104.2	38.6	27.2	18.1
Staffed beds (no.)[b]	122.6	118.1	180.0	429.2	260.0	158.7	119.8	90.5	73.9	23.7	42.7
Drug costs ($'000)	3 049.0	1 215.5	5 782.9	13 132.7	2 977.9	3 051.1	1 349.0	1 258.9	637.8	174.1	210.3
Other hospital costs ($'000)	7 781.2	11 68.6	15 222.2	28 494.5	28 806.1	9 728.1	11 835.8	4 842.8	5 327.5	1 331.4	2 232.5
Medical & surgical supplies cost ($'000)	5 357.6	3 088.7	8 513.2	21 948.5	7 624.2	6 454.8	3 704.3	2 666.3	1 400.1	355.7	525.2
Partial productivity measures											
Casemix-adj. seps. per non-medical staff member (no.)	23.7	64.7	65.9	25.9	67.1	27.9	65.4	26.5	66.0	21.0	60.1
Occupancy rate (%)	69.3	77.5	82.3	96.7	95.0	87.4	77.4	80.5	74.6	54.5	64.9
Number of observations	**1354**	**389**	**63**	**252**	**87**	**155**	**85**	**167**	**np**	**780**	**np**

[a] Sample refers to all the acute hospitals included in the Commission's analysis. Data disaggregated by size excludes public contract hospitals due to ABS confidentiality requirements. Private hospital data disaggregated by size refers to both for-profit and not-for-profit hospitals. [b] Public hospital beds are reported staffed beds and private and public contract hospital beds are estimated staffed beds. **np** Not published due to ABS confidentiality concerns. **..** Not applicable. – Nil or rounded to zero.

Source: Productivity Commission estimates based on unpublished ABS and AIHW data

Public hospitals treat a relatively larger proportion of patients aged less than 20 years, while private hospitals treat a relatively larger proportion of patients aged 20 to 69 years.

Output measures

On average, public hospitals report a lower volume of casemix-adjusted separations than private or public contract hospitals. The extent of variation among public hospitals, however, is much larger than the variation among private hospitals in the sample. Public contract hospitals report higher average volumes of activity than all other hospitals included in the sample.

Emergency department services are concentrated in the public hospital sector, and a similar pattern of activity is observed for outpatient services. A high volume of outpatient service activity, on par with public hospitals, is reported for public contract hospitals.

Input measures

The average public contract hospital employs more nursing, diagnostic and allied health and more other staff than the average public and private hospitals. Compared to public hospitals, private hospitals in the sample employ fewer nurses, diagnostic and allied health and fewer other staff. Very large and large public and private hospitals recorded higher costs than smaller hospitals, across all cost types.

Partial productivity measures

The number of separations per non-medical staff member and separations per bed are higher among private hospitals than among public hospitals. This differential is consistent across all hospital sizes and also applies to private hospitals. For these partial productivity measures, the public contract hospitals in the sample generally report rates that are higher than public hospitals yet lower than other private hospitals.

Occupancy rates of 95 per cent or more were reported for very large public and private hospitals. Large, small and very small private hospitals had higher occupancy rates than public hospitals, while the reverse was true in medium hospitals. Public contract hospitals had higher overall occupancy rates than both public and private hospitals, on average.