5 Technical efficiency

Key points

- The Commission measured hospital technical efficiency in terms of:
  - output orientation — how well a hospital maximises output from its given resources
  - input orientation — how well a hospital economises on resources to produce a given output level.
- Subject to data limitations outlined in chapter 3, hospitals are estimated to have the potential to increase their output by almost 10 per cent based on their current level of input use, under the output-orientation approach.
  - Public contract hospitals are the most efficient, followed, in order, by for-profit private hospitals, public hospitals and not-for-profit private hospitals.
  - These relative rankings are statistically significant and generally stable across different hospital sizes.
- The efficiency of public hospital tends to be higher among the larger hospitals. The efficiency of private hospitals shows not discernibly change with hospital size.
- Hospitals have the potential to reduce their input use by just over 10 per cent, based on their current level of output, under the input-orientation method.
  - Public contract hospitals are the most efficient. Differences between the other hospitals are not statistically significant.
- Hospitals with higher than expected hospital-standardised mortality ratios (HSMRs) (that is, poorer quality) are estimated to be less productive and more resource intensive than hospitals with lower than expected HSMRs (that is, higher quality).

Building on the explanation of modelling methods given in chapter 2 and the description of the dataset presented in chapter 3, this chapter presents the results of the estimated distance functions and technical efficiency scores of hospitals in Australia. A summary of the Commission's approach is outlined in section 5.1. The coefficient results of the models are presented in section 5.2. The technical efficiency scores are reported and discussed in section 5.3.

5.1 Summary of Commission's approach

The Commission used stochastic frontier analysis (SFA) to estimate the output-oriented and input-oriented technical efficiency of hospitals in Australia.

The variables used to explain efficiency include:

- hospital outputs
- hospital inputs
- quality of outputs
- patient risk characteristics
- hospital characteristics.

The rationale for the inclusion of these variables is described in chapter 2 and appendix C. A description of the available data, summary statistics, and expected signs of the coefficients is given in chapter 3. To recap the Commission's approach, the estimated models are based on the following specifications:

- data for the years 2003-04 to 2006-07 pooled into a single cross section
- weighted dataset to represent the true population
- translog functional form
- variable returns-to-scale
- a half-normal distribution for the efficiency term.

Data limitations

As noted in chapter 3, data are available for the number of medical staff in public hospitals, but not for medical staff in private hospitals and doctors exercising their private practice rights in public hospitals. To ensure comparability between public and private hospitals, the analysis therefore excludes all medical staff. There are also limitations to the availability of data for hospital capital. In the analysis, capital is measured by the number of staffed beds and a set of binary variables which indicate the presence of particular facilities in a hospital. Future analysis would benefit from attempts to include the effects of medical staff on hospital efficiency, as well as more detailed estimates of capital usage in hospitals.

5.2 Estimation results

The first step in the analysis is to determine the best-practice frontier for each hospital. The 'frontier' can be interpreted as the optimal level of productivity or the level of resource intensity that is *expected* of a hospital, given its characteristics. The coefficients, therefore, show how a particular characteristic influences a

hospital's expected productivity (in the output-oriented model) or expected resource-intensity (in the input-oriented model). In effect, the coefficients show by how much and in what direction a variable shifts a hospital's best-practice frontier (see box 5.1).

Box 5.1 Coefficients in the distance function

The sign and magnitude of the coefficients of a distance function indicate how each variable affects a hospital's distance to the frontier (chapter 2; appendix C).

While distance can be considered synonymous with inefficiency, there is not a simple linear relationship between distance and efficiency, because efficiency is also determined by the relative distances of other hospitals and the assumed distribution of efficiency term.

Since, as a computational convention, distance functions are estimated using either an output or an input as a dependent variable, it is sometimes easier to conceptualise the coefficients of variables as representing *shifts* of the frontier relative to a hospital's position.

Additionally, the dependent variables for the output and input-distance functions are inverted, as is common practice in this field of analysis (chapter 3). The effect of this is to change the interpretation of the respective signs of the coefficients, as explained in this section.

The expected signs of the coefficients were discussed in chapter 3. In brief, the sign of:

- each output is expected to be negative (positive) in the output (input) oriented distance function
- each input is expected to be positive (negative) in the output (input) oriented distance function
- hospital quality is expected to be negative (positive) in the output (input) oriented distance function
- each patient and hospital characteristic is expected to be negative (positive) in the output (input) oriented distance function, where these characteristics are associated with a reduction in a hospital's expected productivity (an increase in a hospital's expected input use).[1]

For both model orientations, the squared terms show the rate at which the impact of a particular variable can vary over its range. The second-order terms (the output and

1 Assuming the dependent variable has been inverted.

input cross-terms) are more complex to interpret but are included to refine the fit of the overall model.

With respect to the quality variables, it should be noted that these coefficients do not necessarily reflect any causal link between hospital quality and efficiency. Rather, they are used to capture any systematic correlation between these two indicators of performance.

Ownership variables

The ownership variables are not included in the frontier equation, because the analysis is not intended to control for differences by ownership when determining the best-practice frontiers. Rather, the ownership variables are regressed against the inefficiency error term, in order to identify which hospitals are further away from their respective benchmarking frontier, where this distance represents the extent of their technical inefficiency. A positively-signed ownership coefficient would indicate that a hospital with that ownership status is further away from its frontier. That is, the hospital is further from its maximum level of output capacity (in the output-oriented model) or minimum level of resource use (in the input-oriented model). The significance level of the coefficients verifies whether any differences in efficiency between hospitals, according to their ownership type, are statistically significant or not (appendix C).

Reported results

The following tables present the estimated coefficient results of the output-oriented model (table 5.1) and the input-oriented model (table 5.2). The significance of the coefficients are found to differ, to some degree, according to the model orientation. This reveals that an analysis of hospitals' technical efficiency needs to acknowledge whether hospitals can — in practice — gain efficiency by expanding their output (as per the output-oriented model) or by economising on inputs (as per the input-oriented model).

Table 5.1 **Coefficient estimates — output-oriented distance function[a]**

	Coefficient	*Standard error*	*z-value*
Frontier equation			
Outputs			
Acute separations	-0.4682 ***	0.0155	-30.21
Acute separations — squared	-0.0174 ***	0.0019	-8.95
Pregnancy & neonate separations	-0.0916 ***	0.0116	-7.90
Pregnancy & neonate separations — squared	-0.0422 ***	0.0060	-7.01
Mental & alcohol separations	-0.0576 ***	0.0076	-7.60
Mental & alcohol separations — squared	-0.0052 **	0.0023	-2.29
Other separations	-0.0841 ***	0.0080	-10.49
Other separations — squared	-0.0359 ***	0.0030	-12.05
Accident & emergency occasions of services	-0.0568 ***	0.0185	-3.08
Accident & emergency occasions of service — squared	-0.0196 **	0.0090	-2.17
Pathology & radiology occasions of service	-0.0229 *	0.0138	-1.66
Pathology & radiology occasions of service — squared	-0.0168 ***	0.0054	-3.09
Dialysis & endoscopy occasions of service	-0.0077	0.0159	-0.49
Dialysis & endoscopy occasions of service — squared	-0.0027 **	0.0013	-2.05
Allied health & dental occasions of service	-0.0187	0.0119	-1.57
Allied health & dental occasions of service — squared	0.0051	0.0046	1.11
Mental, alcohol & psychiatric occasions of services	-0.0168	0.0121	-1.39
Mental, alcohol & psychiatric occasions of services — squared	-0.0012	0.0014	-0.80
Inputs			
Nursing staff	0.1393 ***	0.0227	6.13
Nursing staff — squared	0.0483	0.0580	0.83
Diagnostic & allied health staff	0.0067	0.0104	0.65
Diagnostic & allied health staff — squared	0.0063	0.0075	0.83
Drug costs	0.1404 ***	0.0155	9.06
Drug costs — squared	0.0985 ***	0.0214	4.59
Supplies costs	0.1041 ***	0.0164	6.35
Supplies costs — squared	0.0535	0.0430	1.24
Other costs	0.0533 ***	0.0141	3.79
Other costs — squared	0.0804 ***	0.0249	3.23
Beds	0.2573 ***	0.0168	15.35
Beds — squared	-0.0154	0.0260	-0.59
Quality indicator			
HSMR	-0.0323 ***	0.0123	-2.62
HSMR — squared	0.0047	0.0033	1.45
Outputs — cross terms			
Acute seps × Preg & neo seps	0.0205 *	0.0115	1.78
Acute seps × Mental & alc seps	0.0381 ***	0.0064	5.95
Acute seps × Other seps	0.0731 ***	0.0072	10.21
Acute seps × Acc & emerg sv	0.0151 ***	0.0053	2.86
Acute seps × Path & rad sv	0.0141	0.0098	1.44
Acute seps × Dial & endo sv	0.0080	0.0073	1.10
Acute seps × Allied & dental sv	0.0049	0.0040	1.21

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Table 5.1 (continued)

	Coefficient	*Standard error*	*z-value*
Acute seps × Mental, alc & psych sv	-0.0412 ***	0.0025	-16.48
Preg & neo seps × Mental & alc seps	0.0091 ***	0.0029	3.13
Preg & neo seps × Other seps	-0.0033	0.0045	-0.74
Preg & neo seps × Acc & emerg sv	0.0072	0.0060	1.20
Preg & neo seps × Path & rad sv	-0.0280 ***	0.0069	-4.07
Preg & neo seps × Dial & endo sv	-0.0055	0.0038	-1.45
Preg & neo seps × Allied health & dent sv	0.0045	0.0062	0.72
Preg & neo seps × Mental, alc & psych sv	0.0039	0.0043	0.90
Mental & alc seps × Other seps	-0.0182 ***	0.0035	-5.22
Mental & alc seps × Acc & emerg sv	0.0073 *	0.0038	1.90
Mental & alc seps × Path & rad sv	-0.0013	0.0049	-0.26
Mental & alc seps × Dial & endo sv	-0.0074 **	0.0031	-2.40
Mental & alc seps × Allied health & dent sv	-0.0060	0.0045	-1.34
Mental & alc seps × Mental & alc & psych sv	0.0015	0.0041	0.37
Other seps × Acc & emerg sv	0.0194 ***	0.0050	3.88
Other seps × Path & rad sv	-0.0097 *	0.0058	-1.66
Other seps × Dial & endo sv	0.0048	0.0052	0.94
Other seps × Allied health & dent sv	-0.0015	0.0040	-0.38
Other seps × Mental, alc & psych sv	0.0024	0.0048	0.50
Acc & emerg sv × Path & rad sv	0.0126 **	0.0059	2.14
Acc & emerg sv × Dial & endo sv	0.0000	0.0089	0.00
Acc & emerg sv × Allied health & dent sv	-0.0126 **	0.0059	-2.12
Acc & emerg sv × Mental, alc & psych sv	0.0002	0.0066	0.02
Path & rad sv × Dial & endo sv	-0.0012	0.0059	-0.20
Path & rad sv × Allied health & dent sv	0.0046	0.0055	0.85
Path & rad sv × Mental, alc & psych sv	0.0039	0.0055	0.72
Dial & endo sv × Allied health & dent sv	-0.0040	0.0049	-0.81
Dial & endo sv × Mental, alc & psych sv	0.0027	0.0029	0.93
Allied health & dent sv × Mental, alc & psych sv	-0.0003	0.0045	-0.07
Inputs — cross terms			
Nursing staff × Diag & allied health staff	-0.0683 **	0.0341	-2.00
Nursing staff × Drug cost	0.0282	0.0728	0.39
Nursing staff × Supplies cost	0.0235	0.0796	0.29
Nursing staff × Other cost	-0.0420	0.0560	-0.75
Nursing staff × Beds	-0.0031	0.0491	-0.06
Diag & allied health staff × Drug cost	-0.0003	0.0243	-0.01
Diag & allied health staff × Supplies cost	-0.0380	0.0295	-1.28
Diag & allied health staff × Other cost	0.0615 **	0.0257	2.39
Diag & allied health staff × Beds	0.0107	0.0224	0.48
Drug cost × Supplies cost	-0.2191 ***	0.0467	-4.69
Drug cost × Other cost	-0.0095	0.0468	-0.20
Drug cost × Beds	-0.0303	0.0595	-0.51
Supplies cost × Other cost	-0.0829	0.0538	-1.54
Supplies cost × Beds	0.1282 **	0.0590	2.17

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Table 5.1 (continued)

	Coefficient	*Standard error*	*z-value*
Other costs × Beds	-0.0847 **	0.0333	-2.55
Outputs & inputs — cross terms			
Acute seps × Nursing staff	-0.0525 ***	0.0197	-2.66
Acute seps × Diag & allied health staff	-0.0107	0.0078	-1.37
Acute seps × Drug costs	-0.0241 *	0.0146	-1.65
Acute seps × Supplies costs	0.0388 ***	0.0082	4.75
Acute seps × Other costs	0.0150	0.0095	1.58
Acute seps × Beds	0.0225	0.0159	1.41
Preg & neo seps × Nursing staff	-0.0029	0.0239	-0.12
Preg & neo seps × Diag & allied health staff	-0.0066	0.0068	-0.97
Preg & neo seps × Drug costs	0.0273	0.0184	1.48
Preg & neo seps × Supplies costs	0.0048	0.0224	0.21
Preg & neo seps × Other costs	-0.0221	0.0135	-1.64
Preg & neo seps × Beds	-0.0170	0.0179	-0.95
Mental & alc seps × Nursing staff	-0.0050	0.0175	-0.29
Mental & alc seps × Diag & allied health staff	0.0133 **	0.0061	2.17
Mental & alc seps × Drug costs	-0.0414 ***	0.0148	-2.80
Mental & alc seps × Supplies costs	0.0385 ***	0.0134	2.87
Mental & alc seps × Other costs	-0.0129	0.0127	-1.01
Mental & alc seps × Beds	-0.0036	0.0151	-0.24
Other seps × Nursing staff	0.0121	0.0208	0.58
Other seps × Diag & allied health staff	0.0099	0.0077	1.28
Other seps × Drug costs	0.0135	0.0166	0.81
Other seps × Supplies costs	-0.0183	0.0148	-1.24
Other seps × Other costs	-0.0420 ***	0.0134	-3.13
Other seps × Beds	0.0262	0.0163	1.61
Acc & emerg sv × Nursing staff	0.0303	0.0258	1.18
Acc & emerg sv × Diag & allied health staff	-0.0099	0.0081	-1.23
Acc & emerg sv × Drug costs	0.0490 ***	0.0169	2.90
Acc & emerg sv × Supplies costs	0.0378 **	0.0164	2.31
Acc & emerg sv × Other costs	0.0005	0.0146	0.03
Acc & emerg sv × Beds	-0.0873 ***	0.0211	-4.14
Path & rad sv × Nursing staff	0.0942 ***	0.0274	3.44
Path & rad sv × Diag & allied health staff	-0.0279 ***	0.0102	-2.73
Path & rad sv × Drug costs	-0.0420 *	0.0217	-1.94
Path & rad sv × Supplies costs	-0.0071	0.0211	-0.34
Path & rad sv × Other costs	-0.0327 **	0.0167	-1.96
Path & rad sv × Beds	0.0189	0.0205	0.92
Dial & endo sv × Nursing staff	-0.0385	0.0382	-1.01
Dial & endo sv × Diag & allied health staff	0.0054	0.0136	0.39
Dial & endo sv × Drug costs	-0.0102	0.0184	-0.56
Dial & endo sv × Supplies costs	0.0106	0.0171	0.62
Dial & endo sv × Other costs	0.0236 **	0.0100	2.36
Dial & endo sv × Beds	0.0268	0.0270	0.99
Allied health & dent sv × Nursing staff	0.0407 *	0.0237	1.71

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Table 5.1 (continued)

	Coefficient	*Standard error*	*z-value*
Allied health & dent sv × Diag & allied health staff	0.0230 ***	0.0087	2.64
Allied health & dent sv × Drug costs	-0.0459 ***	0.0179	-2.57
Allied health & dent sv × Supplies costs	-0.0154	0.0195	-0.79
Allied health & dent sv × Other costs	0.0459 ***	0.0155	2.95
Allied health & dent sv × Beds	-0.0552 ***	0.0176	-3.14
Mental, alc & psych sv × Nursing staff	-0.0230	0.0258	-0.89
Mental, alc & psych sv × Diag & allied health staff	-0.0103	0.0110	-0.93
Mental, alc & psych sv × Drug costs	0.0112	0.0193	0.58
Mental, alc & psych sv × Supplies costs	0.0258 *	0.0137	1.88
Mental, alc & psych sv × Other costs	0.0205	0.0147	1.39
Mental, alc & psych sv × Beds	-0.0170	0.0197	-0.86
Quality indicator — cross terms			
HSMR × Acute seps	-0.0134 ***	0.0046	-2.94
HSMR × Preg & neo seps	-0.0092	0.0072	-1.28
HSMR × Mental & alc seps	0.0136 ***	0.0051	2.66
HSMR × Other seps	0.0159 **	0.0068	2.34
HSMR × Acc & emerg sv	0.0047	0.0096	0.48
HSMR × Path & rad sv	-0.0218 *	0.0112	-1.95
HSMR × Dial & endo sv	-0.0146	0.0116	-1.26
HSMR × Allied health & dent sv	0.0051	0.0106	0.48
HSMR × Mental & alc sv	0.0075	0.0079	0.95
Patient characteristics[b]			
Share of patients aged <1 year	-0.0056 **	0.0028	-2.00
Share of patients aged 1-4 years	0.0088 ***	0.0033	2.68
Share of patients aged 5-19 years	-0.0045 *	0.0025	-1.79
Share of patients aged 60-69 years	0.0014	0.0010	1.45
Share of patients aged 70+ years	-0.0022 ***	0.0004	-5.79
Share of patients from SEIFA 1	0.0000	0.0002	-0.19
Share of patients from SEIFA 2	-0.0002	0.0002	-0.99
Share of patients from SEIFA 3	0.0003	0.0002	1.55
Share of patients from SEIFA 4	-0.0002	0.0003	-0.71
Share of patients with Charlson score 2	-0.0007 *	0.0004	-1.80
Share of patients with Charlson score 3	-0.0070 ***	0.0024	-2.97
Share of patients with Charlson score 4	-0.0024 ***	0.0009	-2.61
Share of patients with Charlson score 5	-0.0016	0.0010	-1.59
Share of patients with Charlson score 6+	0.0289 ***	0.0082	3.54
Establishment characteristics[c]			
Located in major city	0.0259 **	0.0103	2.52
Located in outer regional area	-0.0494 ***	0.0091	-5.41
Located in remote area	-0.1468 ***	0.0173	-8.48
Located in very remote area	-0.2353 ***	0.0196	-11.98
Surgical & other DRG separations	0.0010 ***	0.0004	2.66
Public patients	0.0006 **	0.0003	2.11

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Table 5.1 (continued)

	Coefficient	*Standard error*	*z-value*
Teaching hospital	0.0198 **	0.0093	2.13
Member of hospital network	0.0161	0.0138	1.17
High-level intensive care unit	-0.0209 **	0.0095	-2.20
Palliative care unit	0.0223 **	0.0094	2.38
Rehabilitation unit	0.0104	0.0088	1.18
Domiciliary care unit	-0.0051	0.0075	-0.68
Evans and Walker Index 2	0.3532 ***	0.0334	10.56
State or Territory[d]			
New South Wales	-0.0557 ***	0.0121	-4.60
Victoria	-0.0600 ***	0.0127	-4.71
South Australia	-0.0088	0.0201	-0.44
Western Australia	-0.0134	0.0169	-0.80
Tasmania	0.1953 ***	0.0249	7.84
Northern Territory	-0.0707 **	0.0307	-2.30
ACT	-0.0235	0.0262	-0.90
Year[e]			
2004-05	-0.0196 ***	0.0076	-2.57
2005-06	-0.0242 ***	0.0073	-3.33
2006-07	-0.0223 ***	0.0084	-2.65
Constant	0.1901 ***	0.0482	3.94
Inefficiency equation			
Ownership[f]			
Private (vs. Public & Contracted)	np ***	np	3.84
For-profit (vs. Not-for-profit)	np ***	np	-5.64
Contracted (vs. Not contracted)	np ***	np	-3.06
ln σ^2_u	np ***	np	-27.90
ln σ^2_v	np ***	np	-27.05
Model criteria			
Log likelihood (pseudo)	2 319.98		
Akaike Information Criterion (AIC)	-4 237.97		
Bayesian Information Criterion (BIC)	-3 132.70		
Degrees of freedom	1 605		
Number of observations	1 806		

a Data for 2003-04 to 2006-07, weighted by sample representation. Output and input variables are logged, mean-centred and normalised. Dummy variables for zero values included in regression but not reported. The model applies a half-normal distribution to the efficiency equation. **b** Base categories are: share of patients aged 20-59 years; share of patients from SEIFA 5 (least disadvantaged); share of patients with Charlson score 1 or below (fewest comorbidities). **c** Base category is inner regional area. **d** Base jurisdiction is Queensland. **e** Base year is 2003-04. **f** Due to their confidentiality restrictions, the coefficient terms for ln σ^2_v and ln σ^2_u were suppressed by the ABS because these values would enable the calculation of efficiency scores for individual hospitals or hospital groups. The ABS also deemed it necessary to suppress the coefficient terms and standard errors of the ownership dummy variables. Significance levels denoted as: * 10%; ** 5%; *** 1%. Standard errors are robust due to the sample weighting. **seps**: number of separations. **sv**: number of occasions of service. **np** Not available for publication due to ABS confidentiality concerns.

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

Table 5.2 **Coefficient estimates — input-oriented distance function[a]**

	Coefficient	*Standard error*	*z-value*
Frontier equation			
Outputs			
Acute separations	0.7880 ***	0.0274	28.77
Acute separations — squared	0.0585 ***	0.0067	8.72
Pregnancy & neonate separations	0.1717 ***	0.0138	12.42
Pregnancy & neonate separations — squared	0.1091 ***	0.0097	11.24
Mental & alcohol separations	0.0772 ***	0.0086	8.99
Mental & alcohol separations — squared	0.0242 ***	0.0055	4.38
Other separations	0.1158 ***	0.0079	14.61
Other separations — squared	0.0856 ***	0.0075	11.47
Accident & emergency occasions of services	0.0245	0.0245	1.00
Accident & emergency occasions of services — squared	0.1232 ***	0.0320	3.85
Pathology & radiology occasions of services	0.0253	0.0217	1.17
Pathology & radiology occasions of services — squared	0.0297 *	0.0180	1.65
Allied health & dental occasions of services	0.0517 ***	0.0185	2.79
Allied health & dental occasions of services — squared	-0.0141	0.0187	-0.76
Mental, alcohol & psychiatric occasions of services	0.0200	0.0243	0.82
Mental, alcohol & psychiatric occasions of services — squared	0.0091	0.0102	0.89
MDC 1 separations	0.0340 *	0.0203	1.68
MDC 1 separations — squared	-0.0255 **	0.0123	-2.08
Inputs			
Nursing staff	-0.0366 ***	0.0111	-3.28
Nursing staff — squared	0.0132 ***	0.0046	2.85
Drug costs	-0.0549 ***	0.0152	-3.61
Drug costs — squared	-0.0280 ***	0.0051	-5.54
Supplies costs	-0.0369 ***	0.0134	-2.75
Supplies costs — squared	0.0078	0.0095	0.82
Other costs	-0.0105	0.0120	-0.88
Other costs — squared	0.0021	0.0035	0.59
Quality indicator			
HSMR	0.0772 ***	0.0139	5.54
HSMR — squared	-0.0139 ***	0.0039	-3.59
Outputs — cross terms			
Acute seps × Preg & neo seps	-0.0816 ***	0.0249	-3.28
Acute seps × Mental & alc seps	0.0346 *	0.0186	1.87
Acute seps × Other seps	-0.0539 **	0.0215	-2.51
Acute seps × Acc & emerg sv	0.0197	0.0122	1.61
Acute seps × Path & rad sv	-0.0341 *	0.0193	-1.77
Acute seps × Allied health & dent sv	-0.0127	0.0148	-0.86
Acute seps × Mental, alc & psych sv	0.0373 ***	0.0106	3.53
Acute seps × MDC 1 seps	-0.0305 ***	0.0073	-4.20
Preg & neo seps × Mental & alc seps	-0.0230 ***	0.0090	-2.57
Preg & neo seps × Other seps	-0.0156 **	0.0066	-2.37
Preg & neo seps × Acc & emerg sv	0.0238 ***	0.0089	2.68

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Table 5.2 (continued)

	Coefficient	*Standard error*	*z-value*
Preg & neo seps × Dial & endo sv	0.0063	0.0081	0.78
Preg & neo seps × Allied health & dent sv	0.0061	0.0074	0.83
Preg & neo seps × Other outpatient sv	-0.0490 ***	0.0127	-3.85
Preg & neo seps × MDC 1 seps	0.0036	0.0108	0.33
Mental & alc seps × Other seps	-0.0140 *	0.0083	-1.69
Mental & alc seps × Acc & emerg sv	0.0032	0.0102	0.32
Mental & alc seps × Dial & endo sv	0.0040	0.0103	0.39
Mental & alc seps × Allied health & dent sv	-0.0028	0.0085	-0.33
Mental & alc seps × Other outpatient sv	0.0149	0.0153	0.97
Mental & alc seps × MDC 1 seps	-0.0061	0.0095	-0.64
Other seps × Acc & emerg sv	0.0633 ***	0.0115	5.49
Other seps × Dial & endo sv	-0.0230 *	0.0131	-1.75
Other seps × Allied health & dent sv	-0.0340 ***	0.0097	-3.51
Other seps × MDC 1 seps	0.0119	0.0106	1.12
Acc & emerg sv × Dial & endo sv	-0.0304 ***	0.0117	-2.61
Acc & emerg sv × Allied health & dent sv	-0.0256	0.0158	-1.62
Acc & emerg sv × Other outpatient sv	0.0303 ***	0.0116	2.62
Path & rad sv × Dial & endo sv	0.0023	0.0065	0.36
Path & rad sv × Allied health & dent sv	-0.0009	0.0059	-0.15
Path & rad sv × Other outpatient sv	-0.0801 ***	0.0172	-4.66
Allied health & dent sv × Mental, alc & psych sv	0.0101	0.0067	1.51
Allied health & dent sv × MDC 1 seps	-0.0018	0.0162	-0.11
Inputs — cross terms			
Nursing staff × Drug cost	0.0282 ***	0.0097	2.89
Nursing staff × Supplies cost	-0.0305 ***	0.0100	-3.05
Nursing staff × Other cost	-0.0062	0.0058	-1.07
Drug cost × Supplies cost	-0.0459 ***	0.0106	-4.33
Drug cost × Other cost	-0.0043	0.0084	-0.51
Supplies cost × Other cost	0.0388 ***	0.0098	3.97
Outputs & inputs — cross terms			
Acute seps × Nursing staff	0.0860 ***	0.0128	6.71
Acute seps × Other staff	0.0890 ***	0.0157	5.67
Acute seps × Drug costs	0.0189 **	0.0084	2.25
Acute seps × Supplies costs	-0.0547 ***	0.0116	-4.71
Preg & neo seps × Nursing staff	-0.0112	0.0090	-1.25
Preg & neo seps × Other staff	0.0304 ***	0.0110	2.77
Preg & neo seps × Drug costs	-0.0254 *	0.0138	-1.84
Preg & neo seps × Supplies costs	0.0248 ***	0.0081	3.08
Mental & alc seps × Nursing staff	0.0074	0.0092	0.80
Mental & alc seps × Other staff	-0.0180	0.0113	-1.59
Mental & alc seps × Drug costs	0.0019	0.0126	0.15
Mental & alc seps × Supplies costs	-0.0170 **	0.0075	-2.26
Other seps × Nursing staff	0.0207 **	0.0101	2.06
Other seps × Other staff	-0.0512 ***	0.0130	-3.95
Other seps × Drug costs	-0.0034	0.0127	-0.27
Other seps × Supplies costs	0.0176 **	0.0077	2.28

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Table 5.2 (continued)

	Coefficient	*Standard error*	*z-value*
Acc & emerg sv × Nursing staff	0.0079	0.0084	0.95
Acc & emerg sv × Other staff	-0.0275 ***	0.0099	-2.78
Acc & emerg sv × Drug costs	-0.0115	0.0101	-1.14
Acc & emerg sv × Supplies costs	0.0157 **	0.0066	2.37
Path & rad sv × Nursing staff	-0.0115	0.0104	-1.11
Path & rad sv × Other staff	0.0024	0.0102	0.24
Path & rad sv × Drug costs	0.0237 **	0.0117	2.04
Path & rad sv × Supplies costs	0.0054	0.0082	0.66
Allied health & dent sv × Nursing staff	0.0098	0.0106	0.92
Allied health & dent sv × Other staff	0.0302 **	0.0119	2.53
Allied health & dent sv × Drug costs	0.0101	0.0102	0.99
Allied health & dent sv × Supplies costs	-0.0248 ***	0.0078	-3.18
Mental, alc & psych sv × Nursing staff	-0.0283 ***	0.0110	-2.58
Mental, alc & psych sv × Other staff	0.0134	0.0086	1.55
Mental, alc & psych sv × Drug costs	-0.0188 **	0.0082	-2.29
Mental, alc & psych sv × Supplies costs	0.0077	0.0070	1.10
MDC 1 seps × Nursing staff	-0.0511 ***	0.0136	-3.74
MDC 1 seps × Drug costs	0.0311	0.0239	1.30
MDC 1 seps × Supplies costs	0.0496 **	0.0235	2.11
MDC 1 seps × Other costs	-0.0180	0.0128	-1.40
Quality indicator — cross terms			
HSMR × Nursing staff	0.0147 *	0.0080	1.84
HSMR × Drug costs	0.0236 *	0.0129	1.83
HSMR × Supplies costs	-0.0046	0.0103	-0.44
HSMR × Other costs	0.0078	0.0082	0.95
Patient characteristics[b]			
Share of patients aged <1 year	0.0050 **	0.0024	2.08
Share of patients aged 1-4 years	-0.0088 **	0.0038	-2.33
Share of patients aged 5-19 years	0.0023	0.0031	0.75
Share of patients aged 60-69 years	-0.0009	0.0011	-0.80
Share of patients aged 70+ years	0.0028 ***	0.0004	6.23
Share of patients from SEIFA 1	0.0002	0.0003	0.66
Share of patients from SEIFA 2	0.0001	0.0003	0.27
Share of patients from SEIFA 3	-0.0003	0.0003	-1.14
Share of patients from SEIFA 4	-0.0001	0.0003	-0.30
Share of patients with Charlson score 2	0.0012 ***	0.0003	3.43
Share of patients with Charlson score 3	0.0000	0.0024	0.00
Share of patients with Charlson score 4	0.0005	0.0013	0.41
Share of patients with Charlson score 5	0.0005	0.0010	0.52
Share of patients with Charlson score 6+	-0.0291 ***	0.0076	-3.82
Establishment characteristics[c]			
Located in major city	0.0713 ***	0.0130	5.49
Located in outer regional area	-0.0082	0.0108	-0.75
Located in remote area	0.0075	0.0212	0.35

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Table 5.2 (continued)

	Coefficient	*Standard error*	*z-value*
Located in very remote area	0.0309	0.0269	1.15
Surgical & other DRG separations	-0.0023 ***	0.0005	-5.00
Public patients	-0.0009 **	0.0004	-2.05
Teaching hospital	0.0042	0.0106	0.40
Member of hospital network	-0.0431 ***	0.0150	-2.87
High-level intensive care unit	-0.0046	0.0124	-0.38
Palliative care unit	-0.0095	0.0082	-1.16
Rehabilitation unit	0.0044	0.0092	0.47
Domiciliary care unit	0.0032	0.0083	0.39
Evans and Walker Index 2	0.1441 ***	0.0400	3.61
State or Territory[d]			
New South Wales	0.0636 ***	0.0147	4.33
Victoria	0.0761 ***	0.0161	4.73
South Australia	0.0048	0.0173	0.28
Western Australia	-0.0078	0.0172	-0.46
Tasmania	0.0913 ***	0.0260	3.51
Northern Territory	0.0090	0.0297	0.30
ACT	0.1521 ***	0.0251	6.06
Year[e]			
2004-05	-0.0186 **	0.0084	-2.21
2005-06	-0.0226 ***	0.0084	-2.71
2006-07	-0.0212 **	0.0090	-2.37
Constant	-0.5567 ***	0.0765	-7.27
Inefficiency equation			
Ownership[f]			
Private (vs. Public & Contracted)	np	np	-0.24
For-profit (vs. Not-for-profit)	np	np	-0.62
Contracted (vs. Not contracted)	np ***	np	-4.85
ln σ^2_u	np ***	np	-22.67
ln σ^2_v	np ***	np	-22.67
Model criteria			
Log likelihood (pseudo)	2 156.08		
Akaike Information Criterion (AIC)	-3 984.16		
Bayesian Information Criterion (BIC)	-3 082.34		
Degrees of freedom	1 642		
Number of observations	1 806		

a Data for 2003-04 to 2006-07, weighted by sample representation. Output and input variables are logged, mean-centred and normalised. Dummy variables for zero values included in regression but not reported. The model applies a half-normal distribution to the efficiency equation. **b** Base categories are: share of patients aged 20-59 years; share of patients from SEIFA 5 (least disadvantaged); share of patients with Charlson score 1 or below (fewest comorbidities). **c** Base category is inner regional area. **d** Base jurisdiction is Queensland. **e** Base year is 2003-04. **f** Due to their confidentiality restrictions, the coefficient terms for ln σ^2_v and ln σ^2_u were suppressed by the ABS because these values would enable the calculation of efficiency scores for individual hospitals or hospital groups. The ABS also deemed it necessary to suppress the coefficient terms and standard errors of the ownership dummy variables. Significance levels denoted as: * 10%; ** 5%; *** 1%. Standard errors are robust due to the sample weighting. **seps**: number of separations. **sv**: number of occasions of service. **np** Not available for publication due to ABS confidentiality concerns.

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

Based on preliminary regressions, output and input variables that generated incorrectly-signed coefficients were omitted from the final models reported in the tables. These variables were: district nursing and outreach services, other outpatient services and other staff (in both the output- and input-oriented models), and dialysis and endoscopy services, and diagnostic and allied health staff (in the input-oriented model only).

To test the model's sensitivity to the choice of the half-normal distribution for the inefficiency error term, the model is also estimated with an exponential distribution. The results are presented and briefly discussed in appendix D.

Factors affecting technical efficiency

The most important output that influences a hospital's productivity and resource intensity is the volume of acute separations provided, followed by pregnancy and neonate, mental and alcohol, and other separations. Services to non-admitted patients are found to have less impact. Of these, accident and emergency services are the most important in the output-oriented model, while allied health and dental services are of most importance in the input-oriented model.

The inputs that have the greatest impact on a hospital's productivity include the number of staffed beds, the number of nursing staff and expenditure on drugs. Resource intensity is most greatly affected by expenditure on other items, although the overall importance of the input variables is less profound in the input-oriented model.

Hospitals' mortality ratios prove to be significant in both model orientations, particularly the output-oriented model. This confirms that hospitals which have higher than expected mortality rates are estimated to be relatively less productive for their given input level, and also more resource intensive for their given output level.

Patient and hospital characteristics

When it is assumed that hospitals aim to maximise output from their given resources (as per the output-oriented model), hospitals are expected to be more productive if they:

- treat proportionally fewer patients who are very old (aged over 70) or very young (neonate age or aged 5 to 19), but more patients aged 1 to 4 years

- treat proportionally fewer patients of slightly higher comorbidity (Charlson score 2 to 4, compared to Charlson score 1 or below) but only up to a threshold: hospitals that treat proportionally more patients of highest comorbidity (Charlson score 6) are also expected to be relatively more productive.
- are located in or relatively closer to a major city
- undertake proportionally more surgical or other DRG separations and fewer medical separations
- treat proportionally more public patients
- have university-affiliated teaching status
- have a palliative care unit
- do not have a high-level intensive care unit
- treat relatively more complicated cases for their establishment size (as measured by the Evans and Walker index).

Factors which have no significant impact on expected productivity are: patients' socio-economic status (as represented by SEIFA); the presence of a rehabilitation unit or domiciliary care unit; and whether or not the hospital belongs to a network.

When it is assumed that hospitals aim to minimise their input use to produce a given level of output (as per the input-oriented model), hospitals are expected to be less resource intensive if they:

- treat proportionally fewer patients who are very old (aged over 70) or very young (neonate age), and more patients aged 1 to 4
- treat proportionally fewer patients of slightly higher comorbidity (Charlson score 2 to 4, compared to Charlson 1 or below) but only up to a threshold: hospitals which treat more patients of highest comorbidity (Charlson score 6) are also found to be relatively less resource intense.
- are located outside of a major city
- undertake proportionally more surgical or other DRG separations and fewer medical separations
- treat proportionally more public patients
- belong to a hospital network
- treat relatively more complicated cases for their establishment size (as measured by the Evans and Walker index).

Factors which do not have a significant impact on expected resource intensity are: patients' socioeconomic status (as represented by SEIFA); teaching status; and

specialist units (high-level intensive care, palliative care, rehabilitation and domiciliary care).

Note that state and territory dummy variables are used to control for jurisdiction-specific factors, such as differences in data reporting methods or regulatory settings, and should not be interpreted as indicators of the relative efficiency between the jurisdictions. Similarly, the year dummy variables are included to control for time-specific variations in the data that cannot be captured by the observed variables, and should not necessarily be interpreted as a time-dependent trend in hospital efficiency.

Hospital ownership

The significance of the ownership dummy variables differed depending on the model orientation. All ownership variables were found to be statistically significant in the output-oriented model, whereas only the dummy variable for public contract hospitals was significant in the input-oriented model. The interpretation of these variables and their significance is discussed in the next section.

The value of the ownership coefficients could not be published due to confidentiality requirements for private hospital data.[2] However, the signs of the coefficients, and the magnitude of the significance levels, can still be used to explain the respective rankings of the different hospital groups. For example, the terms of the output-oriented model show that private hospitals are collectively less efficient than public and contracted hospitals. However, they also show that the difference between for-profit and not-for-profit private hospitals is sufficiently large that for-profit private hospitals are more efficient than public hospitals, while not-for-profit hospitals are less so. The relativities between the four hospital groups are illustrated more precisely by the value of the efficiency scores themselves, as discussed in the next section.

2 Due to confidentiality restrictions, the coefficients of the terms σ^2_u and σ^2_v were suppressed by the ABS because it was reasoned that these terms would enable the efficiency scores of individual hospitals or hospital groups in the private sector to be calculated. The ABS also deemed it necessary to suppress the coefficient values and standard errors of the ownership dummy variables.

5.3 Technical efficiency scores

The technical efficiency scores of the output-oriented and input-oriented models are reported in table 5.3 according to hospital ownership, and further disaggregated by hospital size in table 5.4. An averaged measure of efficiency scores generated by both models (averaged at the individual observation level) is also reported.

Table 5.3 **Technical efficiency scores by hospital ownership**

	Public	*Private*			*Public contract*	*All hospitals*
		Not-for-profit	*For-profit*	*All*		
Output-oriented						
Mean	89.1	85.6	94.8	92.6	92.4	90.0
Median	90.6	90.1	95.4	94.8	93.0	91.8
5th percentile	75.6	62.0	89.9	82.9	85.5	76.6
95th percentile	97.0	96.8	97.7	97.6	97.2	97.2
Input-oriented						
Mean	89.1	90.2	91.8	91.4	93.6	89.8
Median	90.8	91.8	93.1	92.6	94.0	91.4
5th percentile	76.3	78.6	83.8	83.2	90.4	77.4
95th percentile	96.6	96.3	96.8	96.7	96.0	96.6
Averaged						
Mean	89.1	87.9	93.3	92.0	93.0	89.9
Median	90.4	90.5	93.9	93.7	93.3	91.2
5th percentile	77.7	77.6	88.2	84.2	89.4	78.6
95th percentile	96.2	96.1	96.9	96.7	96.4	96.4
No. observations	1354	94	295	389	63	1806

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

How to interpret the efficiency scores

Computationally, the technical efficiency scores relate to the distance of a hospital's current production point from its respective benchmarking frontier. The exact interpretation is specific to the model orientation. For the output-oriented model, the efficiency scores measure the volume of output that a hospital is currently producing, relative to the maximum volume it could potentially produce from its current inputs. For example, an output-oriented efficiency score of 90 per cent would mean that a hospital is producing 90 per cent of its full output potential. This could be interpreted to mean that the hospital is producing at 10 per cent below its

maximum capacity, or that it has the potential to increase its current output level by 11 per cent without needing to increase its resources.[3]

For the input-oriented model, the efficiency scores represent the percentage by which a hospital exceeds the minimum volume of inputs required to produce its current output level. As is standard practice in stochastic frontier analysis, the reported scores for the input-oriented model are inverted for comparability with the output-oriented scores and also for the calculation of the averaged scores. For example, an estimated input-oriented efficiency score of 125 per cent is inverted to give a score of 80 per cent. This means that the hospital can reduce its input use by 20 per cent and still produce the same volume of output.[4]

Comparisons across all hospitals

Based on the averaged efficiency scores, hospitals in Australia are performing at around 90 per cent of maximum efficiency (table 5.3). The similarity of the output-oriented and input-oriented scores across all hospitals suggests that Australian hospitals are generally equally as efficient at maximising production from their given inputs, as they are at economising in input use. On average, the most efficient hospitals are for-profit private hospitals, followed closely by public contract hospitals, and then public and not-for-profit private hospitals.

When hospitals are assessed according to how well they maximise production from their inputs, the most efficient hospitals are for-profit private hospitals (94.8 per cent), followed by public contract hospitals (92.4 per cent), public hospitals (89.1 per cent) and not-for-profit private hospitals (85.6 per cent). The differences between all of these hospital groups are found to be statistically significant.

When hospitals are assessed according to how well they economise on inputs to produce their output, the most efficient hospitals are found to be public contract hospitals (93.6 per cent), followed by for-profit private hospitals (91.8 per cent), not-for-profit private hospitals (90.2 per cent) and public hospitals (89.1 per cent). However, only the difference between public contract hospitals above all other hospitals is deemed statistically significant. This means that public, for-profit private and not-for-profit private hospitals perform equally well as each other in terms of economising on input use. As can be seen, the gap between their efficiency

3 Computed as (100 – 90) / 90 = 11.

4 Computed as (125 – 100) / 125 = 20.

scores narrows substantially under this model orientation compared to the output-oriented results.

Comparisons of the output-oriented and input-oriented efficiency scores highlight further differences by hospital ownership. The greatest gap in efficiency scores is observed among not-for-profit hospitals, which are found to be more efficient at economising on inputs rather than expanding production. By a smaller margin, the same can be said for public contract hospitals. In contrast, for-profit private hospitals are found to be better, on average, at expanding production rather than economising on inputs, while public hospitals are found to be equally as efficient according to these two performance measures.

As noted in chapter 2, it was expected that the input-oriented model would favour public hospitals, while the output-oriented model would favour private hospitals. This does not mean that the efficiency scores of public hospitals should be higher under the input-oriented model rather than under the output-oriented model. It also does not necessarily mean that public hospitals should be ranked higher than private hospitals under the input-oriented model, while the rankings should reverse under the output-oriented model. Rather, the effect of the model orientation is shown in the margin of difference between the public and private efficiency scores: under the output-oriented model, private hospitals are more efficient than public hospitals by 3.5 percentage points, yet this difference closes to 2.3 percentage points under the input-oriented model.

The gap between for-profit and not-for-profit private hospitals is also found to depend greatly on the model orientation, increasing to around 9 percentage points in the output-oriented model, while falling to less than 2 percentage points in the input-oriented model. These observations highlight the need to consider both forms of model orientation in order to avoid biasing the results based on the assumption made about hospitals' production behaviour.

Of course, when making these assessments about hospital performance within the bounds of the models' assumptions, it is acknowledged that a hospital's efficiency score is not only reflective of their own production decisions, but also the environment in which they are operating and any external limitations potentially placed on their capacity to expand production or reduce resources.

Comparisons by hospital size

Levels of efficiency, as well as the relativities between types of hospital ownership, are found to vary by hospital size (table 5.4).

Table 5.4 **Technical efficiency scores by hospital ownership and size**

	Public	*Private*			*Public contract*	*All hospitals*
		Not-for-profit	*For-profit*	*All*		
***Very small*[a]**						
Output-oriented						
Mean	87.5	88.0	94.2	89.9	np	87.6
Median	89.3	93.0	95.0	94.9	np	89.6
5th percentile	71.5	64.5	88.9	62.0	np	71.3
95th percentile	97.3	96.2	95.9	95.9	np	97.2
Input-oriented						
Mean	89.0	92.7	92.5	92.9	np	89.1
Median	90.5	94.1	92.8	93.5	np	90.6
5th percentile	75.0	83.3	87.3	87.3	np	75.5
95th percentile	97.1	96.0	96.1	96.1	np	97.0
Averaged						
Mean	88.2	90.4	93.3	91.4	np	88.3
Median	89.4	92.5	93.9	93.0	np	89.7
5th percentile	74.8	79.1	89.1	77.6	np	74.9
95th percentile	96.6	96.1	96.0	96.0	np	96.5
No. observations	558	20	np	np	np	581
***Small*[a]**						
Output-oriented						
Mean	89.7	88.0	94.9	94.2	np	90.8
Median	90.4	93.0	95.7	95.1	np	92.1
5th percentile	79.9	64.5	90.0	88.9	np	80.6
95th percentile	96.6	96.2	97.5	97.2	np	97.1
Input-oriented						
Mean	88.5	92.7	92.9	92.8	np	89.6
Median	90.5	94.1	93.6	93.8	np	91.8
5th percentile	74.1	83.3	85.9	85.4	np	75.8
95th percentile	96.0	96.0	96.9	96.8	np	96.2
Averaged						
Mean	89.1	90.4	93.9	93.5	np	90.2
Median	90.0	92.5	94.7	94.2	np	91.1
5th percentile	80.1	79.1	88.5	87.8	np	80.4
95th percentile	95.7	96.1	96.9	96.8	np	96.5
No. observations	222	20	np	np	np	295

Continued next page

Table 5.4 (continued)

	Public	Private			Public contract	All hospitals
		Not-for-profit	For-profit	All		
Medium						
Output-oriented						
Mean	89.5	77.9	94.8	91.8	np	90.5
Median	90.5	91.8	95.3	94.9	np	92.7
5th percentile	80.4	17.6	89.9	85.3	np	80.5
95th percentile	96.9	96.8	97.7	97.7	np	97.5
Input-oriented						
Mean	88.5	87.9	91.2	90.6	np	89.5
Median	89.9	91.5	91.7	91.7	np	90.8
5th percentile	76.5	70.8	84.4	80.1	np	77.9
95th percentile	95.8	96.4	96.7	96.7	np	96.4
Averaged						
Mean	89.0	82.9	93.0	91.2	np	90.0
Median	89.4	91.0	93.5	93.4	np	91.1
5th percentile	80.9	44.2	88.5	85.2	np	80.9
95th percentile	95.9	96.4	97.0	96.8	np	96.5
No. observations	167	22	np	np	np	295
Large						
Output-oriented						
Mean	90.1	88.1	94.2	93.0	93.1	91.4
Median	91.5	87.9	94.5	94.4	94.1	93.0
5th percentile	77.7	75.3	89.4	83.2	88.3	80.4
95th percentile	96.7	98.2	97.5	97.5	98.0	97.3
Input-oriented						
Mean	89.6	88.2	90.7	90.2	93.3	90.3
Median	91.2	89.5	92.2	91.5	93.2	91.9
5th percentile	77.6	77.2	83.0	80.1	90.4	78.7
95th percentile	95.7	95.7	96.6	96.3	96.5	96.1
Averaged						
Mean	89.8	88.2	92.5	91.6	93.2	90.8
Median	91.5	88.1	93.7	92.5	93.2	92.2
5th percentile	78.5	77.6	87.6	84.2	90.0	81.2
95th percentile	95.9	96.9	96.1	96.1	96.7	96.1
No. observations	155	17	68	85	39	279

Continued next page

Table 5.4 (continued)

	Public	Private			Public contract	All hospitals
		Not-for-profit	For-profit	All		
Very large						
Output-oriented						
Mean	91.4	87.8	95.7	92.5	90.7	91.6
Median	92.0	88.3	96.2	94.9	91.3	92.6
5th percentile	84.1	76.7	92.4	78.6	84.6	83.1
95th percentile	96.7	96.2	97.8	97.7	95.4	97.0
Input-oriented						
Mean	90.1	91.2	93.1	92.4	94.6	90.8
Median	91.3	91.6	94.2	93.6	95.1	92.0
5th percentile	79.7	83.8	83.8	83.8	88.5	80.6
95th percentile	96.5	96.4	97.2	96.8	97.3	96.5
Averaged						
Mean	90.7	89.5	94.4	92.4	92.7	91.2
Median	91.4	90.6	94.8	93.9	93.3	91.9
5th percentile	83.3	80.6	88.2	83.8	87.5	83.7
95th percentile	96.2	94.8	97.2	96.9	96.1	96.3
No. observations	252	35	52	87	17	356

a The small and very small size categories are aggregated for not-for-profit private hospitals due to ABS confidentiality restrictions. Therefore, the same aggregated figures are tabulated for these two categories. **np** Not available for publication due to ABS confidentiality restrictions.

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

In terms of output-oriented technical efficiency, across all size categories, for-profit hospitals (94.8 per cent) perform better than all other hospitals, while not-for-profit hospitals (85.6 per cent) have the greatest scope for improvement. However, the extent of these differences varies, to some degree, according to hospital size. For instance, the gap between for-profit private hospitals and public hospitals is 4.1 percentage points among large hospitals, but widens to 6.6 percentage points among very small hospitals.

Although the output-oriented efficiency scores are fairly stable across hospital sizes among the for-profit hospitals, the efficiency of smaller public hospitals is noticeably lower than that of larger public hospitals. One possible explanation is that smaller public hospitals are operating at lower levels of occupancy rates — arising from the combination of the minimum sizes with which hospitals operate and the relatively low numbers of patients treated in more remote communities.

The output-oriented technical efficiency of medium not-for-profit private hospitals (77.9 per cent) is also noticeably lower than that of all hospitals (90.5 per cent).

Given that there are comparatively few observations in this sample, this result is likely to reflect an outlier observation.

In terms of input-oriented technical efficiency, not-for-profit hospitals are found to outperform both for-profit and public hospitals in the small and very small size categories, as well as public hospitals in the very large size category. While these differences cannot be deemed statistically significant, these comparisons suggest that it is at these sizes of operation that not-for-profit private hospitals can demonstrate their relatively greater input resourcefulness.

The degree of dispersion in efficiency scores — as measured by the 5th and 95th percentiles — also varies by hospital size. In particular, the efficiency scores of the smaller public and not-for-profit hospitals are more dispersed than those of larger hospitals. For example, the efficiency scores of very small public hospitals range from 71.5 to 97.3 per cent, while those of very large public hospitals range from 84.1 to 96.7 per cent. These differences may suggest that smaller public hospitals are more heterogeneous than larger hospitals.[5] That is to say, it is less likely that any two public hospitals of very small size are alike, so their comparative performances are more likely to differ than those of two larger hospitals. This type of variation may have not been captured adequately in the model.

The Commission sought to test whether the observed patterns in efficiency scores were related to the extent to which a hospital can specialise in its services. For example, the finding that small for-profit hospitals are more efficient than small public hospitals may be due to the opportunity for smaller private hospitals to specialise in a narrower range of services. The Commission ran correlation tests between hospitals' efficiency scores and their degree of specialisation. (Specialisation was measured by the share of a hospital's total volume of admitted patient separations that was concentrated in the five most frequent types of services, as defined by major diagnostic categories). There were no consistent findings to support a trend between specialisation and efficiency, although it is possible that this result may reflect this measure of specialisation itself. Results are reported in appendix D.

Correlation between output-oriented and input-oriented efficiency scores

The Commission undertook correlation tests of output and input-oriented technical efficiency scores to examine whether or not hospitals that perform well in terms of maximising output also perform well in terms of economising on resource use

[5] Medium-sized not-for-profit hospitals also stand out for having highly dispersed efficiency scores, but this may be due to outlier effects, as noted earlier.

(table 5.5). A correlation value closer to positive one indicates a greater degree of similarity between a hospital's output- and input-oriented efficiency scores, while a value closer to negative one indicates greater divergence. Values closer to zero indicate that there is little similarity between a hospital's two efficiency scores.

Table 5.5 **Correlation between output and input-oriented efficiency scores**

	Public	*Private*			*Public contract*	*All hospitals*
		Not-for-profit	*For-profit*	*All*		
Very small	0.585	0.126[a]	0.304	-0.168	np	0.569
Small	0.322		0.690	0.664	np	0.416
Medium	0.335	0.868	0.557	0.685	np	0.507
Large	0.571	0.638	0.476	0.532	0.397	0.560
Very large	0.337	0.301	0.531	0.382	0.493	0.336
All hospitals	0.486	0.683	0.550	0.539	0.412	0.500

a Small and very small size categories are aggregated for not-for-profit private hospitals due to ABS confidentiality requirements. **np** Not published due to ABS confidentiality restrictions. Number of observations corresponds to the preceding data reported in tables 5.3 and 5.4.

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

Across all sizes, private hospitals show a higher degree of correlation between their output and input-oriented efficiency scores compared to public hospitals and contracted hospitals. This suggests that private hospitals are more capable of both expanding output while also economising on inputs, compared to other hospital groups. There is, however, wide variation by hospital size. In particular, not-for-profit private hospitals show the greatest degree of correlation in the medium size category (0.868), yet also the weakest degree of correlation in the small and very small size category (0.126).

The negative correlation value for very small private hospitals suggests that, on average, those small private hospitals which are generally better at maximising output are worse at economising on inputs (and vice versa). This link, however, is relatively weak and may be distorted by the pooling of the not-for-profit and for-profit categories.

With the exception of medium-sized not-for-profit private hospitals, no hospital group demonstrates a strong correlation score (very close to one). This suggests that hospitals which perform the best in terms of maximising output are generally unlikely to be the best at economising on inputs too (and vice versa). This lack of correlation highlights the need to independently consider both forms of model

orientation when assessing hospital performance, as well as the limitations of relying on averaged scores.