

D Additional results

D.1 Hospital mortality — negative binomial results

The negative binomial model presented in chapter 4 was also run with the inclusion of hospital ownership variables so as to assess whether hospital ownership has a statistically significant effect on expected mortality rates. Incidence rate ratios from this model specification are presented below in table D.1.

Given the wide variation in mortality observed in very small, small and medium-sized hospitals, the negative binomial regression was also conducted with a sample restricted to large and very large hospitals. Incidence rate ratios for both model specifications are also included in table D.1.

Table D.1 Alternative hospital mortality models^a
Incidence rate ratios

<i>Variables</i>	<i>All hospitals</i>		<i>Very large and large hospitals</i>	
	<i>Standard specification</i>	<i>Incl. ownership variables</i>	<i>Standard specification</i>	<i>Incl. ownership variables</i>
Age <1 yr	0.992 (0.020)	0.993 (0.019)	0.978 (0.017)	0.980 (0.017)
Age 1-4	1.006 (0.016)	1.007 (0.015)	0.990 (0.019)	0.992 (0.019)
Age 5-19	0.969 (0.011)	0.969 (0.011)	0.971 (0.016)	0.966 (0.016)
Age 60-69	0.990 (0.006)	0.992 (0.006)	0.990 (0.012)	0.987 (0.012)
Age >70	1.014 (0.004)	1.017 (0.004)	1.003 (0.005)	1.005 (0.005)
Female (%)	0.999 (0.005)	1.000 (0.004)	0.999 (0.007)	0.993 (0.007)
Indigenous status (%)	0.994 (0.002)	0.995 (0.002)	0.989 (0.004)	0.989 (0.004)
2 < Charlson < 3	1.000 (0.002)	1.000 (0.003)	1.006 (0.003)	1.007 (0.003)
3 < Charlson < 4	1.003 (0.012)	1.000 (0.011)	0.987 (0.026)	0.985 (0.025)
4 < Charlson < 5	0.994 (0.004)	0.990 (0.005)	1.003 (0.009)	1.003 (0.010)
5 < Charlson < 6	1.003 (0.006)	1.006 (0.006)	1.011 (0.013)	1.011 (0.013)
Charlson > 6	1.131 (0.048)	1.105 (0.043)	1.012 (0.053)	0.988 (0.049)
ALOS (medical)	1.156 (0.025)	1.144 (0.022)	1.259 (0.048)	1.253 (0.047)
ALOS (surgical)	0.989 (0.006)	0.990 (0.005)	0.892 (0.031)	0.891 (0.031)
ALOS (other)	1.000 (0.005)	0.999 (0.004)	0.921 (0.037)	0.926 (0.038)
Eye diseases and disorders	1.013 (0.006)	1.003 (0.006)	0.994 (0.012)	0.991 (0.013)
Ear, nose, mouth and throat diseases and disorders	1.003 (0.009)	1.002 (0.009)	0.995 (0.017)	0.994 (0.018)

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Table D.1 (continued)

Variables	<i>All hospitals</i>				<i>Very large and large hospitals</i>			
	Standard specification		Incl. ownership variables		Standard specification		Incl. ownership variables	
Respiratory diseases and disorders	1.038	(0.009)	1.033	(0.009)	1.020	(0.015)	1.023	(0.014)
Circulatory diseases and disorders	1.023	(0.005)	1.021	(0.005)	1.006	(0.007)	1.007	(0.007)
Digestive diseases and disorders	1.049	(0.007)	1.050	(0.008)	1.047	(0.011)	1.042	(0.011)
Hepatobiliary and pancreatic diseases and disorders	1.017	(0.016)	0.999	(0.016)	1.017	(0.024)	1.020	(0.025)
Musculoskeletal and connective tissue diseases and disorders	1.023	(0.005)	1.021	(0.005)	0.998	(0.008)	1.000	(0.008)
Skin, subcutaneous tissue and breast diseases and disorders	1.009	(0.010)	1.008	(0.009)	1.004	(0.013)	1.009	(0.014)
Endocrine, nutritional and metabolic diseases and disorders	0.993	(0.014)	0.998	(0.014)	0.983	(0.031)	0.993	(0.034)
Kidney and urinary tract diseases and disorders	1.009	(0.011)	1.001	(0.011)	1.023	(0.023)	1.019	(0.021)
Male reproductive diseases and disorders	0.996	(0.019)	1.012	(0.019)	1.006	(0.040)	0.995	(0.040)
Female reproductive diseases and disorders	1.027	(0.008)	1.022	(0.008)	1.033	(0.015)	1.039	(0.016)
Pregnancy, childbirth and the puerperium	1.014	(0.006)	1.009	(0.006)	0.964	(0.011)	0.969	(0.012)
Newborns and other neonates	1.017	(0.013)	1.013	(0.012)	1.019	(0.017)	1.019	(0.017)
Diseases and disorders of blood, blood forming organs, immunological disorders	0.989	(0.020)	0.976	(0.018)	1.054	(0.042)	1.066	(0.044)
Neoplastic disorders	1.017	(0.009)	1.013	(0.009)	0.983	(0.014)	0.982	(0.014)
Infectious and parasitic diseases	1.014	(0.019)	1.008	(0.018)	1.031	(0.045)	1.039	(0.045)
Mental diseases and disorders	1.015	(0.008)	1.010	(0.007)	0.984	(0.008)	0.983	(0.008)
Drug and alcohol related diseases	0.952	(0.026)	0.961	(0.023)	1.009	(0.024)	1.019	(0.027)
Injuries, poisoning and effects of drugs	0.998	(0.015)	0.994	(0.014)	1.017	(0.025)	1.019	(0.025)
Burns	1.032	(0.050)	1.014	(0.046)	1.038	(0.043)	1.036	(0.046)
Factors influencing health status	1.008	(0.005)	1.006	(0.005)	1.000	(0.012)	1.003	(0.013)
SEIFA 1	1.005	(0.001)	1.005	(0.001)	1.002	(0.002)	1.002	(0.002)
SEIFA 2	1.004	(0.001)	1.004	(0.001)	1.001	(0.002)	1.002	(0.001)
SEIFA 3	1.005	(0.001)	1.005	(0.001)	1.002	(0.001)	1.003	(0.001)
SEIFA 4	1.005	(0.002)	1.005	(0.002)	0.999	(0.002)	1.000	(0.002)
Surgery/other (% of seps.)	0.978	(0.003)	0.981	(0.003)	0.965	(0.005)	0.966	(0.005)
Ratio of emerg. visits to seps.	1.000	(0.009)	0.997	(0.009)	1.020	(0.056)	1.020	(0.053)
Transfers from other hospital (% of admissions)	0.976	(0.006)	0.975	(0.006)	0.992	(0.007)	0.996	(0.007)
Transfers to other hospital (% seps.)	1.006	(0.004)	1.003	(0.004)	0.992	(0.008)	0.993	(0.008)
Sameday (% of seps.)	1.003	(0.002)	1.003	(0.002)	0.986	(0.004)	0.986	(0.004)
Top five MDCs (% of seps.)	0.977	(0.004)	0.980	(0.004)	0.993	(0.006)	0.992	(0.006)
Recognised teaching hospital	0.990	(0.054)	0.964	(0.053)	1.006	(0.048)	1.027	(0.051)
Neonatal intensive care unit	1.048	(0.088)	1.033	(0.084)	1.122	(0.107)	1.126	(0.107)
Obstetric unit	0.920	(0.047)	0.955	(0.051)	1.145	(0.091)	1.158	(0.094)
Intensive care unit	1.053	(0.055)	1.040	(0.056)	1.008	(0.051)	1.021	(0.050)

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Table D.1 (continued)

<i>Variables</i>	<i>All hospitals</i>		<i>Very large and large hospitals</i>	
	<i>Standard specification</i>	<i>Incl. ownership variables</i>	<i>Standard specification</i>	<i>Incl. ownership variables</i>
Coronary care unit	1.010 (0.075)	1.053 (0.084)	1.028 (0.074)	1.023 (0.076)
Palliative care unit	1.253 (0.063)	1.241 (0.059)	1.196 (0.079)	1.209 (0.081)
Domiciliary care unit	0.997 (0.032)	0.922 (0.031)	0.973 (0.048)	0.964 (0.050)
Rehabilitation unit	0.924 (0.035)	0.908 (0.035)	0.859 (0.040)	0.863 (0.041)
Evans & Walker 2 (x 100)	1.002 (0.001)	1.002 (0.001)	1.002 (0.002)	1.001 (0.002)
Large hospital	1.181 (0.074)	1.159 (0.073)		
Medium hospital	1.221 (0.112)	1.201 (0.109)		
Small or very small hospital	1.638 (0.194)	1.577 (0.178)		
For-profit		0.627 (0.063)		0.917 (0.113)
Not-for-profit		0.660 (0.082)		1.228 (0.156)
Public contract		0.968 (0.095)		1.013 (0.088)
2005	0.967 (0.017)	0.971 (0.017)	0.920 (0.028)	0.935 (0.028)
2006	0.961 (0.020)	0.965 (0.020)	0.921 (0.034)	0.932 (0.033)
2007	0.958 (0.023)	0.960 (0.022)	0.897 (0.035)	0.910 (0.035)
Number of observations	1 806	1 806	635	635
Log likelihood (pseudo)	-8 020.06	-7 974.07	-3 451.96	-3 440.73
Akaike Information Criterion	16 168.11	16 082.14	7 025.93	7 009.47
Bayesian Information Criterion	16 520.04	16 450.57	7 297.60	7 294.50

^a Standard errors in parentheses.

Source: Productivity Commission estimates.

D.2 Technical efficiency — modelling sensitivity tests

In stochastic frontier analysis, the distribution of the error term can be specified as half normal, truncated normal or exponential. The choice of distribution does not affect the ranking of individual hospitals by efficiency score, although it can affect the magnitude of the efficiency scores themselves. The Commission's analysis (presented in chapters 5 and 6) applied a half normal distribution because it reflected the actual dispersion of the data more precisely than the alternative options. The exponential distribution was found to have the effect of unduly dispersing the efficiency scores too widely, while the truncated normal distribution could not produce a model that solved.

For comparison, the results of the output oriented and input oriented distance functions with the exponential error term are reported in tables D.2 and D.3 respectively. Correlation and rank tests were conducted to verify that the stability of the ordinal ranking of hospitals remained stable between the two different models.

Table D.2 Coefficient estimates — output-oriented distance function with normal–exponential error term^a

	<i>Coefficient</i>	<i>Standard error</i>	<i>z-value</i>
Frontier equation			
Outputs			
Acute separations	-0.4731 ***	0.0158	-29.97
Acute separations – squared	-0.0167 ***	0.0020	-8.20
Pregnancy & neonate separations	-0.0799 ***	0.0103	-7.73
Pregnancy & neonate separations – squared	-0.0350 ***	0.0040	-8.64
Mental & alcohol separations	-0.0614 ***	0.0074	-8.26
Mental & alcohol separations – squared	-0.0058 ***	0.0021	-2.74
Other separations	-0.0858 ***	0.0079	-10.92
Other separations – squared	-0.0361 ***	0.0031	-11.77
Accident & emergency occasions of services	-0.0800 ***	0.0188	-4.25
Accident & emergency occasions of service – squared	-0.0132	0.0107	-1.24
Pathology & radiology occasions of service	-0.0165	0.0129	-1.28
Pathology & radiology occasions of service – squared	-0.0121 **	0.0054	-2.26
Dialysis & endoscopy occasions of service	-0.0167	0.0202	-0.82
Dialysis & endoscopy occasions of service – squared	-0.0020	0.0013	-1.52
Allied health & dental occasions of service	-0.0142	0.0129	-1.10
Allied health & dental occasions of service – squared	0.0085	0.0053	1.59
Mental, alcohol & psychiatric occasions of services	-0.0200	0.0129	-1.55
Mental, alcohol & psychiatric occasions of services – squared	-0.0015	0.0015	-1.03
Inputs			
Nursing staff	0.1528 ***	0.0217	7.06
Nursing staff – squared	0.0014	0.0531	0.03
Diagnostic & allied health staff	0.0017	0.0104	0.16
Diagnostic & allied health staff – squared	0.0014	0.0067	0.21
Drug costs	0.1386 ***	0.0153	9.04
Drug costs – squared	0.1059 ***	0.0196	5.39
Supplies costs	0.0981 ***	0.0162	6.04
Supplies costs – squared	0.0682	0.0460	1.48
Other costs	0.0605 ***	0.0128	4.71
Other costs – squared	0.0796 ***	0.0238	3.35
Beds	0.2564 ***	0.0173	14.86
Beds – squared	-0.0010	0.0259	-0.04
Quality indicator			
HSMR	-0.0252 **	0.0123	-2.05
HSMR – squared	0.0034	0.0034	0.98
Outputs – cross terms			
Acute seps × Preg & neo seps	0.0102	0.0098	1.05
Acute seps × Mental & alc seps	0.0368 ***	0.0067	5.52
Acute seps × Other seps	0.0774 ***	0.0071	10.87
Acute seps × Acc & emerg sv	0.0144 ***	0.0055	2.61
Acute seps × Path & rad sv	0.0116	0.0096	1.20
Acute seps × Dial & endo sv	0.0015	0.0075	0.21

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Table D.2 (continued)

	<i>Coefficient</i>	<i>Standard error</i>	<i>z-value</i>
Acute seps × Allied & dental sv	0.0011	0.0043	0.25
Acute seps × Mental, alc & psych sv	-0.0396 ***	0.0027	-14.89
Preg & neo seps × Mental & alc seps	0.0084 ***	0.0030	2.84
Preg & neo seps × Other seps	-0.0053	0.0041	-1.27
Preg & neo seps × Acc & emerg sv	0.0020	0.0052	0.39
Preg & neo seps × Path & rad sv	-0.0244 ***	0.0065	-3.76
Preg & neo seps × Dial & endo sv	-0.0074	0.0046	-1.61
Preg & neo seps × Allied health & dent sv	0.0045	0.0064	0.70
Preg & neo seps × Mental, alc & psych sv	0.0067	0.0046	1.46
Mental & alc seps × Other seps	-0.0167 ***	0.0035	-4.72
Mental & alc seps × Acc & emerg sv	0.0088 **	0.0039	2.29
Mental & alc seps × Path & rad sv	0.0028	0.0047	0.60
Mental & alc seps × Dial & endo sv	-0.0061 ***	0.0022	-2.82
Mental & alc seps × Allied health & dent sv	-0.0053	0.0048	-1.10
Mental & alc seps × Mental & alc & psych sv	0.0002	0.0045	0.05
Other seps × Acc & emerg sv	0.0225 ***	0.0050	4.54
Other seps × Path & rad sv	-0.0141 **	0.0055	-2.54
Other seps × Dial & endo sv	0.0085	0.0056	1.51
Other seps × Allied health & dent sv	-0.0020	0.0044	-0.46
Other seps × Mental, alc & psych sv	0.0039	0.0051	0.76
Acc & emerg sv × Path & rad sv	0.0136 **	0.0055	2.49
Acc & emerg sv × Dial & endo sv	0.0088	0.0078	1.13
Acc & emerg sv × Allied health & dent sv	-0.0141 **	0.0066	-2.13
Acc & emerg sv × Mental, alc & psych sv	-0.0025	0.0071	-0.36
Path & rad sv × Dial & endo sv	-0.0069	0.0055	-1.24
Path & rad sv × Allied health & dent sv	0.0024	0.0057	0.43
Path & rad sv × Mental, alc & psych sv	0.0007	0.0050	0.13
Dial & endo sv × Allied health & dent sv	-0.0056	0.0065	-0.86
Dial & endo sv × Mental, alc & psych sv	0.0048	0.0040	1.19
Allied health & dent sv × Mental, alc & psych sv	-0.0002	0.0047	-0.04
Inputs – cross terms			
Nursing staff × Diag & allied health staff	-0.0440	0.0337	-1.31
Nursing staff × Drug cost	0.0791	0.0749	1.06
Nursing staff × Supplies cost	-0.0270	0.0986	-0.27
Nursing staff × Other cost	0.0055	0.0544	0.10
Nursing staff × Beds	0.0204	0.0525	0.39
Diag & allied health staff × Drug cost	-0.0069	0.0251	-0.28
Diag & allied health staff × Supplies cost	-0.0318	0.0305	-1.04
Diag & allied health staff × Other cost	0.0537 **	0.0240	2.24
Diag & allied health staff × Beds	0.0039	0.0231	0.17
Drug cost × Supplies cost	-0.1689 ***	0.0528	-3.20
Drug cost × Other cost	-0.0383	0.0492	-0.78
Drugs cost × Beds	-0.1107 *	0.0628	-1.76
Supplies cost Other cost	-0.1115 **	0.0445	-2.51

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Table D.2 (continued)

	<i>Coefficient</i>	<i>Standard error</i>	<i>z-value</i>
Supplies cost × Beds	0.1364 **	0.0629	2.17
Other costs × Beds	-0.0695 **	0.0319	-2.18
Outputs & inputs – cross terms			
Acute seps × Nursing staff	-0.0589 ***	0.0210	-2.80
Acute seps × Diag & allied health staff	-0.0082	0.0082	-1.00
Acute seps × Drug costs	-0.0261	0.0166	-1.57
Acute seps × Supplies costs	0.0420 ***	0.0089	4.71
Acute seps × Other costs	0.0117	0.0099	1.18
Acute seps × Beds	0.0248	0.0162	1.53
Preg & neo seps × Nursing staff	0.0015	0.0229	0.06
Preg & neo seps × Diag & allied health staff	-0.0073	0.0064	-1.14
Preg & neo seps × Drug costs	0.0278	0.0176	1.57
Preg & neo seps × Supplies costs	-0.0238	0.0183	-1.30
Preg & neo seps × Other costs	-0.0070	0.0117	-0.59
Preg & neo seps × Beds	-0.0057	0.0172	-0.33
Mental & alc seps × Nursing staff	-0.0091	0.0176	-0.51
Mental & alc seps × Diag & allied health staff	0.0109 *	0.0059	1.85
Mental & alc seps × Drug costs	-0.0473 ***	0.0144	-3.29
Mental & alc seps × Supplies costs	0.0396 ***	0.0139	2.86
Mental & alc seps × Other costs	-0.0001	0.0121	-0.01
Mental & alc seps × Beds	-0.0036	0.0155	-0.23
Other seps × Nursing staff	0.0071	0.0216	0.33
Other seps × Diag & allied health staff	0.0123	0.0078	1.57
Other seps × Drug costs	0.0189	0.0174	1.08
Other seps × Supplies costs	-0.0092	0.0139	-0.66
Other seps × Other costs	-0.0527 ***	0.0139	-3.79
Other seps × Beds	0.0274	0.0179	1.53
Acc & emerg sv × Nursing staff	0.0448 *	0.0254	1.77
Acc & emerg sv × Diag & allied health staff	-0.0110	0.0080	-1.38
Acc & emerg sv × Drug costs	0.0504 ***	0.0167	3.01
Acc & emerg sv × Supplies costs	0.0394 **	0.0172	2.28
Acc & emerg sv × Other costs	-0.0143	0.0129	-1.11
Acc & emerg sv × Beds	-0.0934 ***	0.0205	-4.56
Path & rad sv × Nursing staff	0.0632 **	0.0263	2.40
Path & rad sv × Diag & allied health staff	-0.0123	0.0093	-1.33
Path & rad sv × Drug costs	-0.0482 **	0.0217	-2.22
Path & rad sv × Supplies costs	-0.0023	0.0213	-0.11
Path & rad sv × Other costs	-0.0344 **	0.0157	-2.19
Path & rad sv × Beds	0.0405 **	0.0198	2.04
Dial & endo sv × Nursing staff	-0.0122	0.0345	-0.35
Dial & endo sv × Diag & allied health staff	-0.0108	0.0152	-0.71
Dial & endo sv × Drug costs	-0.0125	0.0177	-0.70
Dial & endo sv × Supplies costs	0.0168	0.0170	0.99
Dial & endo sv × Other costs	0.0205 *	0.0120	1.71
Dial & endo sv × Beds	0.0189	0.0271	0.70

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Table D.2 (continued)

	<i>Coefficient</i>	<i>Standard error</i>	<i>z-value</i>
Allied health & dent sv × Nursing staff	0.0474 *	0.0261	1.82
Allied health & dent sv × Diag & allied health staff	0.0176 **	0.0089	1.98
Allied health & dent sv × Drug costs	-0.0457 ***	0.0170	-2.68
Allied health & dent sv × Supplies costs	-0.0067	0.0212	-0.32
Allied health & dent sv × Other costs	0.0426 ***	0.0152	2.81
Allied health & dent sv × Beds	-0.0623 ***	0.0184	-3.39
Mental, alc & psych sv × Nursing staff	-0.0093	0.0255	-0.36
Mental, alc & psych sv × Diag & allied health staff	-0.0098	0.0108	-0.90
Mental, alc & psych sv × Drug costs	0.0225	0.0203	1.11
Mental, alc & psych sv × Supplies costs	0.0308 **	0.0156	1.97
Mental, alc & psych sv × Other costs	0.0161	0.0149	1.08
Mental, alc & psych sv × Beds	-0.0423 **	0.0209	-2.02
Quality indicator – cross terms			
HSMR × Acute seps	-0.0134 ***	0.0045	-2.98
HSMR × Preg & neo seps	-0.0109	0.0073	-1.49
HSMR × Mental & alc seps	0.0159 ***	0.0053	3.02
HSMR × Other seps	0.0180 ***	0.0068	2.65
HSMR × Acc & emerg sv	0.0124	0.0100	1.24
HSMR × Path & rad sv	-0.0296 ***	0.0108	-2.75
HSMR × Dial & endo sv	-0.0051	0.0146	-0.35
HSMR × Allied health & dent sv	0.0032	0.0109	0.29
HSMR × Mental & alc sv	0.0099	0.0086	1.14
Patient characteristics^b			
Share of patients aged <1 year	-0.0070 **	0.0028	-2.51
Share of patients aged 1-4 years	0.0079 **	0.0031	2.52
Share of patients aged 5-19 years	-0.0041 *	0.0024	-1.66
Share of patients aged 60-69 years	0.0005	0.0009	0.56
Share of patients aged 70+ years	-0.0023 ***	0.0004	-6.19
Share of patients from SEIFA 1	0.0001	0.0002	0.51
Share of patients from SEIFA 2	-0.0001	0.0002	-0.59
Share of patients from SEIFA 3	0.0004 **	0.0002	2.01
Share of patients from SEIFA 4	-0.0001	0.0002	-0.40
Share of patients with Charlson score 2	-0.0007 **	0.0003	-2.03
Share of patients with Charlson score 3	-0.0076 ***	0.0024	-3.13
Share of patients with Charlson score 4	-0.0019 **	0.0009	-2.06
Share of patients with Charlson score 5	-0.0015	0.0010	-1.49
Share of patients with Charlson score 6+	0.0267 ***	0.0079	3.36
Establishment characteristics^c			
Located in major city	0.0239 **	0.0094	2.55
Located in outer regional area	-0.0453 ***	0.0088	-5.14
Located in remote area	-0.1354 ***	0.0172	-7.90
Located in very remote area	-0.2184 ***	0.0195	-11.21
Surgical & other DRG separations	0.0006 *	0.0004	1.74
Public patients	0.0006 **	0.0003	1.97
Teaching hospital	0.0180 **	0.0090	1.99
Member of hospital network	0.0243 *	0.0144	1.69

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Table D.2 (continued)

	Coefficient	Standard error	z-value
High-level intensive care unit	-0.0219 **	0.0090	-2.44
Palliative care unit	0.0242 ***	0.0088	2.73
Rehabilitation unit	0.0158 **	0.0080	1.97
Domiciliary care unit	-0.0062	0.0074	-0.85
Evans and Walker Index 2	0.3313 ***	0.0335	9.89
State or Territory^d			
New South Wales	-0.0432 ***	0.0116	-3.72
Victoria	-0.0472 ***	0.0129	-3.67
South Australia	-0.0083	0.0190	-0.44
Western Australia	-0.0087	0.0162	-0.54
Tasmania	0.1813 ***	0.0237	7.64
Northern Territory	-0.0660 **	0.0272	-2.43
ACT	-0.0149	0.0238	-0.63
Year^e			
2004-05	-0.0209 ***	0.0073	-2.87
2005-06	-0.0244 ***	0.0069	-3.53
2006-07	-0.0211 ***	0.0080	-2.64
Constant	0.1723 ***	0.0493	3.50
Inefficiency equation			
Ownership^f			
Private (vs. Public & Contracted)	np **	np	1.96
For-profit (vs. Not-for-profit)	np ***	np	-4.66
Contracted (vs. Not contracted)	np ***	np	-3.25
$\ln \sigma_u^2$	np ***	np	-30.03
$\ln \sigma_v^2$	np ***	np	-37.43
Model criteria			
Log likelihood (pseudo)	2 458.34		
Akaike Information Criterion (AIC)	-4 514.68		
Bayesian Information Criterion (BIC)	-3 409.40		
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 an exponential distribution to the efficiency term. ^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 $\ln \sigma_v^2$ and $\ln \sigma_u^2$ 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 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 D.3 Coefficient estimates — input-oriented distance function with normal–exponential error term^a

	<i>Coefficient</i>	<i>Standard error</i>	<i>z-value</i>
Frontier equation			
Outputs			
Acute separations	0.8206 ***	0.0277	29.58
Acute separations – squared	0.0454 ***	0.0063	7.17
Pregnancy & neonate separations	0.1195 ***	0.0105	11.35
Pregnancy & neonate separations – squared	0.0735 ***	0.0083	8.88
Mental & alcohol separations	0.0841 ***	0.0077	10.87
Mental & alcohol separations – squared	0.0260 ***	0.0056	4.66
Other separations	0.1205 ***	0.0073	16.56
Other separations – squared	0.0939 ***	0.0068	13.87
Accident & emergency occasions of services	0.0126	0.0245	0.52
Accident & emergency occasions of services – squared	0.0935 ***	0.0307	3.04
Pathology & radiology occasions of services	0.0417 **	0.0207	2.02
Pathology & radiology occasions of services – squared	0.0475 ***	0.0169	2.82
Allied health & dental occasions of services	0.0441 ***	0.0168	2.62
Allied health & dental occasions of services – squared	0.0026	0.0161	0.16
Mental, alcohol & psychiatric occasions of services	0.0340	0.0231	1.47
Mental, alcohol & psychiatric occasions of services – squared	0.0020	0.0100	0.20
MDC 1 separations	0.0394 **	0.0178	2.22
MDC 1 separations – squared	-0.0259**	0.0108	-2.41
Inputs			
Nursing staff	-0.0203 **	0.0099	-2.04
Nursing staff – squared	0.0113 ***	0.0043	2.61
Drug costs	-0.0398 ***	0.0140	-2.85
Drug costs – squared	-0.0303 ***	0.0045	-6.67
Supplies costs	-0.0331 ***	0.0124	-2.66
Supplies costs – squared	-0.0030	0.0076	-0.39
Other costs	-0.0303 ***	0.0096	-3.17
Other costs – squared	0.0001	0.0033	0.02
Outputs – cross terms			
Acute seps × Preg & neo seps	-0.0005	0.0210	-0.03
Acute seps × Mental & alc seps	0.0129	0.0154	0.84
Acute seps × Other seps	-0.1557 ***	0.0245	-6.35
Acute seps × Acc & emerg sv	0.0203 *	0.0118	1.72
Acute seps × Path & rad sv	-0.0716 ***	0.0234	-3.06
Acute seps × Allied health & dent sv	-0.0293 **	0.0146	-2.00
Acute seps × Mental, alc & psych sv	0.0596 ***	0.0096	6.20
Acute seps × MDC 1 seps	-0.0199 ***	0.0068	-2.92
Preg & neo seps × Mental & alc seps	-0.0117	0.0080	-1.47
Preg & neo seps × Other seps	-0.0099	0.0068	-1.46
Preg & neo seps × Acc & emerg sv	0.0189 **	0.0079	2.40
Preg & neo seps × Dial & endo sv	0.0049	0.0073	0.67
Preg & neo seps × Allied health & dent sv	-0.0073	0.0066	-1.11
Preg & neo seps × Other outpatient sv	-0.0800 ***	0.0129	-6.19

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Table D.3 (continued)

	<i>Coefficient</i>	<i>Standard error</i>	<i>z-value</i>
Preg & neo seps × MDC 1 seps	-0.0046	0.0102	-0.46
Mental & alc seps × Other seps	-0.0069	0.0089	-0.78
Mental & alc seps × Acc & emerg sv	0.0017	0.0098	0.17
Mental & alc seps × Dial & endo sv	-0.0020	0.0105	-0.19
Mental & alc seps × Allied health & dent sv	-0.0027	0.0084	-0.33
Mental & alc seps × Other outpatient sv	0.0280 **	0.0132	2.12
Mental & alc seps × MDC 1 seps	-0.0054	0.0095	-0.57
Other seps × Acc & emerg sv	0.0426 ***	0.0111	3.85
Other seps × Dial & endo sv	-0.0103	0.0129	-0.79
Other seps × Allied health & dent sv	-0.0204 **	0.0089	-2.29
Other seps × MDC 1 seps	-0.0050	0.0109	-0.45
Acc & emerg sv × Dial & endo sv	-0.0180 *	0.0106	-1.69
Acc & emerg sv × Allied health & dent sv	-0.0191	0.0154	-1.24
Acc & emerg sv × Other outpatient sv	0.0187	0.0122	1.54
Path & rad sv × Dial & endo sv	0.0038	0.0061	0.62
Path & rad sv × Allied health & dent sv	-0.0038	0.0054	-0.71
Path & rad sv × Other outpatient sv	-0.0285	0.0232	-1.23
Allied health & dent sv × Mental, alc & psych sv	0.0097	0.0064	1.50
Allied health & dent sv × MDC 1 seps	-0.0079	0.0164	-0.48
Inputs – cross terms			
Nursing staff × Drug cost	0.0261 ***	0.0088	2.95
Nursing staff × Supplies cost	-0.0271 ***	0.0094	-2.87
Nursing staff × Other cost	-0.0036	0.0059	-0.62
Drug cost × Supplies cost	-0.0289 ***	0.0099	-2.93
Drug cost × Other cost	-0.0091	0.0075	-1.20
Supplies cost × Other cost	0.0392 ***	0.0091	4.31
Outputs & inputs – cross terms			
Acute seps × Nursing staff	0.0552 ***	0.0137	4.02
Acute seps × Other staff	0.0712 ***	0.0140	5.10
Acute seps × Drug costs	-0.0038	0.0085	-0.45
Acute seps × Supplies costs	-0.0193	0.0125	-1.55
Preg & neo seps × Nursing staff	0.0003	0.0083	0.03
Preg & neo seps × Other staff	0.0243 **	0.0104	2.34
Preg & neo seps × Drug costs	0.0004	0.0124	0.04
Preg & neo seps × Supplies costs	0.0014	0.0066	0.20
Mental & alc seps × Nursing staff	0.0109	0.0082	1.34
Mental & alc seps × Other staff	-0.0105	0.0106	-0.99
Mental & alc seps × Drug costs	-0.0165	0.0133	-1.24
Mental & alc seps × Supplies costs	-0.0076	0.0077	-0.98
Other seps × Nursing staff	0.0091	0.0088	1.03
Other seps × Other staff	-0.0246 **	0.0124	-1.98
Other seps × Drug costs	0.0263 **	0.0107	2.45
Other seps × Supplies costs	0.0189 ***	0.0071	2.67
Acc & emerg sv × Nursing staff	0.0045	0.0083	0.54
Acc & emerg sv × Other staff	-0.0250 ***	0.0088	-2.83
Acc & emerg sv × Drug costs	-0.0098	0.0096	-1.02

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Table D.3 (continued)

	<i>Coefficient</i>	<i>Standard error</i>	<i>z-value</i>
Acc & emerg sv × Supplies costs	0.0193 ***	0.0065	2.97
Path & rad sv × Nursing staff	-0.0190 **	0.0096	-1.98
Path & rad sv × Other staff	0.0029	0.0096	0.30
Path & rad sv × Drug costs	0.0324 ***	0.0100	3.23
Path & rad sv × Supplies costs	0.0088	0.0076	1.16
Allied health & dent sv × Nursing staff	0.0029	0.0096	0.30
Allied health & dent sv × Other staff	0.0444 ***	0.0122	3.64
Allied health & dent sv × Drug costs	0.0104	0.0099	1.06
Allied health & dent sv × Supplies costs	-0.0227 ***	0.0072	-3.14
Mental, alc & psych sv × Nursing staff	-0.0180 *	0.0100	-1.79
Mental, alc & psych sv × Other staff	0.0174 **	0.0078	2.22
Mental, alc & psych sv × Drug costs	-0.0144 *	0.0079	-1.81
Mental, alc & psych sv × Supplies costs	-0.0041	0.0064	-0.64
MDC 1 seps × Nursing staff	-0.0347 **	0.0141	-2.47
MDC 1 seps × Drug costs	0.0085	0.0212	0.40
MDC 1 seps × Supplies costs	0.0201	0.0180	1.12
MDC 1 seps × Other costs	-0.0188 *	0.0106	-1.77
Quality indicator			
HSMR	0.0784 ***	0.0130	6.03
HSMR – squared	-0.0149 ***	0.0035	-4.21
HSMR × Nursing staff	0.0043	0.0075	0.57
HSMR × Drug costs	0.0139	0.0117	1.19
HSMR × Supplies costs	-0.0016	0.0099	-0.17
HSMR × Other costs	0.0159 **	0.0078	2.05
Patient characteristics^b			
Share of patients aged <1 year	0.0070 ***	0.0025	2.82
Share of patients aged 1-4 years	-0.0049	0.0030	-1.64
Share of patients aged 5-19 years	-0.0021	0.0024	-0.87
Share of patients aged 60-69 years	-0.0008	0.0010	-0.86
Share of patients aged 70+ years	0.0025 ***	0.0005	5.11
Share of patients from SEIFA 1	0.0002	0.0003	0.90
Share of patients from SEIFA 2	0.0004	0.0003	1.40
Share of patients from SEIFA 3	-0.0001	0.0002	-0.28
Share of patients from SEIFA 4	0.0001	0.0003	0.22
Share of patients with Charlson score 2	0.0010 ***	0.0003	3.07
Share of patients with Charlson score 3	0.0028	0.0022	1.26
Share of patients with Charlson score 4	0.0012	0.0012	1.04
Share of patients with Charlson score 5	0.0005	0.0010	0.44
Share of patients with Charlson score 6+	-0.0333 ***	0.0075	-4.46
Establishment characteristics^c			
Located in major city	0.0720 ***	0.0109	6.58
Located in outer regional area	0.0018	0.0092	0.19
Located in remote area	0.0374 **	0.0164	2.28
Located in very remote area	0.0680 ***	0.0216	3.15
Surgical & other DRG separations	-0.0022 ***	0.0004	-4.96
Public patients	-0.0006 *	0.0003	-1.89

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Table D.3 (continued)

	<i>Coefficient</i>	<i>Standard error</i>	<i>z-value</i>
Teaching hospital	0.0103	0.0099	1.05
Member of hospital network	-0.0489 ***	0.0143	-3.41
High-level intensive care unit	0.0116	0.0101	1.15
Palliative care unit	-0.0082	0.0074	-1.11
Domiciliary care unit	0.0098	0.0077	1.27
Evans and Walker Index 2	0.0680 ***	0.0216	3.15
State or Territory^d			
New South Wales	0.0740 ***	0.0119	6.20
Victoria	0.0890 ***	0.0144	6.16
South Australia	0.0192	0.0165	1.17
Western Australia	0.0091	0.0149	0.61
Tasmania	0.0954 ***	0.0238	4.01
Northern Territory	0.0430	0.0269	1.60
ACT	0.1663 ***	0.0209	7.95
Year^e			
2004-05	-0.0164 **	0.0076	-2.16
2005-06	-0.0202 ***	0.0076	-2.66
2006-07	-0.0183 **	0.0085	-2.16
Constant	-0.5316 ***	0.0607	-8.75
Inefficiency equation			
Ownership^f			
Private (vs. Public & Contracted)	np ***	np	2.71
For-profit (vs. Not-for-profit)	np ***	np	-4.13
Contracted (vs. Not contracted)	np ***	np	-3.24
$\ln \sigma_u^2$	np ***	np	-28.76
$\ln \sigma_v^2$	np ***	np	-38.70
Model criteria			
Log likelihood (pseudo)	2 244.97		
Akaike Information Criterion (AIC)	-4 161.94		
Bayesian Information Criterion (BIC)	-3 260.12		
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 an exponential distribution to the efficiency term. ^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 $\ln \sigma_v^2$ and $\ln \sigma_u^2$ 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 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.

To test the consistency of efficiency scores between the half-normal distribution and the exponential distribution, a Pearson's correlation test was used to measure the

strength of similarity between the estimates of the two models, while a Spearman's rank test was used to test whether the ordinal ranking of the efficiency scores remained stable between the two models (table D.4). The results show that the relativities of the efficiency scores do not significantly differ between the two models.

Table D.4 Results of sensitivity tests between half-normal and exponential error distributions^a

	<i>Results</i>
Output-oriented model	
Correlation between efficiency scores	0.9708
Spearman's rho	0.9851
Spearman rank test ^b	0.0000
No. observations	1 806
Input-oriented model	
Correlation between efficiency scores	0.9698
Spearman's rho	0.9874
Spearman rank test ^b	0.0000
No. observations	1 806

^a Correlation tests based on unweighted estimates. ^b Test statistic means that the null hypothesis — that the efficiency scores of the two models are independent of each other — can be rejected. This means that the scores of the two model follow a sufficiently similar ordinal ranking.

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

D.3 Technical efficiency — selected correlation results

The Commission undertook correlation tests to test whether there was an observable pattern between the output-oriented efficiency scores and hospital occupancy rates and the degree of hospital specialise in particular activities (table D.5). A hospital's occupancy rate is defined as the number of patient days divided by the number of beds multiplied by 365. A hospital's degree of specialisation was defined 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.

A correlation value closer to positive one indicates a greater similarity between a hospital's efficiency score and their degree of specialisation, while a value closer to negative one would indicates the opposite. A value close to zero signals little similarity either way.

The correlation values suggest a variety of trends across hospital ownership groups and sizes. Occupancy rates are generally positively, and significantly correlated,

with output oriented efficiency for public hospitals and some groups of not-for-profit hospitals. This suggests that these groups of hospitals, increases in occupancy rates are associated with increases with efficiency.

Table D.5 Correlation between output-oriented efficiency scores and occupancy rates and specialisation

	<i>Very large</i>	<i>Large</i>	<i>Medium</i>	<i>Small</i>	<i>Very small</i>	<i>All sizes</i>
<i>Occupancy rates</i>						
Public	0.2450*	0.4750*	0.2759*	0.2407*	0.3637*	0.3761*
Private	-0.0233	-0.4297*	-0.2591*	-0.2032	0.8112*	0.0558
For profit	-0.0129	-0.1552	-0.2815*	-0.3113*	-0.0277	-0.021
Not-for-profit	0.2203	-0.5896*	-0.5788*	————	0.7274*————	0.1063
Public contract	0.0097	-0.1007	np	np	np	-0.1799
All types	0.1504*	0.3152*	0.0744	0.2782*	0.3821*	0.3348
<i>Specialisation</i>						
Public	-0.114	-0.254*	0.066	-0.056	-0.072	-0.055*
Private	0.042	0.012	0.108	0.018	0.163	0.213
For profit	-0.246	0.039	0.015	0.130	-0.027	0.002
Not-for-profit	0.007	0.568*	-0.746*	————	0.225————	-0.036
Public contract	0.250	0.305	np	np	np	0.207
All types	0.034	0.094	0.050	0.182*	0.051	0.083

^a Small and very small size categories are aggregated for not-for-profit private hospitals due to ABS confidentiality requirements. Number of observations corresponds to the preceding data reported in tables 5.3 and 5.4. **np** Not available for publication due to ABS confidentiality concerns. * Significant at the five per cent level.

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

In contrast, a hospital's degree of specialisation is not highly correlated with its output-oriented technical efficiency. This finding, however, may reflect the limited nature of the variable used to reflect hospital specialisation. Other variables that might have proven more effective in measuring specialisation would include the Evans and Walker (1972) index of specialisation, and the Gini coefficient (Daidone and D'Amico 2009).