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Improving the Efficiency of Health Care Spending: What Can be Learnt from Partial and Selected Analyses of Hospital Performance?

by
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Introduction and findings

This study explores the possibility of measuring cross-country differences in health care performance at the hospital sub-sector level. A cross-country comparison of health care performance is relevant for the adoption of best international practice, which is becoming increasingly important for supporting fiscal sustainability in the context of population ageing and the rapid advances in medical technology (allowing for new treatments and changes in clinical practice).[1] The performance of hospitals in providing health care services appears to be an attractive place to start when aiming to assess overall health sector efficiency from an international viewpoint, since it constitutes a large share (typically one-third) of total health expenditure in OECD countries. Partial evidence indicates that the efficiency with which patients are treated can change dramatically over time, for example with respect to average length of stay, suggesting substantial apparent cross-country differences in hospital performance.[2] Finally, the hospital sector has been analysed extensively in the literature, allowing insight into the complexities of measuring hospital performance at the national level, which could provide better knowledge about the factors that are key to reaping efficiency gains.[3]

There are no ready-made data on hospital outputs and inputs which would allow a comprehensive international comparison of hospital efficiency to be carried out (Häkinnen and Joumard, 2007). Preferably, such an analysis should be based on aggregate output measures that are adjusted for the patient case mix. The implementation of the Diagnosis Related Groups (DRG) classification system in a number of OECD countries, which relate patient treatments to the resources consumed, is therefore promising as it allows aggregate output measures to be constructed capturing case severity. But the fact that there remain important differences in the systems actually used reduces cross-country comparability of aggregate output measures based on this concept.

The following analysis presents elected evidence on hospital performance in a number of OECD countries, in particular: Australia, Denmark, Finland, France, Germany, Iceland, Norway, Sweden, the United Kingdom and the United States, based on the three following approaches to international comparison:

- Differences in the *unit costs* of typical, individual clinical interventions based on DRGs.
- Differences in aggregate hospital efficiency *levels* between (mainly) pairs of countries, based on hospital studies that have applied different "matching techniques" so as to improve cross-country comparability of aggregate output measures.
- Differences in the within-country *dispersion* of individual hospital efficiency (a "differences-in-differences" approach), based on a subset of national hospital studies that have applied "similar" modelling assumptions.

The article ends with a discussion of whether the partial approaches, in combination, provide a consistent picture when they are cross-checked against one another. Technical notes are contained in the Annex.

The main findings of the study are as follows:

- Comparisons based on unit costs suggest that, on average for the interventions covered and disregarding potential differences in quality, countries could potentially reduce costs by between 5% and 48% if unit costs were to be reduced to the level of the best performer for each intervention.
- Bilateral comparisons of aggregate efficiency levels indicate substantial cross-country differences in hospital performance, with an input saving potential ranging from on average 6% to 36%. In addition, preliminary results from a four-country comparison of Nordic hospitals show that hospital efficiency appears to vary considerably, even between countries with relatively similar institutional features, with cost-saving potential ranging from, on average, 23% to 44%.
- The evidence on within-country dispersion indicates large cross-country differences. To the extent that higher dispersion indicates a potential for efficiency gains, there could be substantial scope for improvements in several countries by bringing the performance of inefficient hospitals up to best national practice. While possibly reflecting differences in the composition of health-service outputs, the evidence suggests that the scope for improvements could be larger for private hospitals than for public hospitals.
- While country coverage varies from indicator to indicator, making it difficult to assess the extent to which they provide a consistent picture of national efficiency levels, cross-checks between the different indicator sets tend to support the robustness of the country rankings.

It should, however, be acknowledged that the approach followed here is highly exploratory, and that analysing the determinants of the observed cross-country differences in hospital performance is beyond the scope of this study. The different set of country rankings should thus be seen as a starting point for further research, rather than as decisive evidence on cross-country differences in hospital efficiency. The ultimate objective would be to link measures of hospital performance to factors describing the institutional setting under which hospitals operate so as to draw relevant policy conclusions for the adoption of best international practice.

A cross-country comparison of hospital unit costs

One way of assessing cross-country differences in hospital performance, elaborated here, is to compare unit costs for specific interventions.[4] Unit costs for seven hospital interventions for which clinical procedures are fairly standardised across countries are presented for ten countries in Table 1. The specific definitions of the interventions chosen are based on the use of DRGs, which is a system for grouping patient treatments into a restricted set of clinically and economically homogenous groups, according to the resources used (Box 1).[5] In the second part of the table, the unit costs per treatment, as derived from national DRG schedules, have been normalised by adjusting for cross-country differences in the price level of goods and services in general, using economy-wide Purchasing Power Parities (PPPs).[6] Remaining relative price variations will reflect both differences in technical efficiency and differences in the price of hospital services relative to the whole economy (or more likely, a combination of the two).[7]

There appear to be relatively large cross-country variations in unit costs for the specific interventions examined here. In the third part of Table 1, the potential for cost savings is measured by using the unit costs of the best-performing country as a benchmark: the unit cost indicator for under-performing countries is defined as the ratio

Table 1. **Cross-country comparison of hospital unit costs for seven DRGs, 2006**

	AUS[8]	DNK	FIN	FRA[9]	DEU	ISL	NOR	SWE	GBR[11]	USA[12]
	Mapping of interventions (Grouping system)									
	AR-DRG	DkDRG	Nord-DRG	PMSI	G-DRG	Nord-DRG	Nord-DRG	Nord-DRG	HRG	HCFA-DRG
Primary prosthetic operation (S)[1]	I03B, I03C, I04B[10]	0880, 0884, 0896[10]	209A	08C02Z	I03Z, I04Z[10]	209A	209A	209A	H04, H80, H81[10]	209
Laparoscopic cholecystectomy (S)[2]	H04B	0 708	494, 494O	07C04V	H08B	494, 494O[10]	494	494, 494O[10]	G14	494
Inguinal and femoral hernia (S)[3]	G09Z	0 620	162, 162O[10]	06C12V	G09Z	162, 162O[10]	162	162, 162O[10]	F74	
Coronary bypass (S)[4]	F05A	0 507	107C	05C04W	F05Z	107C	107C	107C	E04	
Lens procedures (S)[5]	C08Z	0205, 0206	39A, 39B, 39O, 39P[10]	02C05Z	C08Z	39, 39O[10]	39	39, 39O[10]	B13, B14, B15[10]	
Simple pneumonia and pleurisy (M)[6]		0445, 0446[10]	89	04M05V		89	89	89	D42	89
Vaginal delivery (M)[7]	O60D	1 407	373	14Z02A	O60D	373	373	373	N07	
	Unit costs per intervention, measured in 2006 US$ PPP									
Primary prosthetic operation	13 523	8 730	8 424	12 972	12 379	11 361	14 438	10 099	8 413	11 761
Laparoscopic cholecystectomy	3 346	2 236	2 323	3 760	2 825	3 374	4 941	4 171	2 802	5 971
Inguinal and femoral hernia	2 365	1 736	1 557	2 564	2 655	2 409	1 829	2 910	1 617	
Coronary bypass	23 464	13 948	18 428	20 225	19 782	24 577	15 754	19 911	11 626	
Lens procedures	2 443	971	1 139	2 308	1 417	1 607	1 348	1932	1 161	
Simple pneumonia and pleurisy		2 869	3 324	5 200		4 190	5 134	4 540	5 428	5 934
Vaginal delivery	1934	1 236	1 484	2 363	1 772	2 372	1 604	2 740	1 188	
	Unit cost indicator, with unit costs of the country with lowest unit costs used as a benchmark									
Primary prosthetic operation	0.62	0.96	1.00	0.65	0.68	0.74	0.58	0.83	1.00	0.72
Laparoscopic cholecystectomy	0.67	1.00	0.96	0.59	0.79	0.66	0.45	0.54	0.80	0.37
Inguinal and femoral hernia	0.66	0.90	1.00	0.61	0.65	0.65	0.85	0.54	0.96	
Coronary bypass	0.50	0.83	0.63	0.57	0.59	0.47	0.74	0.58	1.00	
Lens procedures	0.40	1.00	0.85	0.42	0.69	0.60	0.72	0.50	0.84	
Simple pneumonia and pleurisy		1.00	0.86	0.55		0.68	0.56	0.63	0.53	0.48
Vaginal delivery	0.61	0.96	0.80	0.50	0.67	0.50	0.74	0.43	1.00	
Average (unweighted)	0.58	0.95	0.87	0.56	0.68	0.62	0.66	0.58	0.88	0.52
i.e. potential for cost reductions(%)[13]	42	5	13	44	32	38	34	42	12	48

Table 1. **Cross-country comparison of hospital unit costs for seven DRGs, 2006** *(cont.)*

	AUS[8]	DNK	FIN	FRA[9]	DEU	ISL	NOR	SWE	GBR[11]	USA[12]
	Within country variation in unit costs, normalised on the unit costs for primary prosthetic operations									
Primary prosthetic operation	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Laparoscopic cholecystectomy	0.25	0.26	0.28	0.29	0.23	0.30	0.34	0.41	0.33	0.51
Inguinal and femoral hernia	0.17	0.20	0.18	0.20	0.21	0.21	0.13	0.29	0.19	
Coronary bypass	1.74	1.60	2.19	1.56	1.60	2.16	1.09	1.97	1.38	
Lens procedures	0.18	0.11	0.14	0.18	0.11	0.14	0.09	0.19	0.14	
Simple pneumonia and pleurisy		0.33	0.39	0.40		0.37	0.36	0.45	0.65	0.50
Vaginal delivery	0.14	0.14	0.18	0.18	0.14	0.21	0.11	0.27	0.14	

1. Primary prosthetic operation in hip/knee/ankle, lower extremity cases. Available data do not allow for a cross-country consistent split of unit costs for hip, knee and ankle operations.
2. A non-invasive method for removal of gall bladder, non-complicated cases.
3. Hernia procedures, non-complicated cases.
4. Major heart disease, complicated cases.
5. Include mainly cataract treatments.
6. Infection in the lungs, complicated cases.
7. Normal birth, non-complicated cases.
8. New South Wales. Fiscal year 2005/2006.
9. Fiscal year 2005.
10. The reported unit cost figure is derived by averaging over the individual cost weights for these groups.
11. Fiscal year 2006/2007.
12. Fiscal year 2005.
13. Computed as: 1-average unit cost indicator.

Note: M = Medical DRG, S = Surgical DRG.

Source: OECD Secretariat (see the Annex for further details).

Box 1. **Diagnosis Related Groups (DRGs)**

The DRG system is used to describe the patient case-mix in hospital care. It was developed by Professor Robert Fetter and colleagues at Yale University during the 1970s as a new management tool that could improve cost control in hospitals (Fetter and Freeman, 1986). The basic idea was to describe hospital activity by focusing on the total hospital spell as the final product, measured as discharges defined according to the patient's diagnosis (described according to the International Classification of Diseases, or ICD-codes), and reflecting resources used.

Conceptually, the DRG system groups patients by means of specially designed software into a certain number of categories based on their main diagnosis, clinical procedure codes, gender, age, and the presence of complications and bi-diagnosis. The grouping procedure starts out by categorising patients in (typically 23-25) *Major Diagnostic Categories* (MDCs) according to their main diagnosis. Subsequently, separation is made between medical and surgical cases. The resulting DRGs are assumed to be categorised in a way so that each group is homogenous with respect to clinical and economic resource requirements.

The DRG system was first applied in the United States in 1983 as basis for the Prospective Payment System (PPS) introduced in Medicare (and is often termed the HCFA-DRG system, after the Health Care Financing Administration who was responsible for its implementation). Since then, a number of countries have implemented DRG systems in hospital care (see table below). DRGs are used mainly as a basis for hospital financing based on activity (Docteur and Oxley, 2003), but the system has also been used for benchmarking of national hospitals (*e.g.* in Finland since 1994). Currently, DRG systems capture mainly inpatient care activities although some countries have developed DRGs also for outpatient care (*e.g.* day surgery).

Grouping systems used in hospital care

	Type of grouping system	Year introduced in hospital financing schedules	Number of groups, 2006	Share of hospital budget financed by DRG based activity	Share of hospitals using a DRG system
Australia	AR-DRG	1997	657[1]	65%[1]	100%[1]
Austria	LDF	1997	883	50%	100%
Denmark	DkDRG	2000	599	50% by 2007	100%
Finland	NordDRG	2000	914	43-75%	36%
France	PMSI	2004	768	50% by 2007	100%
Germany	G-DRG	2003	914	20%	100%
Hungary	HBC	1993	786	100%	100%
Iceland	NordDRG	..[2]	744	0%	10%
Italy	DRG	1995	506	100%	100%
Netherlands	DBC[3]	2005	..	..[4]	100%
Norway	NordDRG	1999	532	40%	100%
Spain	DRG	1997[5]	..	35%[5]	..
Sweden	NordDRG	1997	696	55%	80-90%
United Kingdom	HRG	2003[6]	600	35-70%	100% by 2008
United States	HCFA-DRG	1983[7]	543[7]	..	100%[7]

1. New South Wales.
2. Used only for collecting information on provision of hospital care.
3. DBC was introduced in February 2005 for reimbursement of hospital care. However, the DBC system is still under development.
4. In the DBC case-mix system, a distinction is made between DBCs with fixed prices and with negotiable prices.
5. Catalonian region.
6. Only in England.
7. Medicare.

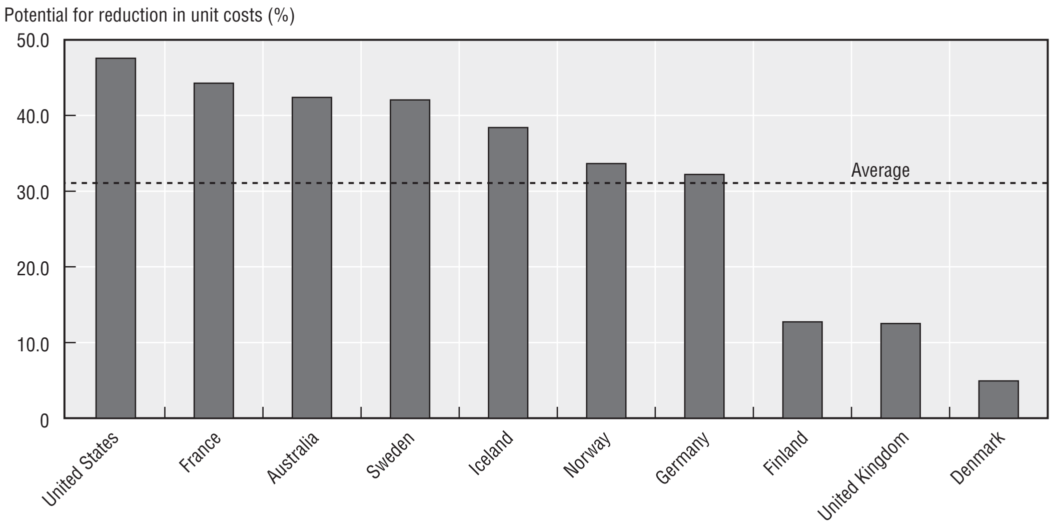
Note: DkDRG = Danish DRG; AR DRG = Australian Refined DRG; HRG = Health Resource Groups; DBC = Diagnose Behandelings Combinaties; PMSI = Programme de médicalisation des systems d'information; LDF = Leistungsbezogene Diagnose-Fallgruppen; NordDRG = Nordic DRG; HBC = Homogén Betegségcsoportok.

Source: OECD Secretariat; Busse *et al.* (2006); The Nordic Case Mix Conference, Copenhagen, 2006; Schreyögg *et al.* (2006).

of the benchmark country's unit costs to their own costs, the potential saving being calculated as the difference between the two.[8] For example, in the case of *laparoscopic cholecystectomy* (a non-invasive method for removal of the gall bladder) the unit cost indicator varies between 0.37 and 0.96 in relation to the benchmark country, Denmark, suggesting a cost-saving potential of around two-thirds for the country having the highest unit costs and less than five per cent for the second most efficient. Likewise, unit costs vary substantially even for a standard clinical intervention like *vaginal delivery* (normal birth without complications), with three countries appearing to have a cost-saving potential of 50% or more.

The potential for reducing unit costs, based on simple averaging over the seven interventions (the lack of data on the number of *e.g.* discharges for each DRG hindered the calculation of a weighted average), appears to be relatively large in Australia, France, Sweden and the United States, while being relatively low in Denmark, Finland and the United Kingdom (Figure 1). Germany, Iceland, and Norway seem to be in intermediate positions. A robustness check of the relative country ranking reported in the Annex shows that using alternative deflators (*i.e.* gross wage earnings and GDP per capita) to economy-wide PPPs does not change relative rankings by very much.

Figure 1. **Cross-country differences in unit costs for seven hospital interventions, 2006**



Source: OECD Secretariat.

In addition, the relative unit costs for the various treatments vary considerably within countries. This is illustrated in the fourth part of Table 1, where unit costs within each country are measured with primary prosthetic operation used as a *numeraire*. For example, unit costs of *vaginal delivery* vary between one-tenth and a quarter of the costs of a primary prosthetic operation, while unit costs of *coronary bypass* vary from being roughly equal to the unit costs for primary prosthetic operation to more than double. Assuming that the DRG-based interventions are indeed consistent across countries, these wide variations in relative unit cost structures are suggestive of considerable scope for efficiency gains.

Although the evidence presented in Table 1 points to areas in which real improvements in unit costs might be achieved, several factors may be behind the substantial variation in cost performance across countries, reducing cross-country comparability. They include the following:

- First, as countries use different DRG systems, the interventions covered here may not be fully comparable if the diagnosis and clinical procedures reflected in each DRG differ across countries (Box 2).[9] Apparently, there are large variations in the number of groups

Box 2. **Factors affecting the degree of comparability of DRGs across countries**

The fact that no international DRG system has so far been developed[1] – which would permit international comparisons – is due to the following factors (Schreyögg *et al.*, 2006):

- *Differences in the definition of data samples*, *e.g.* in the number of hospitals from which cost data are collected and pooled. The percentage of hospitals that use DRGs varies from less than one per cent of the total data sample (in Italy) to 100% (in the United Kingdom), reflecting differences in the selection criteria. These criteria usually seek to balance the need to ensure high-quality data standards with obtaining a representative sample of hospitals.
- *Differences in the use of trimming methods to detect outlier cases*, *i.e.* treatment episodes which use significantly higher (or lower) resources than the average. Typically, long-stay outliers occur more frequently than short-stay outliers, implying that the average cost per DRG tends to exceed the median, or typical, case. For this purpose, trimming methods that define threshold values (trim-points) are applied but these methods vary across countries.[2]
- *Differences in the methods for calculating individual cost-weights*. Basically, countries apply two different methods to derive reimbursement rates for hospital activity based on DRGs. The first method is based on the concept of individual cost-weights, which define a relationship between the treatment episodes according to the intensity of resources used.[3] However, cost accounting methodology used to establish this relationship varies both within and across countries (see the 2006 August volume of *Health Care Management Science* for details). The second method is based on calculating unit costs (or setting the reimbursement rate) for each group directly. Both methods capture variation in relative resource requirement between different groups of patients, but additional adjustments are typically required to take account of differences in hospital structure and/or regional differences. Countries use different mechanisms for conducting these adjustments.

Another factor which may blur the comparability of unit costs derived from DRG cost-weights is, for example, the frequency at which the weights are updated, implying that the unit costs may reflect cost conditions for different time periods. A further factor is that some countries apply the DRG system uniformly, while others apply different sets of cost-weights, depending on the administrative unit responsible for the provision of hospital care. There is also variation related to hospital ownership, implying that cost-weights may depend on the financing structure of the health care system as a whole. Finally, there is a variation in the type of cost components included in the cost base used to derive national cost-weights (see Annex for details).

1. The Nordic countries have developed a common DRG system (*i.e.* the common version of the NordDRG system) – which to a large extent is inspired by the US HCFA-DRG system. Although each country uses a national version of the NordDRG in hospital reimbursements, reflecting specific institutional specificities, the common system could be utilised to draw inter-Nordic comparisons (see Linna *et al.*, 2006).
2. Cases of extreme resource use are typically excluded and reimbursed separately. Countries use mainly two types of trimming methods, parametric and non-parametric methods, and some also use additional techniques that may lead to exclusion of certain observations. For short-stay outliers, some countries use lower trim-points, whereas other countries do not use lower thresholds.
3. The advantage with this method is that only the reimbursement rate for the average patient (*i.e.* the DRG with a cost-weight of 1.0) has to be set. The individual rates for all the other groups could then be calculated by multiplying the individual cost-weights with the reimbursement rate for the average patient.

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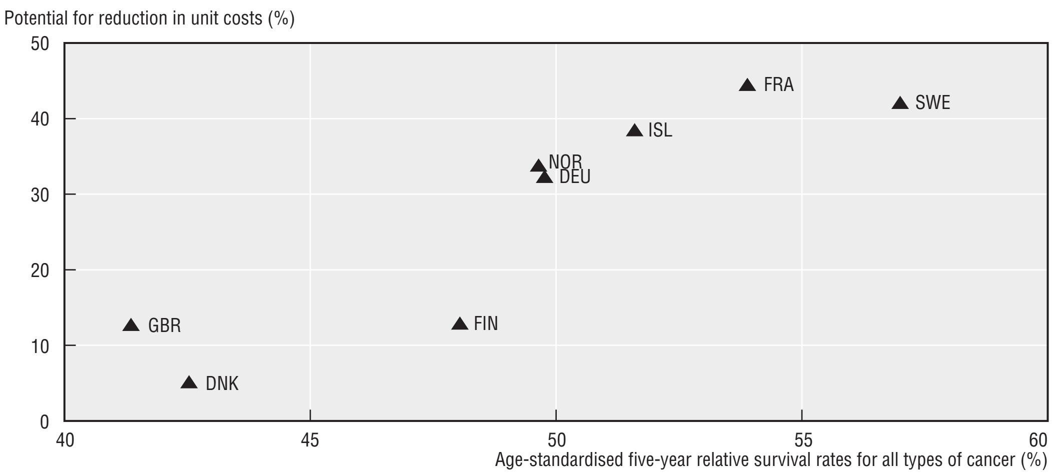
across the different systems in use (from around 500 to more than 900 groups), suggesting that unit costs may better reflect underlying costs for the individual interventions where there are more DRGs (and narrower groupings).

- Second, the methods used to calculate individual cost-weights vary between countries (Box 2 and Schreyögg *et al.*, 2006). Among factors that may reduce comparability of the derived unit cost figures are differences in the type of cost components included in the national cost base used to estimate national cost-weights, differences in trimming methods used to detect outlier cases, differences in the intensity with which care is provided,[10] whether or not a specific intervention is performed as day surgery,[11] and to what extent the cost-weights are representative for the country as a whole.
- Third, countries may attach different weights to the use of medical equipment *versus* the use of labour intensive care. Insofar as the derived figures capture mainly current expenditure, low unit costs may reflect that the country concerned is relatively well-equipped with medical equipment or that such equipment is financed outside the DRG schedule. This could reduce the need for labour-intensive care (which is measured), but would increase capital costs (which are typically not measured). Hence, the presented figures may be biased as indicators of overall, long-term unit costs.[12]
- Fourth, there may be economies of scale, *i.e.* reaping the indicated cost saving potentials might require larger hospitals or higher turnover within hospitals.[13] Although the latter would raise overall spending, even then there would be savings per treatment.

An investigation of the factors behind the cross-country differences in unit costs is beyond the scope of this study, although (unalterable) national characteristics as well as institutional factors are likely to be key determinants.[14] However, to the extent that quality is closely linked to resources consumed, low unit costs could potentially reflect that quality of care is relatively low. In the absence of available indicators on the quality of the specific clinical interventions covered here, Figure 2 illustrates the relationship between the unit cost indicator presented above and 5-year relative survival rates for all types of cancer. The apparent positive correlation between the potential for reduction in unit costs and survival rates is striking (the correlation coefficient is 0.90).[15] This suggests that superior unit cost

Figure 2. **Cross-country variation in hospital unit costs and quality of care**

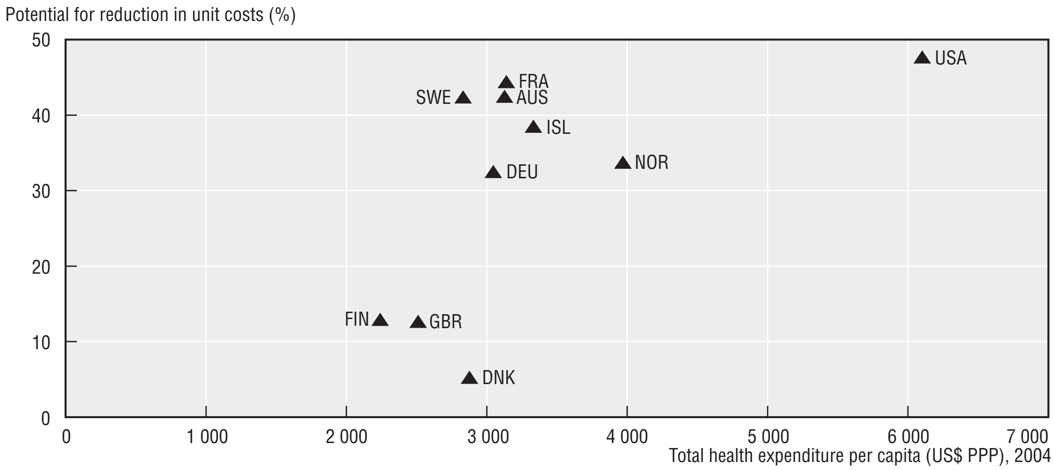


Note: The survival rates for cancer are taken from the Eurocare-3 study, and are based on adults diagnosed 1990-1994.
Source: Sant *et al.* (2003).

performance could come at the cost of low quality services, but the relationship may also reflect differences in priorities. For example, the relatively high survival rates for cancer in France and Sweden could be taken to indicate that more weight is attached to preventive care (*e.g.* screening), implying that patients that are admitted to elective care have a relatively higher case severity (contributing to higher unit costs).

There is also an empirically demonstrated correlation between income and health expenditure, in that countries with higher GDP per capita tend to spend more per capita on health (OECD, 2005). However, high levels of income may lead to failures in providing sufficiently strong incentives to cost containment.[16] A recent report by the McKinsey Global Institute suggests that one of the overriding causes of high health care spending in the United States is the lack of sufficiently strong incentives to promote rational supply of care (McKinsey Global Institute, 2007). Figure 3 is suggestive of a positive relationship between potential cost savings and per capita spending on health (the correlation coefficient is 0.56).

Figure 3. **Cross-country variation in unit costs and spending on health care**



Note: Total health expenditure includes public and private spending.

Source: OECD Health Data 2006.

Comparing hospital efficiency across pairs of countries

Although an international comparison of unit costs for specific clinical interventions could allow for insight into cost performance, the extent to which they are representative for the hospital sub-sector level may be limited insofar as they account for only a small share of total hospital activity. A cross-country comparison of hospital performance should preferably be based on aggregate efficiency measures. Ideally, this would be based on outcome measures that capture value added, *i.e.* the change in a patient's health status with and without the clinical treatment (Jacobs *et al.*, 2006). Since such data rarely exist on an internationally comparable basis, in practice, researchers are usually dependent on hospital outputs.[17] In national studies, typically this has been measured by the (aggregated) number of discharges (or patient days)[18] – a measure equivalent to defining output in the education sector according to the number of students passing through school. There are, however, no ready-made data on hospital discharges which allow comprehensive comparisons of hospital efficiency to be carried out across OECD countries.[19]

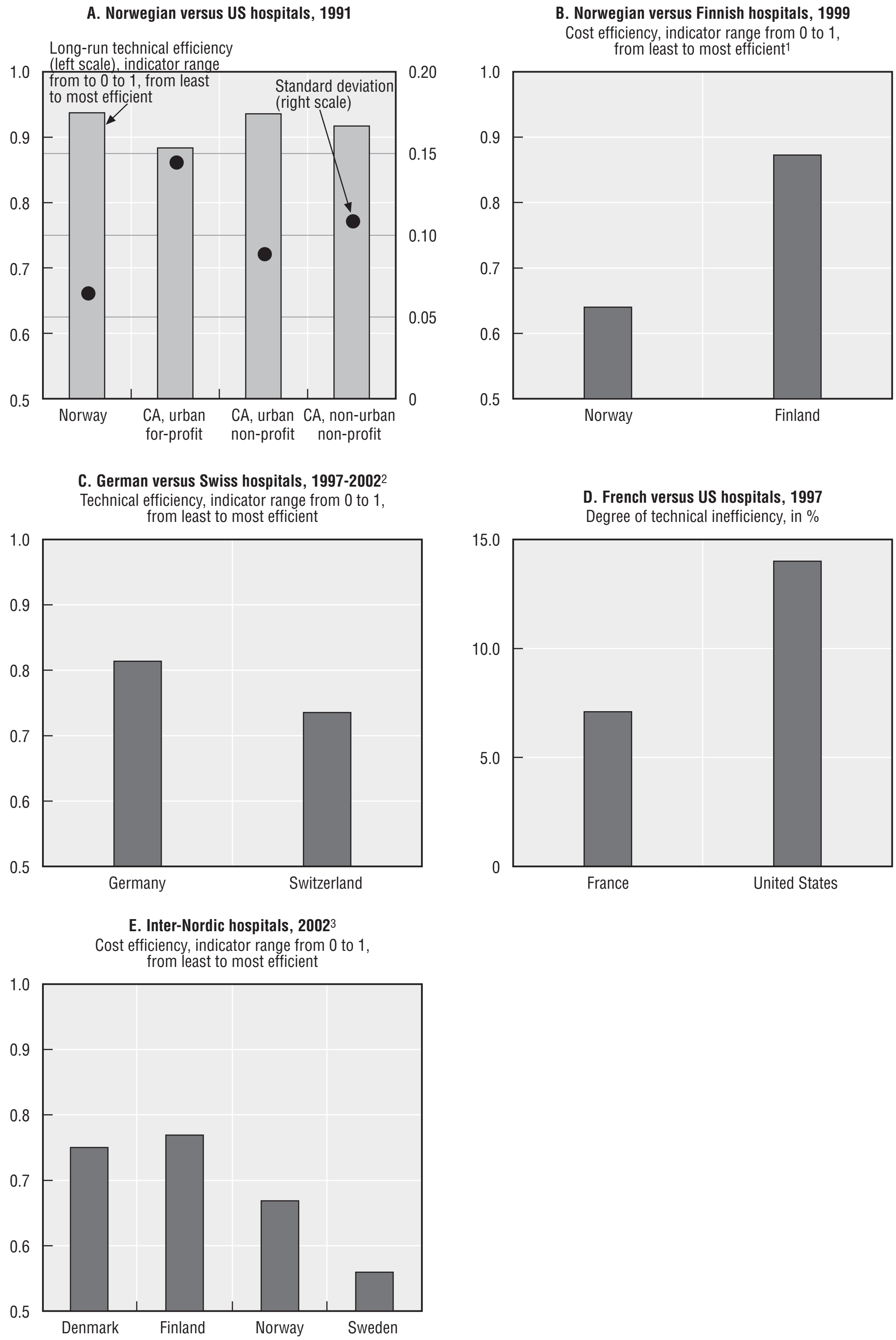
Notably, the lack of an international DRG system and an associated weighting set means that comparing aggregate hospital output internationally would be associated with great uncertainties. Thus the limitations of such comparisons are likely to be non-negligible. Aggregate output measures could, in principle, be computed, for example, by multiplying the number of discharges for each group by respective weights adjusted for case severity. But, while many countries have implemented DRG systems in hospital care, there remain important differences between the systems in use (see Box 2). Countries have found it necessary to adapt the detailed design of the DRG system to national circumstances. Cross-country differences with respect to DRG systems concern all levels of its implementation, including grouping logic and the classification system for diseases (*i.e.* the version of the ICD-system) actually used.

A small number of hospital studies have applied different "matching techniques" so as to permit comparisons to be made of efficiency across (mainly) pairs of countries. Two main approaches have been applied in this respect. The first approach is based on matching groups of hospitals according to specific criteria, *e.g.* hospital type, hospital size, length of stay, the number of bed days, etc.[20] The second approach is based on utilising existing DRG systems allowing for international comparisons. Currently, this is possible only for inter-Nordic comparisons.[21]

The results from the international comparisons of hospital efficiency are summarised in Figure 4, panels A-E. Efficiency scores have in all cases been computed on the basis of non-parametric measurement methods (mainly Data Envelopment Analysis, DEA).[22] With the caveat that there may remain some factors reducing cross-country comparability (*e.g.* quality of care), the evidence from these studies points to substantial bilateral differences in hospital efficiency:

- Mobley and Magnussen (1998) compared Norwegian and US (Californian) hospitals based on aggregate output measures adjusted for case severity (partly by using the age distribution of the patients, and partly by using DRGs). In addition, US physician input data were adjusted to better reflect full-time work effort so as to make them more comparable with Norwegian input data. Norwegian and Californian urban non-profit hospitals were found to be the most (technically) efficient, although the differences appear in general as relatively small (Figure 4, panel A).[23] Californian urban for-profit hospitals were found to be most inefficient, reflecting relatively low bed capacity utilisation.
- Another study compared Norwegian and Finnish hospitals based on aggregate output measures adjusted for the patient case-mix (Linna *et al.*, 2006).[24] Norwegian hospitals were found to be less (cost) efficient than Finnish hospitals (Figure 4, panel B).[25] The computed cost-saving potentials are 36% and 13%, respectively.
- Steinmann *et al.* (2004) compared Swiss and German (Saxony) hospitals based on aggregate measures of the number of cases treated. Swiss hospitals were found to be on average 8% less (technically) efficient than German hospitals (Figure 4, panel C).[26]
- Dervaux *et al.* (2004) compared French and US hospitals based on aggregate measures of number of treatments for different categories. US hospitals were found to have a potential for efficiency gains around twice the level in French hospitals (Figure 4, panel D).[27]
- Kittelsen *et al.* (2007) compared hospital efficiency in Denmark, Finland, Norway and Sweden based on aggregate output measures adjusted for case-severity.[28] Preliminary results indicate that cost efficiency is relatively high in Finland and Denmark, while relatively low in Sweden. Norwegian hospitals appear to be in an intermediate position. Computed cost-saving potential range from, on average, 23% to 44% (Figure 4, panel E).[29] These results are roughly in line with those on unit costs reported above.

Figure 4. **International comparisons of hospital efficiency**



Note: CA denotes Californian hospitals.

1. The reported cost efficiency scores for Finland and Norway is the average efficiency score across four different model specifications (all based on a pooled sample).
2. The reported efficiency scores are calculated as the average over the years from 2000 to 2002 for Germany, and as the average over the years from 1997 to 2000 for Switzerland.
3. Preliminary results from Kittelsen *et al.* (2007).

Source: Mobley and Magnussen (1998); Linna *et al.* (2006); Steinmann *et al.* (2004); Dervaux *et al.* (2004); Kittelsen *et al.* (2007).

Comparing differences in efficiency within countries

There is an extensive literature on within-country efficiency measurement in hospital care which could potentially be utilised to calculate cross-country differences in efficiency *levels* based on within-country data (Box 3), if problems of comparability could be

Box 3. **Comparing efficiency in health care across countries based on national studies**

The empirical literature on efficiency measurement in health care is extensive. According to Hollingsworth (2003), up to the end of 2002, 188 journal papers and book chapters had been published on this subject, a large bulk being within-country analyses. Most of these studies have applied non-parametric measurement methods, notably DEA, and more than half of them are conducted in the area of hospital and nursing home care. The majority of the studies are based on US data. Increasingly, analyses of efficiency at the hospital sub-sector level are based on a two-stage approach, where DEA is used to derive efficiency scores while regression methods (*e.g.* TOBIT) are applied to link variation in efficiency to factors describing the institutional setting under which hospitals operate.

According to national studies based on DEA applications, there could be substantial differences in health care efficiency, both across countries as well as between the different areas of the health care sector (see table below). Based on simple averaging across the studies surveyed, Hollingsworth (2003) finds that efficiency seems to be somewhat higher in European countries than in the United States with a measured degree of inefficiency around 17% and 25%, respectively (averaging across all health care sub-sectors). There appear to be considerable differences in efficiency also between the areas of the health care sector, with the largest potential for efficiency gains appearing to be in primary and nursing home care. Although the figures reported below could be seen as a crude illustration of cross-country differences in health care performance, they should not be taken as *prima facie* evidence on differences in efficiency across countries as their comparability may be limited.

Summary statistics on efficiency in health care

Indicator range from 0 to 1, from least to most efficient

	Number of studies	Efficiency[1]		
		Average[2]	Median	Minimum
Hospitals USA	48	0.834	0.860	0.600
Hospitals EU	17	0.892	0.897	0.751
Health districts USA	9	0.742	0.800	0.500
Health districts EU	4	0.839	0.838	0.800
Nursing homes USA	18	0.746	0.806	0.380
Nursing homes EU	4	0.765	0.750	0.700
Primary care USA	4	0.648	0.635	0.427
Primary care EU	5	0.817	0.790	0.675

1. Summary indicators reflect the use of different efficiency concepts (*i.e.* cost efficiency, technical efficiency) as well as differences in the number and type of hospitals that have been analysed, the specification of hospital production in outputs and inputs, assumptions about scale properties, and other technical assumptions.
2. "Average" efficiency shows the average score reported across the number of studies surveyed. For example, the average efficiency of 0.834 for US hospitals is derived by averaging across the 48 hospital studies the average efficiency score reported in each study.

Source: Hollingsworth (2003).

overcome. However, hospital studies suffer from cross-country heterogeneity along several important dimensions, such as the types of hospitals that have been analysed, the specification of hospital production in outputs and inputs, efficiency concepts applied, technical assumptions about scale properties, etc.[30] This avenue of comparison is therefore not followed further in this study. Instead, existing within-country studies of hospital efficiency have been used to draw cross-country comparisons of domestic *dispersion* in hospital performance based on aggregate efficiency measures. Such dispersion in individual hospital efficiency could be taken to indicate that the scope for efficiency gains is relatively large by letting hospitals catch-up to best national practice.[31]

To enhance comparability, this study focuses on a subset of hospital studies matched according to the following criteria: first, only studies based on DEA applications are examined; second, the efficiency concept applied in all studies is technical efficiency; third, only studies that have assumed variable returns to scale production properties are included; fourth, efficiency scores are computed in an input-oriented direction, *i.e.* meaning how much inputs could be reduced for given levels of outputs.[32] Due to these restrictions the subset of empirical studies examined here is confined to 15 national hospital analyses compared with the 68 studies surveyed by Hollingsworth (2003).[33]

This restricted sample of national hospital studies shows that there are substantial differences in the dispersion of hospital performance (Figure 5). Domestic dispersion in aggregate efficiency measures for hospital care appears to be particularly prevalent in Australia and Italy (with the United States close behind), with reported standard deviation figures being around twice the level in Spain and Norway which appears to have the most homogeneously performing hospitals. The United Kingdom and Germany are in intermediate positions. The implication is that there could be considerable scope for improvements in efficiency in the first group of countries by making hospitals operate closer to best national practice.

Although the issue of comparability initially has been addressed by focusing on studies using "similar" modelling assumptions, some heterogeneity is likely to remain which may blur the comparability of domestic dispersion in hospital efficiency, as illustrated in Figure 5. Among factors that could hamper comparability are differences in the type of hospitals (*e.g.* public or private, local or university hospital) analysed, differences in the specification of hospital production into outputs and inputs,[34] and to the extent that the studies examined portray a non-representative picture of national performance. For example, the figure reported for Australia is based on a study of private hospitals, while the figures reported for Italy and the United States are based on a mix of public and private hospitals. In contrast, the figures reported for the other countries capture mainly public or non-profit care providers. Taken together with the cross-country pattern of dispersion in efficiency, this could be taken to indicate that dispersion in performance is larger for private hospitals than for public and non-profit hospitals.[35] However, caution should be taken when drawing comparisons of performance in public *versus* private hospitals as some non-observed factor, such as quality, may vary more across private hospitals, or there may be systematic differences in the composition of health-service outputs between public and private providers.

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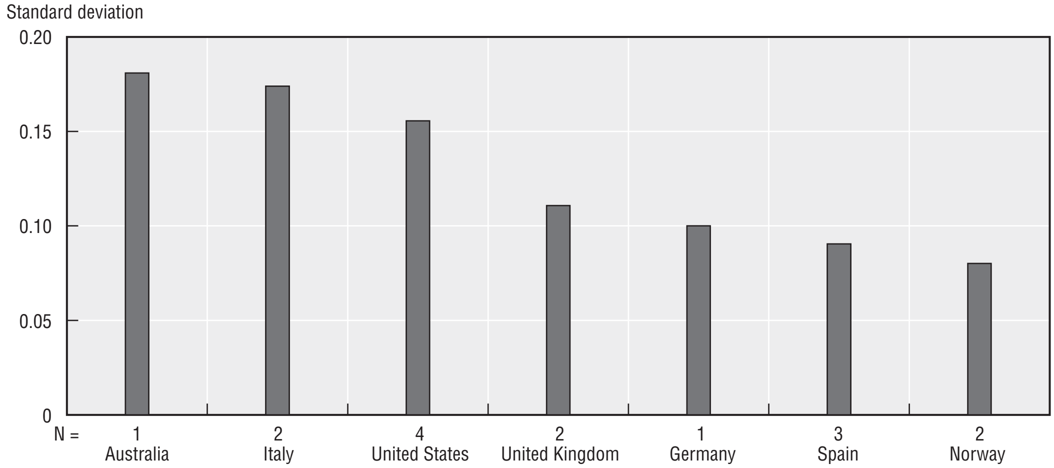
Figure 5. **Cross-country dispersion in hospital efficiency within countries**



Note: N denotes the number of within-country studies over which the standard deviation estimate for each country is based, *i.e.* for countries where more than one study is available, the reported figure is the average standard deviation across these studies.

Source: See Annex, Table A16.

Partial approaches to assessing hospital performance can be cross-checked for consistency

The partial indicators of hospital performance analysed above can be cross-checked for consistency, to see whether a consistent picture of relative national efficiency levels emerges. Table 2 does indeed suggest such a pattern:

- Countries that perform relatively well with respect to cost performance (as measured by the potential for reduction in unit costs) also appear to do well in comparisons of

Table 2. **Country rankings based on different indicators of hospital performance**

Indicator range from 1 to 10, with 1 as best performance

	Comparison of hospital unit costs	Comparison of between-country differences in efficiency					Comparison of within-country differences
	Unit cost indicator for seven interventions	Norway *vs.* United States	Norway *vs.* Finland	Germany *vs.* Switzerland	France *vs.* United States	Nordic comparison[1]	Domestic dispersion in aggregate efficiency
Australia	8						7
Denmark	1					2	
Finland	3		1			1	
France	9				1		
Germany	4			1			3
Iceland	6						
Italy							6
Norway	5	1	2			3	1
Spain							2
Sweden	7					4	
Switzerland				2			
United Kingdom	2						4
United States	10	2			2		5

1. Ranking based on preliminary results from Kittelsen *et al.* (2007).

Source: See Figures 1, 4 and 5.

aggregate efficiency levels between countries or sets of countries (*e.g.* Denmark, Finland).

- Countries that have a relatively large cost-saving potential according to unit cost comparisons also appear to be relatively inefficient according to comparisons based on either aggregate efficiency levels (*e.g.* Sweden) or within-country dispersion (*e.g.* Australia and the United States).
- In contrast, there are countries for which a consistent picture does not emerge from the various comparisons of efficiency (*e.g.* the United Kingdom).

Overall, and taken together, the partial indicators presented here are suggestive of substantial differences in hospital cost performance across OECD countries. The discussion of factors that may explain this variation, as well as appropriate policies to address any associated inefficiencies, is, however, beyond the scope of this study.

Notes

1. OECD projections suggest that the average public spending share on health could almost double by 2050, from around 6% to nearly 10% of GDP, assuming no policy change action to break with past trends (OECD, 2006).
2. The number of acute care hospital beds per capita decreased significantly in a number of OECD countries from 1990 to 2002, at the same time as hospital discharge rates escalated (OECD, 2005). Average length of hospital stay dropped markedly in the same period for almost all OECD countries.
3. See the survey by Hollingsworth (2003), and the references therein.
4. The HealthBASKET project, funded by the European Commission, aims at developing a more general methodology allowing comparisons to be drawn between differences in costs of treatment across and within EU member States, using a selection of "case-vignettes" for both inpatient and outpatient care (*www.ehma.org/projects/default.asp?NCID=112*).
5. A number of countries have implemented DRG systems in hospital care, but comparing unit costs across countries based on DRGs requires a mapping of clinical interventions so as to ensure a match of similar treatments. The mapping in this paper has been conducted at the DRG level, *i.e.* by comparing DRGs which either have the same number or equivalent labels. Medical experts have been consulted in this process. To ensure an accurate match of diagnosis and clinical procedures, the mapping would preferably have been conducted at the patient level, but individual data needed for this have not been available.
6. The figures are derived from national DRG schedules used in the reimbursement of hospital activity (see further details in the Annex). These schedules have been utilised in the following way: unit costs for each clinical intervention have been derived by multiplying the relevant cost-weight with the national reference price (*i.e.* the reimbursement rate for the average patient), or by taking the unit cost (or reimbursement rate) for each intervention directly. Thus, the derived unit costs are taken to reflect the average input costs at the national level required to treat the median, or typical, case.
7. In the case where the price level for hospital services does not differ from the price level for goods and services in general, cross-country differences in unit costs will reflect pure differences in efficiency, *i.e.* higher use of inputs for a given level of treatment. Conversely, if unit costs were measured by deflating national figures by health-specific PPPs, remaining cross-country differences in unit costs would then purely reflect differences in efficiency (Huber, 2006; Triplett, 2003). However, using those health-specific PPPs that are available to normalise unit costs denominated in national currencies is problematic as they are currently derived from the input side and thus disregard cross-country differences in efficiency among producers.
8. The potential for reduction in unit costs is defined as: (1 – unit cost indicator)*100%. Cost-savings could be achieved by reducing wage costs or other inputs used in the hospital sector (relative to other sectors), or by increasing technical efficiency by changing the way that physical inputs are transformed into outputs.
9. See endnote 5.

10. Implicitly, the comparison of unit costs reported here assumes that the intensity of treatment is constant across countries (see endnote 6). To the extent that it varies, the quality of each DRG category may be affected.

11. For the *lens procedures, inguinal* and *femorial hernia,* and *laparoscopic cholecystectomy* interventions, there are variations across countries to the extent that they are performed as outpatient activities (*i.e.* day surgery). Kittelsen *et al.* (2007) finds, for example, that Swedish hospitals use outpatient care less extensively than other Nordic countries.

12. A simple cross-country comparison shows, however, no clear correlation between investment in medical facilities and unit cost performance (see Annex for details), although there are recognised difficulties in measuring capital spending: hospitals may apply different principles for determining whether medical equipment should be regarded as operational expenditure and for assessing depreciation.

13. In OECD work on the linkages between performance and institutions in the primary and secondary education sector it was found that size of a school was a strong indicator of higher efficiency (Sutherland and Price, 2007).

14. Among the factors that may influence unit cost performance are market imperfections (*e.g.* low unit costs could reflect that hospitals have monopsony power in the market for health personnel) and organisational features (*e.g.* high unit costs may reflect that rehabilitation is conducted "in-house", whereas low unit costs reflect that post-surgical care is undertaken by other care providers).

15. However, a caveat should be entered about the robustness of this quality indicator. Huber (2006) finds that different indicators of quality of care tend to be weakly correlated.

16. Empirical evidence on efficiency in local public service provision indicates that high levels of local revenue are associated with low efficiency (Borge and Naper, 2006). The underlying argument is that the service producing agencies are able to take advantage of a rich sponsor to increase budgetary slack.

17. Empirical evidence indicates, however, that medical care may account for only a small proportion of improvements in health outcomes. For example, estimates by Bunker *et al.* (1994) suggest that medical care may account for only 17-18% of the improvement in life expectancy in the United States and the United Kingdom over the past century. In the same vein, Or (2000) finds that far more important for explaining differences in health outcomes in OECD countries than health care inputs are occupational status and the level of income.

18. See Worthington (2004) for a review of output specifications that have been adopted in empirical studies.

19. See Häkkinen and Joumard (2007) for a fuller discussion of appropriate data needed for carrying out international comparisons of hospital performance based on aggregate efficiency measures. An alternative indicator that may be utilised for cross-country comparisons is average length of hospital stay. Countries characterised by relatively short length of stay would typically be taken as relatively efficient, while countries with long length of stay would be taken as inefficient. However, several factors impede cross-country comparisons based on this indicator: first, length of stay is typically sensitive to how the treatment process is organised (*e.g.* whether or not post-surgical care is conducted "in-house" or by other care institutions, see Ham *et al.*, 2003; and Riksrevisjonen, 2003); second, length of stay may be difficult to interpret. For example, is long length of stay due to inefficiency or does it simply reflect the lack of effective co-ordination between care providers?

20. Mobley and Magnussen (1998) compared Norwegian and US (Californian) hospitals by matching four groups of hospitals according to type, hospital size and average length of stay. In addition, hospitals with outlier observations for the specified variables were excluded. Steinmann *et al.* (2004) compared Swiss and German (Saxony) hospitals by matching groups of hospitals according to type, number of beds, and number of cases treated per physician. Dervaux *et al.* (2004) compared France and US hospitals by matching groups of hospitals according to type and number of beds.

21. Linna *et al.* (2006) compared Norwegian and Finnish hospitals by utilising the common version of the NordDRG system, allowing a more accurate match of patient treatments across countries. Kittelsen *et al.* (2007) compared Danish, Finnish, Norwegian and Swedish hospitals based on the national versions of the NordDRG system, but where additional adjustments were made so as to ensure a common set of DRGs for all the four countries.

22. Non-parametric measurement methods imply constructing an efficiency frontier based on output and input data from a set of production units (*e.g.* hospitals or countries). In essence, the frontier is constructed from the production units that envelop the remaining observations and thus

provides a benchmark by which the others can be judged (Sutherland *et al.*, 2007). DEA is a frequently applied non-parametric measurement method, reflecting that it is relatively flexible (*e.g.* allowing for multiple outputs and inputs), but the method also has some drawbacks such as being sensitive to measurement errors. Given that competing methods (*e.g.* stochastic frontier analysis) also suffer from flaws, there is currently no consensus in the literature on the "best method" for deriving best practice production frontiers (Jacobs *et al.*, 2006).

23. Efficiency scores were derived separately for each group of hospitals.
24. For both countries, aggregate output measures were constructed by weighting discharges for each DRG with Finnish cost-weights. See also endnote 21.
25. Efficiency scores were derived from a pooled sample of observations. In addition, efficiency was measured separately, showing similar efficiency scores for Finnish hospitals as in the pooled sample, while somewhat higher efficiency scores for Norwegian hospitals.
26. Efficiency scores were derived from a pooled sample of observations. In addition, efficiency scores were derived on a pooled subset of observations (considered to be better comparable), showing similar efficiency scores on average for German hospitals, while somewhat lower for Swiss hospitals on average.
27. Efficiency scores were derived separately for each group of hospitals.
28. The following specifications were applied: output was measured by three types of discharges for inpatient care (medical, surgical and other), and two types of day care patients (medical and surgical), weighted with respective DRG cost-weights (based on a set of inter-Nordic weights). In addition outpatient visits were included as a measure of hospital output. Hospital current expenditure was used as a measure of input.
29. These preliminary figures are based on data that may be adjusted in the ongoing work.
30. As noted by Sutherland *et al.* (2007), a potential drawback with non-parametric approaches such as the DEA method is the so-called "curse of dimensionality", *i.e.* efficiency scores may be biased due to small samples and relatively large numbers of inputs and/or outputs. DEA is under such circumstances likely to produce less dispersion in efficiency scores, as more units will by construction be deemed efficient due to having a non-comparable input-output mix. In addition, the measured degree of inefficiency for each country (based on within-country analyses) will also be susceptible to the number of studies that the estimate is based on.
31. Assuming that all providers should perform more homogeneously might be too static an efficiency perspective. If innovation is important for longer term efficiency, then variation is not necessarily negative. In a number of countries, private hospitals as providers of publicly funded services could help stimulate innovation, which may increase variation as a prelude to spreading best-practice. In the study by Linna *et al.* (2006) quoted above, domestic dispersion in cost efficiency was found to be larger for Finnish hospitals than for Norwegian hospitals even though efficiency levels were higher. This evidence could be taken to indicate that despite being relatively efficient (on average) compared with Norwegian hospitals, some Finnish hospitals could become much more efficient by catching up to best performance.
32. Under the assumption of variable returns to scale production properties, the direction in which efficiency scores are computed (*i.e.* input-oriented or output-oriented) matters for the results. In contrast, this is not the case when assuming constant returns to scale (compare the corresponding discussion in the paper on public spending efficiency in primary and secondary education by Sutherland *et al.*, 2007).
33. Another factor which has reduced the sample size is the fact that many studies have not reported standard deviation figures.
34. Empirical evidence indicates that individual efficiency measures are sensitive to the output specification (Magnussen, 1996), which may also potentially change the measured coefficient of variation in aggregate efficiency measures.
35. Similarly, Mobley and Magnussen (1998) found that Californian for-profit-hospitals are relatively more heterogeneous in their performance than Norwegian public hospitals and Californian non-profit hospitals.

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Technical Annex

The Technical Annex contains source descriptions as well as more detailed material on some of the issues raised in the paper, and is presented in four sections showing: *i)* national DRG schedules used to calculate unit costs; *ii)* illustrations of the relationship between unit cost performance and investment in health care; *iii)* tests of the robustness of the relative country ranking with respect to unit cost performance, using alternative deflators to economy-wide Purchasing Power Parities (PPPs); and iv) within-country analyses utilised to calculate measures of domestic dispersion in individual hospital efficiency.

National sources utilised in calculating unit costs for seven DRGs

Tables A1-A10 describe the national sources used to derive unit costs for the seven DRGs covered in this paper. For all countries, the PPPs are taken from the OECD Analytical Database.

Table A1. **Australia (New South Wales)**

National source	"NSW Costs of Care Standards 2005/2006", published by the Department of Health, New South Wales. Cover public acute care hospitals, including district level and large (*e.g.* specialised) hospitals.	
Reference price, national currency	ASD 3 584 (including all cost groups, *i.e.* including care undertaken in emergency department and including intensive care cost groups). For the fiscal year 2005/2006.	
Cost elements included	Operational costs. Cost-weights are derived on the basis of cost data for the fiscal year 2003/2004. Cost data were collected from a sample of 84 hospitals.	
Is outpatient care included in the DRG schedule?	No. Separate schedules.	
Interventions examined:	Group number	Cost-weights
Primary prosthetic operation	I03B, I03C, I04B	5.21[1]
Laparoscopic cholecystectomy	H04B	1.29
Inguinal and femoral hernia	G09Z	0.91
Coronary bypass	F05A	9.04
Lens procedures	C08Z	0.94
Simple pneumonia and pleurisy	..	..
Vaginal delivery	O60D	0.75

1. Calculated as the unweighted average of the individual cost-weights for each of the three groups.

Table A2. **Denmark**

National source	"Takstsystem 2006 – en vejledning", published by Sundhedsstyrelsen.
Reference price, national currency	DKK 25 135.
Cost elements included	Operational costs, excluding pension payments, rate of return and depreciation. Cost-weights are derived on the basis of cost data for 2004. Cost data were collected from a sample of 43 public hospitals, representing 81% of annual discharges.
Is outpatient care included in the DRG schedule?	Yes, 75 day surgery groups are included.

Interventions examined:	Group number	Cost-weights
Primary prosthetic operation	0880, 0884, 0896	2.97[1]
Laparoscopic cholecystectomy	0 708	0.76
Inguinal and femoral hernia	0 620	0.59
Coronary bypass	0 507	4.74
Lens procedures	0205, 0206	DKK 8 293[2]
Simple pneumonia and pleurisy	0445, 0446	0.98[3]
Vaginal delivery	1 407	0.42

1. Calculated as the unweighted average of the individual cost-weights for each of the three groups.
2. Calculated as the unweighted average of the individual reimbursement rates for each of the two groups.
3. Calculated as the unweighted average of the individual cost-weights for each of the two groups.

Table A3. **Finland**

National source	"NordDRG-O-kustannuspainot 1-7/2006", published by the Association for Finnish municipalities on www.kunnat.net.
Reference price, national currency	EUR 531.
Cost elements included	Operational and capital costs, net of patient payments. Cost-weights are derived on the basis of cost data, collected from 7 hospitals in one (out of 21) hospital districts.
Is outpatient care included in the DRG schedule?	Yes, some day surgery groups are included.

Interventions examined:	Group number	Cost-weights
Primary prosthetic operation	209A	14.84
Laparoscopic cholecystectomy	494, 494O	4.09[1]
Inguinal and femoral hernia	162, 162O	2.74[1]
Coronary bypass	107C	32.46
Lens procedures	039A, 039B, 039O, 039P	2.01[2]
Simple pneumonia and pleurisy	089	5.86
Vaginal delivery	373	2.61

1. Calculated as the unweighted average of the individual cost-weights for each of the two groups.
2. Calculated as the unweighted average of the individual cost-weights for each of the four groups.

Table A4. **France**

National source	"Echelle nationale de coûts '2005' (données 2002-2003)", published by the Agence Technique de l'Information sur l'Hopitalisation (ATIH). Cover public hospitals.	
Reference price, national currency	Unit costs are calculated for each group directly. Figures are for the year 2005.	
Cost elements included	Operational costs. Cost-weights are derived from cost data collected from hospitals, representing 10-15% of annual discharges.	
Is outpatient care included in the DRG schedule?	..	
Interventions examined:	Group number	Unit costs, EUR
Primary prosthetic operation	08C02Z	11 697
Laparoscopic cholecystectomy	07C04V	3 390
Inguinal and femoral hernia	06C12V	2 312
Coronary bypass	05C04W	18 237
Lens procedures	02C05Z	2 081
Simple pneumonia and pleurisy	04M05W	4 689
Vaginal delivery	14Z02A	2 131

Table A5. **Germany**

National source	"Fallpauschalen-Katalog G-DRG version 2001, Anlage 1", published by the Institut für das Entgeltsystem im Krankenhaus (InEK GmbH) on *www.g-drg.de.*	
Reference price, national currency	The reference price (base rate) for 2005 was EUR 2 785 (national average), according to the article "Cost accounting to determine prices: How well do prices reflect costs in the German DRG-system?", by Schreyögg *et al.* (2006), published in the Health Care Management Science 2006 (9). The base rate for 2006 is calculated by extrapolating the 2005 base rate with the increase in the base rate from 2004 to 2005 (7.4% according to Schreyögg *et al.*). The national average base rate (reference price) for 2006 is thus calculated to EUR 2 991.	
Cost elements included	Operational costs. Cost-weights are derived on the basis of 2004 cost data, collected from 284 (out of 1 800) hospitals.	
Is outpatient care included in the DRG schedule?	Day cases are reimbursed separately.	
Interventions examined:	Group number	Cost-weights
Primary prosthetic operation	I03Z, I04Z	3.87[1]
Laparoscopic cholecystectomy	H08B	0.88
Inguinal and femoral hernia	G09Z	0.83
Coronary bypass	F05Z	6.18
Lens procedures	C08Z	0.44
Simple pneumonia and pleurisy	..	..
Vaginal delivery	060D	0.55

1. Calculated as the unweighted average of the individual cost-weights for each of the two groups.

Table A6. **Iceland**

National source	"DRG prizelist 2006 for patients within the Icelandic Social Security System", provided by Landspitali University Hospital.	
Reference price, national currency	ISK 356 728.	
Cost elements included	Operational costs. Currently, Swedish cost-weights (mainly for Vestra Gotaland) are applied.	
Is outpatient care included in the DRG schedule?	Yes, 139 day surgery groups are included.	
Interventions examined:	Group number	Cost-weights
Primary prosthetic operation	209A	2.92
Laparoscopic cholecystectomy	494, 494O	0.87[1]
Inguinal and femoral hernia	162, 162O	0.62[1]
Coronary bypass	107C	6.32
Lens procedures	039, 039O	0.41[1]
Simple pneumonia and pleurisy	089	1.08
Vaginal delivery	373	0.61

1. Calculated as the unweighted average of the individual cost-weights for each of the two groups.

Table A7. **Norway**

National source	"Innsatsstyrt finansiering 2006", published by the Norwegian Ministry of Health	
Reference price, national currency	NOK 31 614.	
Cost elements included	Operational costs. Cost-weights are derived on the basis of 2004 cost data, collected from a sample of 21 hospitals.	
Is outpatient care included in the DRG schedule?	Yes, 155 day surgery groups and 12 medical day care groups are included.	
Interventions examined:	Group number	Cost-weights
Primary prosthetic operation	209A	4.50
Laparoscopic cholecystectomy	494	1.54
Inguinal and femoral hernia	162	0.57
Coronary bypass	107C	4.91
Lens procedures	039	0.42
Simple pneumonia and pleurisy	089	1.60
Vaginal delivery	373	0.50

Table A8. **Sweden**

National source	"The NordDRG Full 2006", published by Centrum för Patientklassificering.	
Reference price, national currency	SEK 44 300 for 2005, according to Centrum för Patientklassificering. For 2006, the reference price is calculated by extrapolating the 2005 reference price with the annual increase in the reference price over the period 2002-2005 (3.6%). Hence, for 2006 the reference price is calculated to SEK 45 895.	
Cost elements included	Operational and capital costs.	
Is outpatient care included in the DRG schedule?	Yes, some day surgery groups are included.	
Interventions examined:	Group number	Cost-weights
Primary prosthetic operation	209A	2.06
Laparoscopic cholecystectomy	494, 494O	0.85[1]
Inguinal and femoral hernia	162, 162O	0.59[1]
Coronary bypass	107C	4.05
Lens procedures	039, 039O	0.39[1]
Simple pneumonia and pleurisy	089	0.92
Vaginal delivery	373	0.56

1. Calculated as the unweighted average of the individual cost-weights for each of the two groups.

Table A9. **United Kingdom**

National source	Payment by Results in 2006/07, published by the UK Department of Health. For England.
Reference price, national currency	Reimbursement tariffs are calculated for each group directly. Figures are for the fiscal year 2006/2007.
Cost elements included	Operational costs and rents, excluding teaching. Tariffs are derived on the basis of cost data, collected from all NHS hospitals in England.
Is outpatient care included in the DRG schedule?	Yes.

Interventions examined:	Group number	Tariffs, £
Primary prosthetic operation	H04, H80, H81	5 206[1]
Laparoscopic cholecystectomy	G14	1 734
Inguinal and femoral hernia	F74	1 001
Coronary bypass	E04	7 195
Lens procedures	B13, B14, B15	719[1]
Simple pneumonia and pleurisy	D42	3 359
Vaginal delivery	N07	735

1. Calculated as the unweighted average of the individual cost-weights for each of the three groups.

Table A10. **United States**

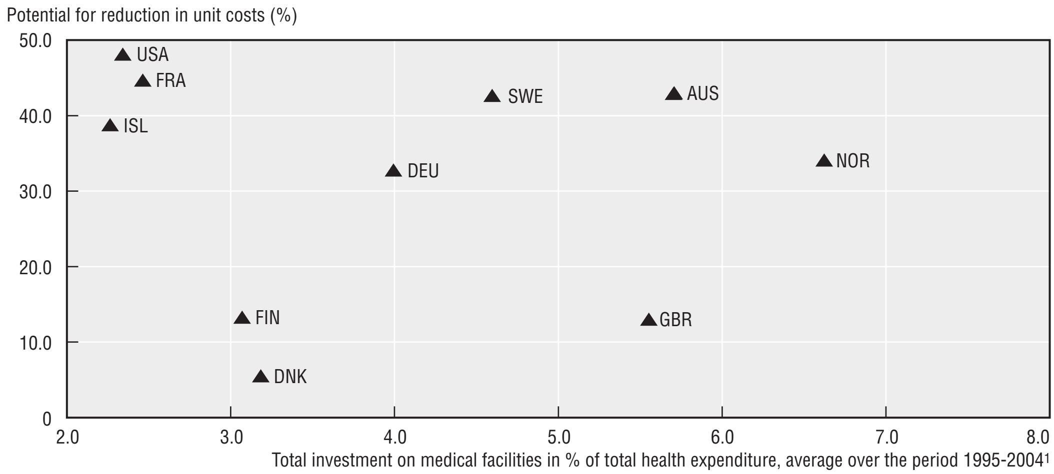
National source	"Top 30 Elective Inpatient Hospitals DRGs", published by the US Center for Medicare and Medicaid Services.
Reference price, national currency	National average Medicare payments.
Cost elements included	The sum of Medicare payments for the DRG, including teaching, disproportionate share, capital, and outlier payments for all cases. Also included in Medicare payments are co-payments and deductibles paid by patients.
Is outpatient care included in the DRG schedule?	..

Interventions examined:	Group number	National average payments, USD
Primary prosthetic operation	209	11 761
Laparoscopic cholecystectomy	494	5 971
Inguinal and femoral hernia		
Coronary bypass		
Lens procedures		
Simple pneumonia and pleurisy	089	5 934
Vaginal delivery		

Cross-country variation in unit costs and investment in medical facilities

Figures A1-A.3 illustrate the relationship between unit costs and different measures of investment in medical facilities, showing that there seems to be no apparent correlation.

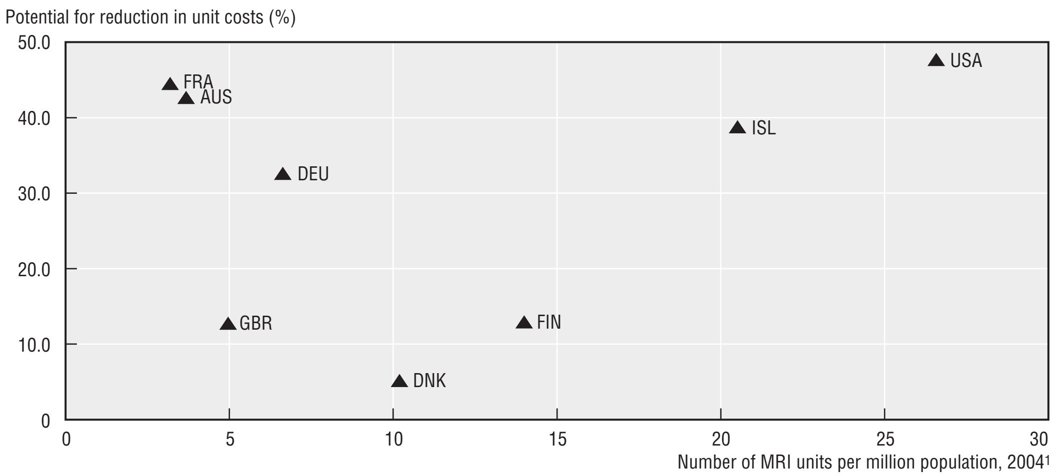
Figure A1. **Cross-country variation in hospital unit costs and investment in medical facilities**



1. Total investment on medical facilities comprises gross capital formation of domestic (public and private) health care provider institutions, excluding those engaged in the retail sale of medical goods and other providers of medical goods. Public investment on health includes publicly financed gross capital formation in health facilities plus capital transfers to the private sector for hospital construction and equipment. Private investment on health comprises private gross capital formation in health care provider industries (excluding retail sale of medical goods.) It excludes capital transfers received from the public sector. Investment in medical facilities does not include depreciation.

Source: OECD Health Data 2006.

Figure A2. **Cross-country variation in hospital unit costs and MRI units**[1]



1. Number of magnetic resonance imaging (MRI) units per million population. MRI refers to a diagnostic modality in which the magnetic nuclei (especially protons) of a patient are aligned in a strong, uniform magnetic field, absorb energy from tuned radio frequency pulses, and emit radio frequency signals as their excitation decays. These signals, which vary in intensity according to nuclear abundance and molecular chemical environment, are converted into sets of tomographic images by using field gradients in the magnetic field, which permit 3-D localization of the point sources of the signals. Unlike conventional radiography or CT, MRI does not expose patients to ionizing radiation.

Source: OECD Health Data 2006.

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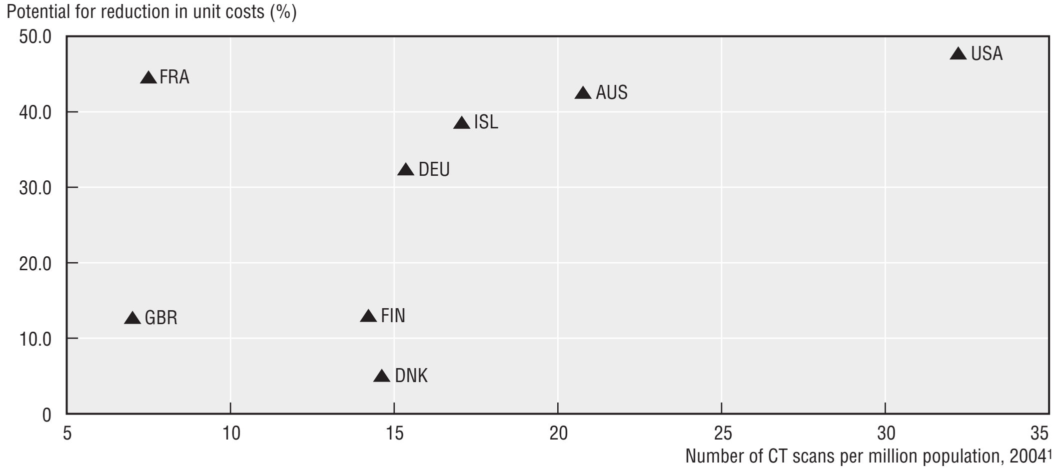
Figure A3. **Cross-country variation in hospital unit costs and CT units**[1]



1. Number of computed tomography (CT) scanners, also known as "CAT" scans for computed axial tomography. CT scanners image anatomical information from a cross sectional plane of the body. Each image is generated by a computer synthesis of x-ray transmission data obtained in many different directions in a given plane.

Source: OECD Health Data 2006.

Testing the robustness of country ranking on cost performance by using alternative deflators

The comparisons of unit costs for specific hospital interventions are based on deflating unit costs denominated in national currency by economy-wide PPPs. To test the robustness of the resulting country ranking, two alternative deflators have been applied, gross wage earnings* and GDP per capita measured in basic prices excluding FISIM.

Using gross wage earnings to deflate national unit costs

Table A.11 displays unit costs for each of the seven hospital interventions covered measured relative to gross wage earnings. Data on wages are taken from the *OECD Taxing Wages 2004-2005* publication (Table I.6). As 2005 is the latest year for which data are available, they have been extrapolated to 2006 levels with the projected wage growth rate from 2005 to 2006 taken from the OECD Analytical Database.

Table A11. **Unit costs for seven hospital interventions measured relative to gross wage earnings, 2006**

	Gross wage earnings, national currency	Unit costs, national currency	Unit costs in % of gross wage earnings
		Primary prosthetic operation	
Australia	54 197	18 667	34.4
Denmark	339 355	74 567	22.0
Finland	33 557	7 879	23.5
France	31 140	11 697	37.6
Germany	41 339	11 576	28.0
Iceland	3 182 911	1 042 110	32.7
Norway	395 245	142 263	36.0
Sweden	318 868	94 387	29.6
United Kingdom	29 598	5 206	17.6
United States	33 914	11 761	34.7

* Average gross wage earnings of adult, full-time workers covering industry sectors C-K inclusive in the ISIC Rev.3 classification, *i.e.* total economy excluding agriculture, fishing and the public sector.

Table A11. **Unit costs for seven hospital interventions measured relative to gross wage earnings, 2006** *(cont.)*

	Gross wage earnings, national currency	Unit costs, national currency	Unit costs in % of gross wage earnings
		Laparoscopic cholecystectomy	
Australia	54 197	4 618	8.5
Denmark	339 355	19 103	5.6
Finland	33 557	2 173	6.5
France	31 140	3 390	10.9
Germany	41 339	2 641	6.4
Iceland	3 182 911	309 497	9.7
Norway	395 245	48 686	12.3
Sweden	318 868	38 983	12.2
United Kingdom	29 598	1 734	5.9
United States	33 914	5 971	17.6
		Inguinal and femoral hernia	
Australia	54 197	3 265	6.0
Denmark	339 355	14 830	4.4
Finland	33 557	1 456	4.3
France	31 140	2 312	7.4
Germany	41 339	2 483	6.0
Iceland	3 182 911	220 939	6.9
Norway	395 245	18 020	4.6
Sweden	318 868	27 193	8.5
United Kingdom	29 598	1 001	3.4
United States	33 914	..	5.7[1]
		Coronary bypass	
Australia	54 197	32 389	59.8
Denmark	339 355	119 140	35.1
Finland	33 557	17 235	51.4
France	31 140	18 237	58.6
Germany	41 339	18 497	44.7
Iceland	3 182 911	2 254 378	70.8
Norway	395 245	155 225	39.3
Sweden	318 868	186 090	58.4
United Kingdom	29 598	7 195	24.3
United States	33 914	..	**49.1**[1]
		Lens procedures	
Australia	54 197	3 373	6.2
Denmark	339 355	8 293	2.4
Finland	33 557	1 065	3.2
France	31 140	2 081	6.7
Germany	41 339	1 325	3.2
Iceland	3 182 911	147 382	4.6
Norway	395 245	13 278	3.4
Sweden	318 868	18 057	5.7
United Kingdom	29 598	719	2.4
United States	33 914	..	4.2[1]

Table A11. **Unit costs for seven hospital interventions measured relative to gross wage earnings, 2006** *(cont.)*

	Gross wage earnings, national currency	Unit costs, national currency	Unit costs in % of gross wage earnings
		Simple pneumonia and pleurisy	
Australia	54 197	..	13.0[1]
Denmark	339 355	24 507	7.2
Finland	33 557	3 109	9.3
France	31 140	4 689	15.1
Germany	41 339	..	13.01
Iceland	3 182 911	384 303	12.1
Norway	395 245	50 582	12.8
Sweden	318 868	42 430	13.3
United Kingdom	29 598	3 359	11.3
United States	33 914	5 934	22.9
		Vaginal delivery	
Australia	54 197	2 669	4.9
Denmark	339 355	10 557	3.1
Finland	33 557	1 388	4.1
France	31 140	2 131	6.8
Germany	41 339	1 657	4.0
Iceland	3 182 911	217 604	6.8
Norway	395 245	15 807	4.0
Sweden	318 868	25 605	8.0
United Kingdom	29 598	735	2.5
United States	33 914	..	4.9[1]

1. Figures in bold indicate that the average value has been set in.
Source: OECD Taxing Wages 2004-2005.

Table A12 shows the resulting country ranking when averaging across the seven interventions.

Table A12. **Country ranking when unit costs are measured relative to gross wage earnings**

Indicator range from 1 to 10, with 1 as best performance

	Unit costs in % of gross wage earnings, averaged over seven interventions	Country ranking
Australia	19.0	6
Denmark	11.4	2
Finland	14.6	3
France	20.4	9
Germany	15.1	4
Iceland	20.5	10
Norway	16.0	5
Sweden	19.4	7
United Kingdom	9.6	1
United States	19.9	8

Using GDP per capita measured in basic prices to deflate national unit costs

Table A13 displays unit costs for each of the seven interventions covered measured relative to GDP per capita measured in basic prices (2005 is the latest year for which population data are available). Data are taken from the OECD National Accounts Database.

Table A13. **Unit costs for seven hospital interventions measured relative to GDP per capita, basic prices, 2005**

	GDP per capita in basic prices, national currency 2005	Unit costs, national currency	Unit costs in % of GDP per capita in basic prices
		Primary prosthetic operation	
Australia	45 930	18 667	42.8
Denmark	286 937	74 567	30.7
Finland	30 030	7 879	30.3
France	28 050	11 697	46.5
Germany	27 060	11 576	47.3
Iceland	3 421 168	1 042 110	39.9
Norway	411 793	142 263	38.1
Sweden	295 742	94 387	36.6
United Kingdom	20 351	5 206	27.5
United States	42 022	11 761	31.8
		Laparoscopic cholecystectomy	
Australia	45 930	4 618	10.6
Denmark	286 937	19 103	7.9
Finland	30 030	2 173	8.4
France	28 050	3 390	13.5
Germany	27 060	2 641	10.8
Iceland	3 421 168	309 497	11.9
Norway	411 793	48 686	13.0
Sweden	295 742	38 983	15.1
United Kingdom	20 351	1 734	9.2
United States	42 022	5 971	16.1
		Inguinal and femoral hernia	
Australia	45 930	3 265	7.5
Denmark	286 937	14 830	6.1
Finland	30 030	1 456	5.6
France	28 050	2 312	9.2
Germany	27 060	2 483	10.1
Iceland	3 421 168	220 939	8.5
Norway	411 793	18 020	4.8
Sweden	295 742	27 193	10.5
United Kingdom	20 351	1 001	5.3
United States	42 022	..	**7.5**[1]

Table A13. **Unit costs for seven hospital interventions measured relative to GDP per capita, basic prices, 2005** *(cont.)*

	GDP per capita in basic prices, national currency 2005	Unit costs, national currency	Unit costs in % of GDP per capita in basic prices
		Coronary bypass	
Australia	45 930	32 389	74.3
Denmark	286 937	119 140	49.1
Finland	30 030	17 235	66.3
France	28 050	18 237	72.5
Germany	27 060	18 497	75.6
Iceland	3 421 168	2 254 378	86.4
Norway	411 793	155 225	41.6
Sweden	295 742	186 090	72.1
United Kingdom	20 351	7 195	38.0
United States	42 022	..	**64.0**[1]
		Lens procedures	
Australia	45 930	3 373	7.7
Denmark	286 937	8 293	3.4
Finland	30 030	1 065	4.1
France	28 050	2 081	8.3
Germany	27 060	1 325	5.4
Iceland	3 421 168	147 382	5.6
Norway	411 793	13 278	3.6
Sweden	295 742	18 057	7.0
United Kingdom	20 351	719	3.8
United States	42 022	..	**5.4**[1]
		Simple pneumonia and pleurisy	
Australia	45 930	..	**14.9**[1]
Denmark	286 937	24 507	10.1
Finland	30 030	3 109	12.0
France	28 050	4 689	18.6
Germany	27 060	..	**14.9**[1]
Iceland	3 421 168	384 303	14.7
Norway	411 793	50 582	13.6
Sweden	295 742	42 430	16.4
United Kingdom	20 351	3 359	17.8
United States	42 022	5 934	16.0
		Vaginal delivery	
Australia	45 930	2 669	6.1
Denmark	286 937	10 557	4.3
Finland	30 030	1 388	5.3
France	28 050	2 131	8.5
Germany	27 060	1 657	6.8
Iceland	3 421 168	217 604	8.3
Norway	411 793	15 807	4.2
Sweden	295 742	25 605	9.9
United Kingdom	20 351	735	3.9
United States	42 022	..	**6.4**[1]

1. Figures in bold indicate that the average value has been set in.

Source: OECD National Accounts Database, 2005.

Table A14 shows the resulting country rankings when simply averaging across the seven interventions.

Table A14. **Country ranking when unit costs are measured relative to GDP per capita**

Indicator range from 1 to 10, with 1 as best performance

	Unit costs in % of GDP per capita measured in basic prices, averaged over seven interventions	Country ranking
Australia	23.4	6
Denmark	15.9	2
Finland	18.9	4
France	25.3	10
Germany	24.4	8
Iceland	25.1	9
Norway	17.0	3
Sweden	24.0	7
United Kingdom	15.1	1
United States	21.0	5

Source: *OECD National Accounts Database*, 2005.

Summarising the different sets of country rankings

Table A15 shows country rankings on unit cost performance based on three different deflators. Overall, the correlation between the ranking based on PPP adjustment and those based on alternative deflators is relatively high (0.842 when using gross wage earnings, and 0.624 when using GDP per capita in basic prices).

Table A15. **Country rankings based on three types of deflator**

Indicator range from 1 to 10, with 1 as best performance

	PPPs	Gross wage earnings	GDP per capita in basic prices
Australia	8	6	6
Denmark	1	2	2
Finland	3	3	4
France	9	9	10
Germany	4	4	8
Iceland	6	10	9
Norway	5	5	3
Sweden	7	7	7
United Kingdom	2	1	1
United States	10	8	5

Source: See Tables 12 and 14.

Utilising empirical studies to construct measures of domestic dispersion in hospital efficiency

Table A16 shows the national studies utilised in calculating measures of domestic dispersion in aggregate efficiency.

Table A16. **Within-country hospital studies**

	Within-country analyses
Australia	• Webster, R., S. Kennedy and L. Johnson (1998), "Comparing Techniques for Measuring the Efficiency and Productivity of Australian Private Hospitals", *Australian Bureau of Statistics, Working Papers in Econometrics and Applied Statistics* No. 98/3.
Germany	• Staat, M. (2006), "Efficiency of Hospitals in Germany: A DEA-bootstrap Approach", *Applied Economics*, 38, pp. 2255-2263.
Italy	• Cellini, R., G. Pignataro and I. Rizzo (2000), "Competition and Efficiency in Health Care: An Analysis of the Italian Case", International Tax and Public Finance, 7, pp. 503-519. • Rebba, V. and D. Rizzi (2006), "Measuring Hospital Efficiency through Data Envelopment Analysis when Policy-makers' Preferences Matter", *University of Venice, Department of Economics Working Paper.*
Norway	• Biørn, E., T.P. Hagen, T. Iversen and J. Magnussen (2006), "Heterogeneity in Hospitals' Responses to a Financial Reform – A Random Coefficient Analysis of the Impact of Activity-based Financing on Efficiency", *Health Economics Research Programme Working Paper* No. 2006:9, University of Oslo. • Magnussen, J. (1996), "Efficiency Measurement and the Operationalization of Hospital Production", *Health Services Research*, 31:1, pp. 22-37.
Spain	• Dalmau-Matarrodona, E. and J. Puig-Junoy (1998), "Market Structure and Hospital Efficiency: Evaluating Potential Effects of Deregulation in a National Health Service", *Review of Industrial Organization*, 13, pp. 447-466. • Lopez-Valcarcel, B.G. and P.B. Perez (1996), "Changes in the Efficiency of Spanish Public Hospitals after the Introduction of Program Contracts", *Investigaciones Economicas*, XX (3), pp. 377-402. • Prior, D. and M. Solà (2000), "Technical Efficiency and Economies of Diversification in Health Care", *Health Care Management Science*, 3, pp. 299-307.
United Kingdom	• Jacobs, R., P.C. Smith and A. Street (2006), *Measuring Efficiency in Health Car*e, Cambridge University Press, Cambridge, UK. • Parkin, D. and B. Hollingsworth (1997), "Measuring Production Efficiency of Acute Hospitals in Scotland, 1991-94: Validity Issues in Data Envelopment Analysis", *Applied Economics,* 29, 1 pp. 425-1433.
United States	• Bates, L.J., K. Mukherjee and R.E. Santerre (2005), "The Impact of Market Pressure on Hospital X-Inefficiency: A DEA approach", *mimeo*. • Ferrier, G.D. and V.G. Valdmanis (2005), "Peer Effects and Efficiency: The Influence of Competitors' Performance on Hospital Efficiency", *mimeo.* • Friesner, D.L., M.Q. McPherson and R. Rosenman (2006), "Are Hospitals Seasonally Inefficient? Evidence from Washington State Hospitals", *School of Economic Sciences Working Paper* No. 3, Washington State Univeristy. • Harrison, J.P., M.N. Coppola and M. Wakefield (2004), "Efficiency of Federal Hospitals in the United States", *Journal of Medical System*s, 28, 5, pp. 411-422.