chapter seven

DRG-based hospital payment and efficiency: Theory, evidence, and challenges

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7.1 Introduction

Diagnosis-related groups (DRGs) were first used to pay hospitals in 1983 under the Medicare Program in the United States. This development was born out of a need to move away from an approach to hospital financing based on fee-for-service payments, which was seen as inherently inefficient and increasingly expensive. Since then, DRG-based hospital payment has been widely adopted internationally with the explicit objective of improving efficiency, principally because of its three overarching strengths, summarized here (see Chapter 2 for further details).

1. By relating provider revenue directly to their workload, DRG-based hospital payment offers greater transparency in the financing of health care.
2. Payments are based on patient characteristics (predominantly demographic and clinical). Fundamental to effective DRG-based hospital payment is an accurate description of the type of patients treated (casemix).
3. DRG-based hospital payment is a form of 'yard stick competition', designed to encourage greater efficiency in the absence of market competition.

Concentrating on the third strength, this chapter considers the relationship between DRG-based hospital payment and efficiency from theoretical and empirical perspectives. It thus first discusses the concepts 'efficiency' and 'yard stick competition'. Different hospital payment models are then compared in section 7.2, with the intention of indicating in each case the incentives for hospitals to pursue efficient behaviour, particularly in terms of maximizing

output and minimizing cost. The empirical evidence regarding the impact of DRG-based hospital payment on efficiency is reviewed in section 7.3 by looking at studies that consider efficiency as defined by economists and those that focus on indicators of efficient practice. Finally, the chapter outlines in section 7.4 some key challenges associated with the use of DRG-based hospital payment. While economic theory suggests that this hospital payment system may provide incentives to encourage efficiency, there could be barriers (such as the system's particular design and operation) to realizing these incentives in practice.

'Efficiency' is a widely used term that can have various meanings. Economists make distinctions between technical, cost- and allocative efficiency. Technical efficiency is defined as maximizing output for given input levels or, in this context, treating as many patients as possible given the resources available. Hospitals are cost-efficient when they minimize costs for any given output level (closely related to, but distinct from, technical efficiency). Allocative efficiency can be defined for both outputs and inputs. The optimal output mix depends on the value of each output, which requires judgements to be made on the relative values of an appendectomy operation, a heart bypass and all other health care interventions. The optimal mix of inputs depends on the relative price of each input type, such as the salaries of doctors and nurses. Alongside these economic terms, reference is often made to things thought to be indicative of efficient behaviour, which – in the hospital sector – might include the number and type of patients treated, unit costs and length of stay, for example. The extent to which DRGs contribute to achieving these forms of efficiency depends on how they are used for payment purposes, which helps to determine the incentives hospitals face to pursue efficient behaviour.

Yard stick competition is designed to encourage providers to reduce their costs in contexts in which they face limited competitive pressure (Shleifer, 1985). If providers outperform others they benefit directly by retaining the generated financial surplus; if they underperform they generate deficits and, ultimately, risk bankruptcy. All providers, including the most efficient, are incentivized to continually reduce costs. Yard stick competition is effective when regulated prices are virtually independent of an individual provider's costs. Ideally, prices should reflect the supply costs of efficient providers, determined across all providers within the same industry.

However, it is not straightforward to identify efficient providers, especially if the regulator is poorly informed about the provider's costs, the exogenous influences on these costs and the level of effort expended by the provider (that is, their efficiency). This asymmetry of information is particularly problematic in the health care sector. In practice, price is often determined on the basis of the average cost of all or a sample of providers (see Chapter 5), although it may remain preferable to base it on 'best practice', set at the level of efficient high-quality providers that deliver care at costs below the average costs in other hospitals. In England, such 'best practice tariffs' have recently been introduced for certain high-volume areas (such as cholecystectomy, hip fractures, cataracts, and stroke), with significant unexplained variation in quality of clinical practice and clear evidence of what constitutes best practice (see Chapter 12).

7.2 Hospital payment models

To understand the role of DRG-based hospital payment in enhancing efficiency, we compare (simplified versions of) the three main forms of provider payment models used in hospital financing: cost-based reimbursement (also known as fee-for-service payment), the global budget model, and DRG-based payment.

7.2.1 Cost-based or fee-for-service reimbursement

With cost-based reimbursement, payments to hospitals are based on the cost incurred by each individual patient (plus potentially a profit margin). The main method of cost control is to specify a price list that details the unit payment for each 'item of service' (for example, medication, X-ray, procedure). Hospitals must therefore provide itemized bills for every patient treated, but there is no incentive to limit what treatments they provide per insured patient – the more diagnostic tests they perform, the more they get paid.

Stated formally, with cost-based reimbursement, hospital revenue (R^C) amounts to the number of patients treated (Q_i) multiplied by the unit cost of treatment (c_i), where i indicates a particular patient:

$$R^C = \sum_{i=1}^{I} [Q_i \times c_i] + Z^C \tag{1}$$

Z^C captures all other forms of revenue that hospitals receive, such as funds for teaching and research. In the hospital sector, cost-based reimbursement was primarily used in the United States during the 1960s and 1970s. This fuelled escalation in health care costs as hospitals engaged in a 'medical arms race', spending ever more on technologies and facilities to attract patients. Hospitals knew that they could reclaim the costs from health insurance companies as well as Medicare and Medicaid, the public insurance programmes for older people and those with low incomes.

7.2.2 Global budgets

Cost control is one of the key advantages of global budget arrangements, which have been used in many European health care systems, at least if the budget constraint is credible and binding, and a separation exists between a payer (also known as 'purchaser') and hospitals as providers of care. This division has traditionally been present in social health insurance systems and, since the 1990s, increasingly also in tax-funded systems (Robinson et al., 2005). A fixed payment is agreed in advance for a target level of activity – often specified at specialty level. Figure 7.1 illustrates the case in which a hospital receives a fixed payment ($\bar{R}$) for carrying out a pre-specified volume of health service activity ($\bar{Q}$).

Difficulties arise if there are deviations from the pre-specified volume. Some form of penalty must be imposed if the volume is not achieved. If the pre-specified volume – usually defined as the number of hospital cases – is exceeded

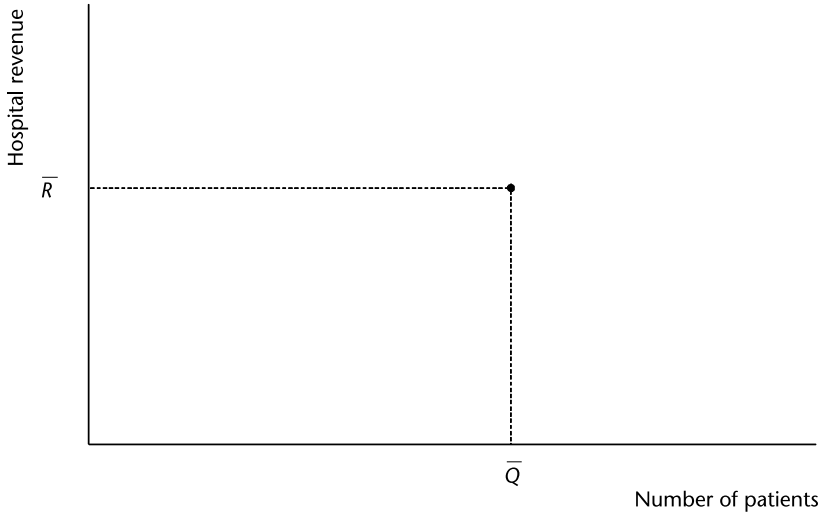

Figure 7.1 Hospital revenues under global budgets

Source: Street et al., 2007.

('overperformance'), the funder must either provide extra money or the hospital will refuse to do extra work, thereby creating waiting lists. 'Cost and volume' contracts were developed to deal with these problems, and we return to a DRG-based hospital payment form of these in the following subsection (7.2.3).

In more advanced global budget systems, activity is specified by specialty. Negotiations between the payer (whether this is a sickness fund or a health authority) and the hospital revolve around the monetary value of each specialty-level contract (B_s) and how much activity ($\overline{Q}_s$) – usually defined as cases per specialty – will be provided under this contract. The local specialty-level price (p_s) is the by-product of negotiations relating to total contract value and the volume of activity. In formal terms, with the approach to financing that uses global budgets, hospital revenue comprises the sum of its contracts across specialties (B_s):

$$R^G = \sum_{s=1}^{S} B_s + \mathbf{Z}^G = \sum_{s=1}^{S} [\overline{Q}_s \times p_s] + \mathbf{Z}^G \quad (2)$$

where $\mathbf{Z}^G$ captures all other forms of revenue that hospitals receive within the framework of these payment arrangements.

7.2.3 DRG-based hospital payment

There are two key features of DRG-based hospital payment. (1) Activity is described using DRGs rather than by specialty. For instance, payment is made for a patient receiving a hip replacement rather than a patient treated in trauma and orthopaedics. (2) The reimbursement per DRG is to a large extent fixed in

advance, as patient characteristics (especially the main diagnosis) determine the DRG category with its fixed 'price'. As this constituted a major shift from the 'retrospective' system of cost-based reimbursement, payment by DRGs was thus termed 'prospective' in the United States – a term which was inappropriate for systems with a global budget approach to financing (where instead 'activity-based' was used to describe the new payment system). As shown in Chapter 4, the 'prospective' nature of DRGs is also weaker if to a large extent procedures determine the DRG classification. However, whether driven by diagnosis or procedure, the 'price' of a DRG is wholly or at least partially independent of an individual provider's costs (see Chapter 5). In many jurisdictions, this fixed price is set nationally rather than locally (see Chapter 6).

The relationship between the unit price and amount of activity can take a number of forms. The main ones discussed here are:

1. linear payments, whereby the total payment equals price multiplied by quantity;
2. mixed payments, whereby hospitals receive additional payments (often in the form of lump sums) that are unrelated to activity levels;
3. marginal payments, whereby different prices are payable for the same type of activity, depending on the quantity provided;
4. mixed and marginal payments, which are a combination of (2) and (3).

To understand the differences between these payment arrangements, we consider how the total revenue received by a particular hospital is calculated.

Linear payments

With the most straightforward DRG-based hospital payment system, using linear payments, hospital revenue is determined simply by multiplying activity in each DRG (Q_j) by the fixed price per DRG ($\hat{p}_j$), where j indicates a DRG:

$$R^A = \sum_{j=1}^{J} [Q_j \times \hat{p}_j] \tag{3}$$

Using this formulation, hospital revenue increases linearly with activity, as illustrated in Figure 7.2. If the hospital treats Q_0 patients it receives revenue amounting to only R_0; if Q_1 patients are treated, revenue increases to R_1. Clearly, then, the revenue consequences of changes in activity are much more transparent than within a system based on global budget arrangements.

Mixed payments

In almost all countries that have introduced DRG-based hospital payment, hospital revenue is not determined solely by the number of patients treated. Hospitals also receive revenue in other forms – for instance, to fund teaching and research, to compensate for different geographical costs, or to cover some element of the fixed costs of providing services. It has been formally demonstrated that such a 'mixed' hospital payment system creates better incentives than 'pure' systems (Ellis & McGuire, 1986; Barnum et al., 1995). The composition

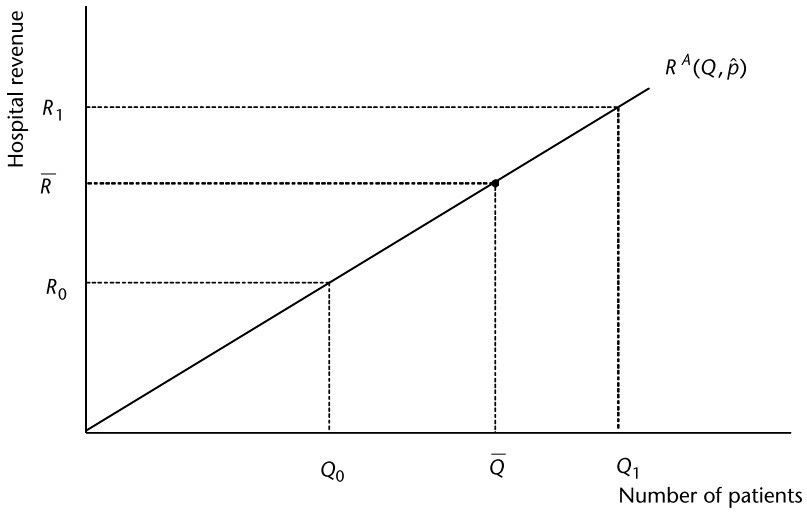

Figure 7.2 Hospital revenue under 'pure' DRG-based hospital payment

Source: Street et al., 2007.

of these other revenue forms is a matter of negotiation between the payer (or 'purchaser') and the hospital sector, and may vary between hospitals, between countries and over time. We define $\mathbf{Z}^A$ as capturing all these sources of revenue not related to health care activity within the category 'DRG-based hospital payment'. Then the revenue function becomes:

$$R^A = \sum_{j=1}^{J} [Q_j \times \hat{p}_j] + \mathbf{Z}^A \tag{4}$$

Figure 7.3 shows how this arrangement changes the relationship between revenue and activity. Hospitals receive a fixed amount $\mathbf{Z}^A$ irrespective of the number of patients treated. On top of this, hospitals receive revenue in line with activity – but the unit price ($\hat{p}_j$) will be lower within the framework of this 'mixed' arrangement than within a 'pure' DRG-based system.

Marginal payments

DRG-based hospital payment can be modified to allow incentives to vary with supply. Quite often, DRG-based hospital payment is introduced to stimulate activity beyond existing levels. But unconstrained growth in activity may be undesirable. First, it undermines control over global expenditure – under the simple formulation (see equation (3)), expenditure may simply keep rising in line with activity. Second, hospitals may be able to expand activity at low marginal cost – perhaps because they have underutilized resources available – and, thus, this differential pricing may be used to exploit economies of scale. If so, there is an argument for reducing the unit price for additional activity.

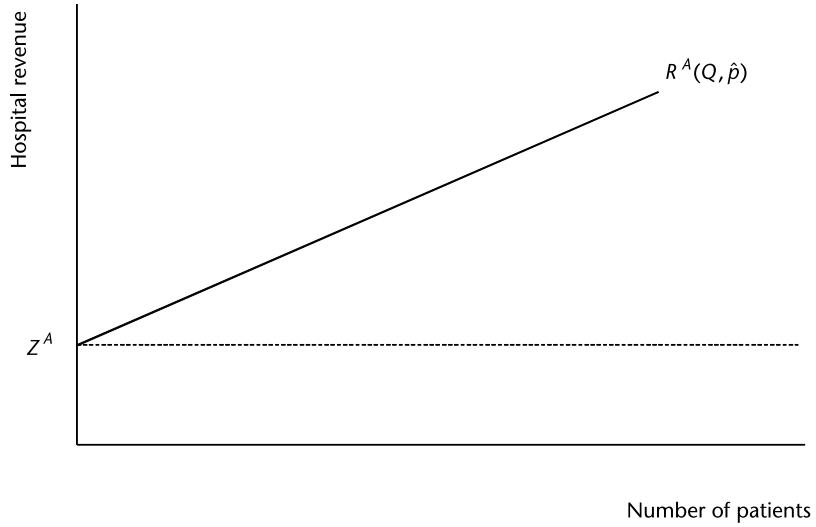

Figure 7.3 Hospital revenue under 'mixed' DRG-based hospital payment

Source: Street et al., 2007.

The resulting arrangements are akin to 'cost and volume' contracts. Two policy decisions are required.

1. A 'target' level of activity ($\overline{Q}_j$) should be defined for each hospital. In some countries, this is based on historical activity. Agreeing a target is more difficult where there is decentralized purchasing, such as in England, because the target has to be agreed between each purchaser and provider.
2. The price that should be paid for activity above the target level must be agreed – this is usually defined as some proportion (α) of the price up to the target level. Formally the revenue function can be expressed as:

$$R^A = \sum_{j=1}^{J} [\overline{Q}_j \times \hat{p}_j] + \sum_{j=1}^{J} [(Q_j - \overline{Q}_j) \times \alpha \hat{p}_j] + \mathbf{Z}^A \quad (5)$$

where $(Q_j - \overline{Q}_j)$ is non-negative and represents activity above the target and $\alpha \hat{p}_j$ is the price paid per unit of additional activity. If $\alpha = 0.5$, the price for additional activity is 50 per cent of that paid for activity up to the target; if $\alpha = 1$, the same price is paid (in which case equations (4) and (5) are equivalent); if $\alpha = 0$, the marginal price is zero, so there is no incentive for hospitals to undertake more activity; and if $\alpha > 1$, additional payments are higher than the base price, which creates very strong incentives to undertake additional work. This may be justified if marginal costs are high, as expansions in activity require additional investment.

Figure 7.4 shows how revenue changes under this arrangement, when the marginal price for additional activity is below the price for activity up to the target; that is, $0 < \alpha < 1$. This results in a 'kinked' revenue function.

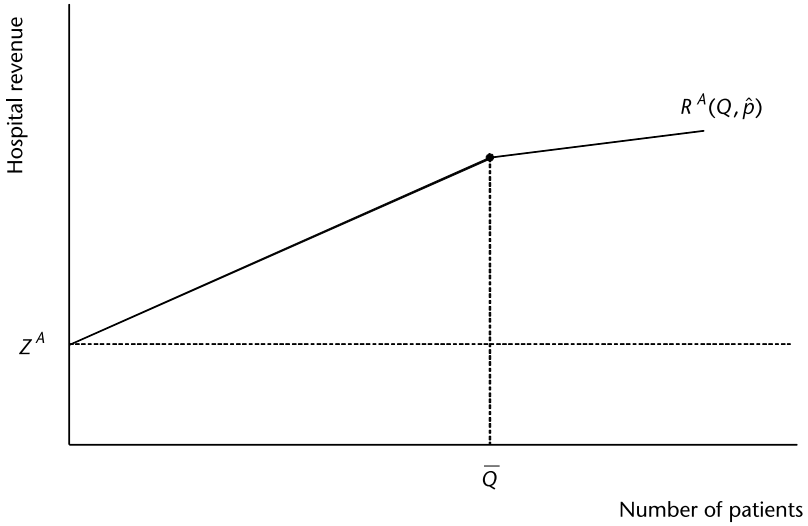

Figure 7.4 Hospital revenue under 'mixed' DRG-based hospital payment with marginal pricing

Source: Street et al., 2007.

7.2.4 Summary

Table 7.1 summarizes the main differences between the three hospital payment systems. Of course, it is important to be cognisant that the hospital payment systems implemented in practice are usually more complicated variants of the simplified models in the previous subsections.

The three models offer different incentives for achieving objectives relating to activity levels, expenditure control, quality of care and the three types of efficiency (Table 7.2). Incentives to increase activity exist in both cost-based and DRG-based hospital payment systems, with the relative strength of the incentives depending on how closely the link between reimbursement and activity levels is

Table 7.1 Main differences across hospital payment systems

System	*Description of patients*	*Amount of activity*	*Price per unit of activity*	*Basic formulation of revenue function*
Cost-based/fee-for-service	Individual	Unrestricted	Item of service	$R^C = \sum_{i=1}^{I} [Q_i \times c_i]$
Global budget	Per hospital/ specialty	Target/ historical	Locally agreed	$R^G = \sum_{s=1}^{S} B_s = \sum_{s=1}^{S} [\overline{Q}_s \times p_s]$
'Pure' DRG-based hospital payment	DRG	Unrestricted	Fixed prospectively	$R^A = \sum_{j=1}^{J} [Q_j \times \hat{p}_j]$

Source: Adapted from Street et al., 2007.

Table 7.2 Incentives offered by three hospital payment models

	Objective					
	Increase activity	*Expenditure control*	*Improve quality*	*Enhance efficiency*		
				Technical	*Cost*	*Allocative*
Cost-based/ fee-for-service	Strong	Weak	Strong*	Weak	Weak	Weak
Global budget	Weak	Strong	Moderate	Weak	Moderate	Moderate
'Pure' DRG-based hospital payment	Moderate	Moderate	Moderate	Strong	Strong	Moderate

*However, quality of care could be adversely affected, as the incentive to increase activity may lead to the provision of inappropriate and potentially harmful services (see Chapter 8 of this volume).

specified (WHO, 2000; Langenbrunner et al., 2005; Moreno-Serra & Wagstaff, 2010). DRG-based hospital payment performs better than cost-based reimbursement with regard to expenditure control, but not as well as global budgets (assuming that budgets are enforced). The potential for quality improvement under a DRG-based hospital payment system may be dependent on whether payments are adjusted for quality of care (see Chapter 8).

Where DRG-based hospital payment provides a fixed price per unit of activity, hospitals are incentivized to increase activity and minimize cost and, therefore, to improve technical efficiency. While cost-based reimbursement also encourages increased activity, there is no motivation to minimize inputs/costs (unless there is a fixed fee schedule). DRG-based hospital payment may offer incentives to improve allocative and cost-efficiency by encouraging providers to consider the prices and amount of inputs they use. It may also promote an efficient allocation of outputs if prices reflect their relative value but, in practice, most jurisdictions still base prices on costs. Nevertheless, overall, DRG-based hospital payment is likely to provide stronger incentives for efficiency compared to either of the alternatives.

7.3 Review of empirical evidence on DRG-based hospital payment and efficiency

The preceding discussion suggests that DRG-based hospital payment may enhance hospital efficiency, either by changing the focus of cost-based reimbursement from retrospective to prospective (as was the case in the United States), or by explicitly linking payment to activity in systems with global budgets (as in most European countries).

This section reviews recent empirical evidence from developed countries. Although improving hospital efficiency is generally a key motivation for introducing DRG-based hospital payment, relatively few studies have explicitly

identified and quantified its impact. Rather, most research has concentrated on indicators of efficiency – such as activity and costs – which are more easily measured, but by definition provide only a partial picture. It is important to note, moreover, that the different starting points in the United States and Europe also imply different hypotheses about the impact of DRG-based payment; that is, moving from cost-based reimbursement to DRGs weakens the activity incentive and strengthens the expenditure control incentive – while the opposite is the case when moving from global budgets to DRG-based payment.

7.3.1 Impact on efficiency

Studies of the impact of DRG-based payment on hospital-level efficiency typically focus on technical efficiency and/or the broader concept of productivity (which incorporates scale, as well as technical, efficiency; see Coelli et al., 2005; Street & Häkkinen, 2010). Data envelopment analysis (DEA) – a well-established non-parametric method – is the most commonly applied approach, although some studies use regression-based (parametric) stochastic frontier analysis. Both methods have advantages and disadvantages (*inter alia*, Jacobs et al., 2006; Street & Häkkinen, 2010; Street et al., 2010) yet, reassuringly, studies that applied both techniques produce broadly consistent results (Gerdtham et al., 1999a, b; Dismuke & Sena, 1999).

Given the challenges inherent in undertaking cross-country efficiency comparisons, all but two of the studies summarized in Table 7.3 adopted a longitudinal perspective, comparing hospital efficiency before and after the introduction of a DRG system. However, the length of follow-up periods varies, complicating interpretation: where the time horizon is short, changes may not be sustained; conversely, a longer time frame may fail to establish a causal relationship, particularly if other reforms are implemented in the interim. Several studies explicitly highlight the difficulty in attributing changes in efficiency, or any of its indicators, to the introduction of DRG-based payment (Farrar et al., 2007; Audit Commission, 2008). Moreover, few studies assess the quality of care, despite the potential trade-off between quality and efficiency (see Chapter 8 of this volume).

Methodological caveats aside, findings relating to the impact of DRG-based payment on hospital efficiency are mixed. The reformed hospital payment system was associated with improved technical efficiency in Portugal (albeit narrowly assessed; Dismuke & Sena, 1999, 2001), Sweden (Gerdtham et al., 1999a, b) and Norway (Biørn et al., 2003; Hagen et al., 2006). By contrast, no positive impact was observed in the United States (Borden, 1988; Chern & Wan, 2000) and there were technological improvements but no technical efficiency gains in Austria (Sommersguter-Reichmann, 2000). The limited evidence on time-series changes to cost-efficiency – confined to Norwegian data – is also mixed (Biørn et al., 2003; Hagen et al., 2006). These divergent results may be explained by the country-specific starting points and contexts in which the hospital payment reforms were implemented, including different incumbent reimbursement mechanisms, the specification of DRG-based payment, and/or the simultaneous introduction of other health care reforms.

Table 7.3 Summary of recent studies examining the impact of DRG-based hospital payment on hospital efficiency

Country, Year of change to DRG-based hospital payment	*Study*	*Methodology*	*Variables*	*Results/Conclusions*
United States, 1983	Borden, 1988[a]	*Method:* DEA, ratio and regression analysis *Sample:*52 hospitals in New Jersey *Study period:* 1979–1984	*Outputs:* (1) Cases treated in each of the eight DRG categories with the highest volumes; (2) Cases treated in the remaining DRG categories *Inputs*: (1) Total FTEs; (2) Nursing FTEs; (3) Other non-payroll expenses; (4) Beds *Quality*: Not included	The hospital payment reform did not have a positive effect on technical efficiency
	Chern & Wan, 2000	*Method*: DEA *Sample*: 80 hospitals in Virginia *Study period*: 1984 & 1993	*Outputs*: (1) Casemix-adjusted inpatient discharges; (2) Visits to the ER and outpatient facilities *Inputs*: (1) Beds and service complexity; (2) Non-physician FTEs and weighted number of part-time personnel; (3) Operating expenses excluding payroll, capital and depreciation *Quality*: Not included	There was no statistically significant difference in technical efficiency between 1984 and 1993, but the percentage of efficient hospitals was higher in 1993
Portugal, 1990	Dismuke & Sena, 1999[b]	*Method*: Two stages: (1) DEA and maximum likelihood estimation of stochastic input requirement frontier; (2) Regression *Sample*: 2 DRGs: (1) Heart Failure and Shock; (2) Specific Cerebrovascular Disorders except Transient Ischaemic Attack *Study period*: 1992–1994	*Outputs*: (1) Number of live discharges within each DRG; (2) Number of dead discharges within each DRG *Inputs*: Utilization of: (1) CAT scanner; (2) Electrocardiogram; (3) Echocardiogram *Quality*: Distinguishes between desirable outputs (live discharges) and undesirable outputs (dead discharges)	Percentage paid through DRGs had a positive impact on productivity

Continued overleaf

Table 7.3 *Continued*

Country, Year of change to DRG-based hospital payment	*Study*	*Methodology*	*Variables*	*Results/Conclusions*
Portugal, 1990	Dismuke & Sena, 2001[b]	*Method*: Malmquist-Luenberger index *Sample*: 2 DRGs *Study period*: 1992–1994	*Outputs*: (1) Number of live discharges within each DRG; (2) Number of dead discharges within each DRG *Inputs*: Utilization of: (1) CAT scanner; (2) Electrocardiogram; (3) Echocardiogram *Quality*: As per Dismuke & Sena, 1999	DRG-based payment appears to have improved the productivity of the diagnostic technologies considered
Sweden, Early 1990s	Gerdtham et al., 1999b	*Method*: Two stages: (1) Modified DEA; (2) Regression *Sample*: 26 county councils *Study period*: 1993 & 1994	*Outputs*: (1) Surgical discharges; (2) Short-term internal medicine discharges; (3) Surgical operations in short-term care; (4) Physician visits in short-term surgical care; (5) Physician visits in internal medicine *Inputs*: (1) Total cost for short-term care; (2) Beds *Quality*: Not included	Hospital services were more efficient in county councils with internal markets and output-based reimbursement, compared to those with a budget-based approach. Potential cost-savings of approximately 13% by switching from budget- to output-based reimbursement
	Gerdtham et al., 1999a	*Method*: Multiple-output stochastic ray frontier model *Sample*: 26 county councils *Study period*: 1989–1995	*Dependent variables*: (1) Operations; (2) Discharges; (3) Physician visits *Independent variables*: (1) Cost; (2) Available beds; (3) Year; (4) Variables to capture the lead effects of reform; (5) Variables for the new reimbursement system; (6) Political majority; (7) Proportion of population aged over 70 years; (8) Proportion of private visits; (9) University hospital *Quality*: Not included	Move to output-based hospital payment increased technical efficiency by 9.7% on average

Austria, 1997	Sommersguter-Reichmann, 2000	*Method*: DEA/ Malmquist *Sample*: 22 hospitals *Study period*: 1994–1998	*Outputs*: (1) Patients treated in the outpatient care unit; (2) Credit points reported by each hospital, multiplied by a steering factor (to differentiate between hospital types) *Inputs*: (1) Labour FTEs; (2) Hospital beds; (3) Expenses for external medical services *Quality*: Not included	There was an improvement in technology between 1996 and 1998, but there was no improvement in technical efficiency
Norway, 1997	Biørn et al., 2003	*Method*: Two stages: (1) DEA; (2) Regression *Sample*: 48 hospitals *Study period*: 1992–2000	*Outputs*: (1) Casemix-adjusted discharges (including day care); (2) Outpatient visits weighted by the fee paid by the state for each visit *Inputs*: (1) Physician FTEs; (2) Other labour FTEs; (3) Medical expenses; (4) Total running expenses (for analysis of cost-efficiency) *Quality*: Not included	The introduction of DRG-based hospital payment improved technical efficiency, but results relating to the impact on cost-efficiency were varied
	Hagen et al., 2006	*Method*: Two stages: (1) DEA; (2) Regression *Sample*: 48 hospitals *Study period*: 1992–2003	*Outputs*: (1) Casemix-adjusted discharges; (2) Outpatient visits weighted by government reimbursement per visit *Inputs*: (1) Physician FTEs; (2) Other labour FTEs; (3) Medical expenses; (4) Total operating costs (for analysis of cost-efficiency) *Quality*: Not included	Technical efficiency increased after the reimbursement reform, but the effect on cost-efficiency was insignificant
Norway, 1997 and Finland	Linna et al., 2006	*Method*: DEA *Sample*: Finland – 47 hospitals and Norway – 51 hospitals *Study period*: 1999	*Outputs*: (1) DRG-weighted admissions; (2) Weighted outpatient visits; (3) Weighted day care; (4) Inpatient days *Inputs*: (1) Net operating costs *Quality*: Not included	The average level of cost-efficiency was lower in Norwegian hospitals

Source: Compiled by the authors based on the works listed in the 'Study' column.

Notes: ER: emergency room; FTE: full-time equivalent; [a]Studies hospitals in New Jersey, in which DRG-based payments were introduced for all payers in 1980; [b]Assesses the productivity and technical efficiency of diagnostic technologies only.

Taking the first of these, the potential for efficiency gains may depend on the pre-existing hospital payment system. Thus, where global budgets preceded DRG-based payment (as in Sweden, Portugal and Norway, detailed in Table 7.3), hospitals' technical efficiency apparently improved (although Linna and colleagues (2006) found lower cost-efficiency in Norwegian hospitals compared to their Finnish counterparts, despite the latter being understood to operate within a global budget framework). Conversely, DRG-based payment did not improve technical efficiency when it replaced retrospective, cost-based reimbursement (as in the United States) or per diem payments (as in Austria).

This apparent greater potential for efficiency gains when moving from global budgets cannot be regarded as definitive, because the operation of the national DRG-based payment system may itself act as a constraint. Hence, initial efficiency improvements in Sweden were subsequently negated when ceilings were imposed on hospital-activity levels (Gerdtham et al., 1999a, b; Anell, 2005; Kastberg & Siverbo, 2007), and analogous restrictions may also help to explain the lack of improvements in the United States and Austria (US Congress Office of Technology Assessment, 1985; Sommersguter-Reichmann, 2000; Böcking et al., 2005). Finally, it is difficult to isolate the impact of DRG-based payment when it is introduced as part of a wider health care reform programme, as was the case in Sweden when an internal market was also established (Gerdtham et al., 1999a, b).

7.3.2 Impact on indicators of efficiency: Activity, length of stay and costs

Table 7.4 summarizes studies that examined country-specific changes in indicators of efficiency. Following the introduction of DRG-based payment, hospital admissions increased in Australia (Ettelt et al., 2006; Street et al., 2007), Denmark (Street et al., 2007), England (Farrar et al., 2007; Audit Commission, 2008; Farrar et al., 2009), France (Or, 2009), Germany (Böcking et al., 2005; Hensen et al., 2008), Norway (Biørn et al., 2003; Kjerstad, 2003; Hagen et al., 2006; Magnussen et al., 2007), Spain (Cots, 2004, cited in Ellis & Vidal-Fernández, 2007) and, at least initially, in Sweden (Anell, 2005; Kastberg & Siverbo, 2007). However, in line with the hypotheses derived from the incentives indicated in Table 7.2, activity did not increase in the United States (US Congress Office of Technology Assessment, 1985; Davis & Rhodes, 1988; Guterman et al., 1988; Manton et al., 1993; Muller, 1993; Rosenberg & Browne, 2001). Results for Italy are mixed (Louis et al., 1999; Ettelt et al., 2006), while Moreoa-Serra & Wagstaff (2010) found no effect on activity countries in central and eastern Europe and central Asia that had introduced DRGs or other activity-based reimbursement systems. Of course, the aforementioned points regarding country-specific contexts and the difficulties in assigning causality also apply here.

The financial incentive to minimize costs under DRG-based hospital payment has often contributed to a shift from inpatient to day-case and/or outpatient settings (for example, in the United States and England, see Rosenberg & Browne, 2001 and Farrar et al., 2009, respectively) – this may also improve the quality of care, as well as efficiency, *ceteris paribus*. Indeed, DRG-based tariffs

Table 7.4 Summary of recent studies examining changes in indicators of hospital efficiency following the introduction of DRG-based hospital payment

Country, Year of change to DRG-based hospital payment	*Study*	*Study period*	*Methodology*	*Hospital activity*	*ALOS*	*Costs*	
						Unit/average	*Total*
United States, 1983	US Congress Office of Technology Assessment, 1985	1983–1984 and Review	Descriptive	–	–		
	Guterman et al., 1988	1983–1986	Descriptive (with some sub-group analysis)	–	–	+	+ (but at a slower rate)
	Davis & Rhodes, 1988	1984–1985	Descriptive	–	–		
	Kahn et al., 1990	1981/1982 & 1985/1986	Retrospective observational study (focusing on five diseases)		–		
	Manton et al., 1993	1982/1983 & 1984/1985	Descriptive (using life table models)	–	–		
	Muller, 1993	1970–1992	Autoregressive-integrated moving average models	–	–		
	Rosenberg & Browne, 2001	Review	Review	–	–		
Australia, 1993[a]	Ettelt et al., 2006	Review	Review	+		–	–
	Street et al., 2007	Review	Review	+			
Sweden, early 1990s	Anell, 2005	Review	Review	+	–		+
	Kastberg & Siverbo, 2007	Review	Review	+	–		+
Italy, 1995	Louis et al., 1999	1993–1996	Descriptive (with some sub-group analysis)	?	–		
	Ettelt et al., 2006	Review	Review	+	–		
Catalonia, Spain, 1997	Cots, 2004[b]	1993–2000	Descriptive	+		–	+ (but at a slower rate)

Continued overleaf

Table 7.4 *Continued*

Country, Year of change to DRG-based hospital payment	*Study*	*Study period*	*Methodology*	*Hospital activity*	*ALOS*	*Costs*	
						Unit/average	*Total*
Norway, 1997	Biørn et al., 2003	1992–2000	Descriptive	+			
	Kjerstad, 2003	1995–1998	Difference-in-difference model	+			
	Hagen et al., 2006	1992–2000	Descriptive	+			
	Magnussen et al., 2007	Review	Review	+			
Austria, 1997	Theurl & Winner, 2007	1989–2003	Econometric model with fixed effects		–		
Denmark, 2002	Street et al., 2007	Review	Review	+			
Germany, 2003	Böcking et al., 2005	Review	Review	+	–		
	Schreyögg et al., 2005	2003–2004 and Review	Descriptive		–		
	Hensen et al., 2008[c]	2003–2006	Descriptive	+	–		
England, 2003/2004	Farrar et al., 2007	2002/2003 & 2005/2006	Difference-in-difference framework	+	–	–	
	Audit Commission, 2008	2003/2004 & 2006/2007	Descriptive	+	–	?	
	Farrar et al., 2009	2003/2004 & 2005/2006	Difference-in-difference analysis	+	–	–	
France, 2004/2005	Or, 2009	2005 and Review	Descriptive	+			
OECD countries	Forgione & D'Annunzio, 1999	1984–1986 & 1994–1996	Descriptive		–		+
Various countries in central and eastern Europe as well as central Asia	Moreno-Serra &Wagstaff, 2010	1990–2004	Difference-in-difference model	=	–		+

Source: Compiled by the authors based on the works listed in the 'Study' column.

Notes: The changes following the introduction of DRG-based hospital payment are denoted by + for an increase, – for a decrease, = for no change, and ? for mixed effects; [a] DRG-based hospital payment was introduced in Victoria in 1993; [b] Not intended as a study of the effect of DRG-based hospital payment; [c] Relates to dermatology.

can be used to explicitly incentivize hospitals to increase day-case activity, as for example in England, where a common national tariff has been applied to most elective activity across inpatient and day-case settings (Epstein & Mason, 2006; Street et al., 2007). In the United States, the shift towards outpatient care may also be explained by the operation (until 2000) of a parallel retrospective cost-based reimbursement system for such treatment (Rosenberg & Browne, 2001).

Average length of stay generally declined following the move to DRG-based payment (for example, Kahn et al., 1990; Böcking et al., 2005; Moreno-Serra & Wagstaff, 2010), although some argue that this was merely consistent with a general trend (Rosenberg & Browne, 2001; Schreyögg et al., 2005). Discharge rates to post-acute institutions (typically less costly than acute facilities) usually increased. On average, the recorded severity of patients remaining in acute settings increased (Böcking et al., 2005), and assuming this was not simply changed coding practice, suggests limited potential for further reductions in length of stay *ceteris paribus* (Guterman et al., 1988; Rosenberg & Browne, 2001).

Finally, in the majority of cases, the introduction of DRG-based hospital payment was associated with higher total costs, partly due to higher activity levels (Forgione & D'Annunzio, 1999; Anell, 2005; Kastberg & Siverbo, 2007; Moreno-Serra & Wagstaff, 2010), whereas unit costs appear to have declined (Böcking et al., 2005; Farrar et al., 2009). In the United States the overall impact was reduced inflation in aggregate costs (Guterman et al., 1988). The initial experience with DRG-based payment in the Netherlands has been a lower rate of increase where prices are negotiated rather than set centrally and there is increased competition among hospitals and health insurers (see Chapter 23 of this volume).

In short, in some cases, hospital-level efficiency has improved following the introduction of DRG-based hospital payment, but establishing causation is difficult, due to confounding factors. Elsewhere its theoretically beneficial effects may have been somewhat offset by other features of the national health care system – such as limitations on activity and/or expenditure, or the pre-existing reimbursement system – leading to mixed results.

7.4 What are the key challenges?

7.4.1 Categorization problems may lead to unfair reimbursement or patient selection

Like any categorization system, DRGs cannot group patients perfectly on the basis of their expected resource requirements. Much health care is highly individualized, so defining a 'standardized package of care' is not straightforward. This would not create hospital payment problems if differences across providers were random, but if the differences across providers are systematic, then the reimbursement system becomes potentially unfair and may encourage hospitals to engage in up-coding or to 'dump' (that is, avoid) high-cost patients. These adverse consequences could be avoided, however, if the financial risks of such cases were shared between payer and hospital (see Part Two of this volume, along with chapters 5 and 6).

7.4.2 Independence in price-setting

In some countries, the number of hospitals may be insufficient to ensure that prices are independent of each hospital's costs. This has two implications. First, the regulator may be unable to determine whether costs are contaminated by inefficient behaviour, especially if provision is concentrated in only one or two hospitals. DRG-based hospital payment is then in danger of reducing to cost-based reimbursement – which embodies little incentive to improve efficiency. Second, this form of reimbursement may encourage collusion between providers in their reporting behaviour or in their efforts to reduce their costs. The likelihood of such behaviour increases if there are few providers that are well informed about each other's behaviour. Collusion will limit the scope for DRG-based hospital payment to deliver efficiency improvements. Where data are collected on a sampling basis, as in Germany, the sample must be representative of all hospitals; otherwise, unfair reimbursement may result (see chapters 5 and 14).

7.4.3 Control of expenditure

DRG-based hospital payment that adopts a simple price-per-unit-of-activity approach offers direct incentives to suppliers to increase activity levels. If marginal cost is lower than marginal revenue, the more providers 'do', the larger their financial surplus/profit. Increases in activity levels may therefore place severe pressure on funders' budgets. Consequently, a number of countries attempt to contain expenditure by a system of operating DRG-based hospital payment within a global budget framework (for example, Catalonia (Spain) and Sweden – see chapters 22 and 19, respectively). In France, local-level contracts were found to be more effective at controlling spending than macro-level mechanisms (see Chapter 13).

7.5 Conclusions

DRG-based hospital payment systems have the potential to enhance efficiency in the delivery of hospital services, more so than other hospital payment models. This is because there are clear incentives for hospitals to work harder, because they are paid according to the number of patients they treat, as well as to control their costs, because the prices they face are set independently of their own costs. These payment characteristics encourage providers to improve their technical and cost-efficiency and to seek allocative efficiency in their choice of input mix. In theory, DRG-based hospital payment can be used to support allocative efficiency in the overall mix of outputs produced by the hospital sector as a whole. This requires the price attached to each DRG to reflect its societal value. In practice, though, DRG prices are based on costs in almost all countries, so the pursuit of allocative efficiency in this sense has not been a feature of DRG-based hospital payment policy.

Empirical evidence is mixed in terms of the extent to which DRG-based hospital payment has improved efficiency. This is partly because of cross-

country heterogeneity in how DRG-based hospital payment systems are operated (detailed in Part Two of this volume) and because attribution is complicated by the existence of confounding factors (such as changes being part of a wider reform package, or the country-specific design and operation of the reimbursement regime). It is generally agreed that DRG-based hospital payment affects indicators of efficiency, such as activity and length of stay, although the same caveats apply. Unintended consequences may include skimping (on quality), cost-shifting, patient selection or up-coding to higher priced DRGs (see Chapter 6).

While we have outlined simplified forms of DRG-based hospital payment, in practice the payment arrangements implemented in each country can be quite sophisticated (see the country-specific chapters in Part Two of this book). More complex formulations may reflect concerns over the ability of DRG classifications to describe casemix accurately, if the need to moderate incentives to undertake more activity in the pursuit of quality, or other regulatory objectives, such as an equitable geographical distribution of hospital provision. Such sophistication is not surprising: the provision of hospital care is a complex process, often requiring packages of care tailored to the individual patient and delivered under conditions of crisis and uncertainty, requiring co-ordination of health professionals both within and beyond the hospital. In the face of such complexity, the method by which payments are made must be sophisticated enough to provide clear incentives for what is desirable and to avoid creating perverse responses. Compared to cost-based reimbursement and global budgets, DRG-based hospital payment is able to embody such sophistication and, thereby, to provide clearer incentives for hospitals to improve their efficiency.

7.7 References

Anell, A. (2005). Swedish health care under pressure. *Health Economics*, 14:S237–54.

Audit Commission (2008). *The Right Result? Payment by Results 2003–2007*. London: Audit Commission (http://www.audit-commission.gov.uk/SiteCollectionDocuments/AuditCommissionReports/NationalStudies/The_right_result_PbR_2008.pdf, accessed 29 June 2011).

Barnum, H., Kutzin, J., Saxenian, H. (1995). Incentives and provider payment methods. *International Journal of Health Planning & Management*, 10:23–45.

Biørn, E., Hagen, T.P., Iversen, T., Magnussen, J. (2003). The effect of activity-based financing on hospital efficiency: a panel data analysis of DEA efficiency scores 1992–2000. *Health Care Management Science*, 6:271–83.

Böcking, W., Ahrens, U., Kirch, W., Milakovic, M. (2005). First results of the introduction of DRGs in Germany and overview of experience from other DRG countries. *Journal of Public Health*, 13:128–37.

Borden, J.P. (1988). An assessment of the impact of diagnosis-related group (DRG)-based reimbursement on the technical efficiency of New Jersey hospitals using data envelopment analysis. *Journal of Accounting and Public Policy*, 7:77–96.

Chern, J.Y., Wan, T.T. (2000). The impact of the prospective payment system on the technical efficiency of hospitals. *Journal of Medical Systems*, 24:159–72.

Coelli, T.J., Rao, D.S.P., O'Donnell, C.J. (2005). *An Introduction to Efficiency and Productivity Analysis*. New York, NY: Springer Science+Business Media.

Cots, F. (2004). La sostenibilidad del sistema hospitalario en Cataluña. El balance de una década [Viability of the hospital system in Catalonia. Balance after a decade]. *Gaceta Sanitaria*, 18:64–7.

Davis, C., Rhodes, D.J. (1988). The impact of DRGs on the cost and quality of health care in the United States. *Health Policy*, 9:117–31.

Dismuke, C., Sena, V. (1999). Has DRG payment influenced the technical efficiency and productivity of diagnostic technologies in Portuguese public hospitals? An empirical analysis using parametric and non-parametric methods. *Health Care Management Science*, 2:107–16.

Dismuke, C., Sena, V. (2001). Is there a trade-off between quality and productivity? The case of diagnostic technologies in Portugal. *Annals of Operations Research*, 107:101–16.

Ellis, R.P., McGuire, T.G. (1986). Provider behaviour under prospective reimbursement: cost sharing and supply. *Journal of Health Economics*, 5:129–51.

Ellis, R.P., Vidal-Fernández, M. (2007). Activity-based payments and reforms of the English hospital payment system. *Health Economics, Policy and Law*, 2:435–44.

Epstein, D., Mason, A. (2006). Costs and prices for inpatient care in England: mirror twins or distant cousins? *Health Care Management Science*, 9:233–42.

Ettelt, S., Thomson, S., Nolte, E., Mays, N. (2006). *Reimbursing Highly Specialised Hospital Services: The Experience of Activity-Based Funding in Eight Countries*. London: London School of Hygiene & Tropical Medicine.

Farrar, S., Sussex, J., Yi, D. et al. (2007). *National Evaluation of Payment by Results*. Aberdeen: University of Aberdeen Health Economics Research Unit.

Farrar, S., Yi, D., Sutton, M. et al. (2009). Has payment by results affected the way that English hospitals provide care? Difference-in-differences analysis. *British Medical Journal*, 339 b3047doi:10.1136/bmj.b3047.

Forgione, D.A., D'Annunzio, C.M. (1999). The use of DRGs in health care payment systems around the world. *Journal of Health Care Finance*, 26:66–78.

Gerdtham, U., Löthgren, M., Tambour, M., Rehnberg, C. (1999a). Internal markets and health care efficiency: a multiple-output stochastic frontier analysis. *Health Economics*, 8:151–64.

Gerdtham, U., Rehnberg, C., Tambour, M. (1999b). The impact of internal markets on health care efficiency: evidence from health care reforms in Sweden. *Applied Economics*, 31:935–45.

Guterman, S., Eggers, P.W., Riley, G., Greene, T.F., Terrell, S.A. (1988). The first 3 years of Medicare prospective payment: an overview. *Health Care Financing Review*, 9:67–77.

Hagen, T.P., Veenstra, M., Stavem, K. (2006). *Efficiency and Patient Satisfaction in Norwegian Hospitals*. Oslo: Health Organization Research Norway (HORN Working Paper 2006:1).

Hensen, P., Beissert, S., Bruckner-Tuderman, L. et al. (2008). Introduction of diagnosis-related groups in Germany: evaluation of impact on inpatient care in a dermatological setting. *European Journal of Public Health*, 18:85–91.

Jacobs, R., Smith, P.C., Street, A. (2006). *Measuring Efficiency in Health Care: Analytic Techniques and Health Policy*. Cambridge: Cambridge University Press.

Kahn, K.L., Keeler, E.B., Sherwood, M.J. et al. (1990). Comparing outcomes of care before and after implementation of the DRG-based prospective payment system. *Journal of the American Medical Association*, 264:1984–8.

Kastberg, G., Siverbo, S. (2007). Activity-based financing of health care – experiences from Sweden. *International Journal of Health Planning and Management*, 22:25–44.

Kjerstad, E. (2003). Prospective funding of general hospitals in Norway: incentives for higher production? *International Journal of Health Care Finance and Economics*, 3:231–51.

Langenbrunner, J.C., Orosz, E., Kutzin, J., Wiley, M.M. (2005). Purchasing and paying providers, in J. Figueras, R. Robinson, E. Jakubowski, eds. *Purchasing to Improve Health Systems Performance*. Maidenhead: Open University Press.

Linna, M., Häkkinen, U., Magnussen, J. (2006). Comparing hospital cost efficiency between Norway and Finland. *Health Policy*, 77:268–78.

Louis, D.Z., Yuen, E.J., Braga, M. et al. (1999). Impact of a DRG-based hospital financing system on quality and outcomes of care in Italy. *Health Services Research*, 34: 405–15.

Magnussen, J., Hagen, T.P., Kaarboe, O.M. (2007). Centralized or decentralized? A case study of Norwegian hospital reform. *Social Science & Medicine*, 64:2129–37.

Manton, K.G., Woodbury, M.A., Vertrees, J.C., Stallard, E. (1993). Use of Medicare services before and after introduction of the prospective payment system. *Health Services Research*, 28:269–92.

Moreno-Serra, R., Wagstaff, A. (2010). System-wide impacts of hospital payment reforms: evidence from central and eastern Europe and central Asia. *Journal of Health Economics*, 29:585–602.

Muller, A. (1993). Medicare prospective payment reforms and hospital utilization: temporary or lasting effects? *Medical Care*, 31:296–308.

Or, Z. (2009). Activity-based payment in France. *Euro Observer*, 11:5–6.

Robinson, R., Jakubowski, E., Figueras, J. (2005). Organization of purchasing in Europe, in J. Figueras, R. Robinson, E. Jakubowski, eds. *Purchasing to Improve Health Systems Performance*. Maidenhead: Open University Press.

Rosenberg. M.A., Browne, M.J. (2001). The impact of the inpatient prospective payment system and diagnosis-related groups: a survey of the literature. *North American Actuarial Journal*, 5:84–94.

Schreyögg, J., Tiemann, O., Busse, R. (2005). The DRG reimbursement system in Germany. *Euro Observer*, 7:4–6.

Shleifer, A. (1985). A theory of yard stick competition. *Rand Journal of Economics*, 16: 319–27.

Sommersguter-Reichmann, M. (2000). The impact of the Austrian hospital financing reform on hospital productivity: empirical evidence on efficiency and technology changes using a non-parametric input-based Malmquist approach. *Health Care Management Science*, 3:309–21.

Street, A., Häkkinen, U. (2010). Health system productivity and efficiency, in P.C. Smith, E. Mossialos, I. Papanicolas, S. Leatherman, eds. *Performance Measurement for Health System Improvement: Experiences, Challenges and Prospects*. Cambridge: Cambridge University Press.

Street, A., Scheller-Kreinsen, D., Geissler, A., Busse, R. (2010). *Determinants of Hospital Costs and Performance Variation: Methods, Models and Variables for the EuroDRG Project*. Berlin: Universitätsverlag der Technischen Universität Berlin (working Papers in Health Policy and Management Volume 3).

Street, A., Vitikainen, K., Bjorvatn, A., Hvenegaard, A. (2007). *Introducing Activity-Based Financing: A Review of Experience in Australia, Denmark, Norway and Sweden*. York: University of York Centre for Health Economics (CHE Research Paper 30).

Theurl, E., Winner, H. (2007). The impact of hospital financing on the length of stay: evidence from Austria. *Health Policy*, 82:375–89.

US Congress Office of Technology Assessment (1985). *Medicare's Prospective Payment System: Strategies for Evaluating Cost, Quality, and Medical Technology*. Washington, DC: United States Government Printing Office.

WHO (2000). *The World Health Report 2000 – Health Systems: Improving Performance*. Geneva: World Health Organization.

7.8 Summary of terms used in the equations

Symbol	*Description*
R^C, R^G, R^A	Hospital revenue under, respectively, cost-based reimbursement (C), global budgets (G) and DRG-based funding (A)
$\mathbf{Z}^C$, $\mathbf{Z}^G$, $\mathbf{Z}^A$	All sources of revenue not related to health to care activity under cost-based reimbursement, global budgets and DRG-based funding
Q	Activity
$\overline{Q}$	Target activity
I	Individual patient
S	Specialty
J	DRG
C	Unit cost
B_s	Specialty contract value
p_s	Locally agreed specialty-level price
$\hat{p}_j$	Prospectively fixed DRG price
α	Proportion of fixed DRG price paid for additional activity