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# HOW DO HOSPITALS RESPOND TO PRICE CHANGES? EVIDENCE FROM NORWAY

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# How do hospitals respond to price changes? Evidence from Norway

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## *Abstract*

Many publicly funded health systems use prospective activity-based financing to increase hospital production and efficiency. The aim of this study is to investigate whether price changes for different treatments affect the mix of activity provided by hospitals. We exploit variations in prices created by changes in the national average treatment cost per DRG offered to Norwegian hospitals over a period of five years (2003-2007). We use data from the Norwegian Patient Register, containing individual-level information on age, gender, type of treatment, diagnosis, number of co-morbidities and the national average treatment costs per DRG. To examine the changes in activity within the DRGs over time, fixed-effect models are applied. The results suggest that a ten-percent increase in price leads to a rise of one percent in the number of patients treated. This increase is mainly due to more admission of emergency patients, rather than to increases in elective activity.

Key words: Hospitals, DRGs, prices, activity.

JEL classification: I0, H0

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# 1. Introduction

In countries with publicly funded health care systems, there are concerns about cost efficiency and patients' access to treatment. Changes or revisions in hospital payment systems are often implemented in order to address these issues. A policy instrument that is frequently introduced is prospective Activity-Based Financing (ABF). The ideas behind such a financing system are twofold: i) to provide incentives for efficient hospital production, since hospitals are allowed to retain any surplus if they provide treatments with costs below the prospective prices; and ii) to provide hospitals with incentives to treat more patients, because payments are proportional to the number of patients discharged.

An ABF system is typically based on Diagnosis-Related Groups (DRGs). The main reason for this is that hospital stays within a DRG are homogeneous, both with respect to medical treatment and to the cost of treating the average patient within that DRG. In 1983, Medicare adopted this system to serve as a basis for a prospective payment system for U.S. hospitals. Later on, the system was introduced and is currently being used in many OECD countries including Australia, Denmark, England, France, Germany, Norway and Sweden (see Street *et al.,* 2007).

Under a DRG-based system, a hospital's income depends on the price per DRG, and the number of patients discharged within each DRG. DRG prices are fixed in advance, and based on cost data collected from a representative group of hospitals in previous years. Hence, the price per DRG is meant to reflect the average costs of providing treatments for typical patients within the DRG. Furthermore, the price per DRG is independent of the costs incurred by any particular hospital.

The strengths and weaknesses of ABF systems are illustrated in several theoretical models (Chalkley and Malcomson, 1998a,b; Ma, 1994; Ellis and McGuire, 1996; Ellis, 1998, and Shleifer, 1985). The main benefits of this type of hospital financing are that it stimulates efficiency, since ABF is a form of yardstick competition (Shleifer, 1985), and that payments are patient-based (money follows the patient), which generates an incentive for hospitals to treat a larger number of patients. The main drawback is that within each category of service (DRG) there may be substantial variation in the appropriate provision of services. This creates selection problems because hospitals will have (financial) incentives to attract profitable patients (cream-skimming) and to skimp and/or dump unprofitable patients within each DRG. As long as hospitals care about profits to some extent, higher prices imply higher marginal revenues, which give incentives to increase activity (see e.g. Ellis, 1998; Kaarbøe and Siciliani, 2011).

While several empirical studies examine how the introduction of ABF that is based on DRGs affects activity, costs and quality,[1] the current paper takes a different focus. We estimate how price changes affect the volume of different types of hospital activity.[2] The price is defined as the National Average Treatment Cost (NATC) which is paid to hospitals for each DRG in each year, and activity is measured at the DRG-level. The data we use is derived from individual level data from a large administrative database from Norway that records the activities of all hospitals. These data are aggregated to DRG level and our main dependent variable is the number of patients treated within a DRG, in each hospital, each year. The study period is the five year period from 2003-2007.

NATC are revised regularly in Norway. Major revisions took place in 2004, 2006 and 2007, and minor ones in 2005. The NATC in the three years where major revisions took place are based on the average costs of a sub-sample of around 25 Norwegian hospitals in 2002, 2004 and 2005, respectively. There is therefore a time lag of two years for changes in costs to be reflected in price changes. Price changes generated by DRG variations can, therefore, be considered to be pre-determined.

We estimate a range of empirical models to examine the effects of DRG price changes on the volume of patients treated. Fixed-effect models are applied to control for unobservable

[1] See e.g. Section 4 in Chalkley and Malcomson (2000) for a review. Biørn *et al.* (2003) and Kjerstad (2003) find that the introduction of ABF in Norway had a significantly positive effect on the number of patients treated and DRG points produced. During the first two years after introduction of DRG-based financing in one Swedish county, a 20-percent increase in productivity was realized, compared to other counties. However, the effect was temporary (Mikkola *et al.,* 2001). Gilman (2000) investigates how the introduction of procedure-based DRGs for HIV-treatments affected the intensity of services provided for (new) the high paying procedural DRGs and for the lower paying non-procedural DRGs. The author finds that hospitals responded to the new incentives by increasing (decreasing) the intensity of services for higher (lower) paying DRGs. See Hafsteinsdottir and Siciliani (2010) for a theoretical analysis of refinements of DRG-based prospective payment systems.

[2] The above mentioned theoretical papers rest on the assumption that the price per DRG is not provider specific. Hence, the price (typically) has to be combined with a lump-sum transfer in order to ensure that the providers stay in the market. Miraldo *et al*., (2011) consider the case where lump-sum transfers are not allowed, but the fixed prices can be adjusted to reflect exogenous cost differences between providers. This resembles the institutional settings in England and in the US, where DRG-based prices are allowed to vary among providers to reflect exogenous cost differences. In Norway all hospitals face the same DRG-based prices in the period studies.

heterogeneity across hospitals and DRGs, and year dummies are included in all the models and capture the time trend in a flexible way. The results suggest that price increases generated by variations in the NATC do lead to increases in the number of patients treated: a 10-percent rise in price leads to about a one-percent increase in the number of patients treated. Furthermore, the results also indicate that the increase in activity is mainly due to a greater number of emergency patients, as opposed to elective ones. When prices increase, hospitals may be more willing to admit emergency patients instead of, for example, sending them back to their general practitioners (GPs).

One potential concern is the endogeneity between activity and changes in the NATC that results from technological developments. For example, a new, more effective technology may make a treatment cheaper and more easily administered, which could result in more patients treated and a lower NATC (a negative correlation between activity and NATC). In such cases, our estimates may be biased downwards. On the other hand, a new, more expensive and effective technology might arise that increases the demand for care and the cost, resulting in a higher volume and a higher NATC (a positive correlation between activity and NATC). In such cases, our estimates may be biased upwards. We tackle these potential biases in two different ways. First, NATC are updated with a delay of two years; therefore, current prices are pre-determined and do not reflect current costs. In addition, and perhaps more importantly, we allow for differential time trends across different DRGs, which allows us to control for differential trends in technological developments. Our analysis shows that allowing for differential time trends across DRGs does not significantly alter the main results.

There are a few studies that investigate how changes in prices affect the number of patients treated. Dafny (2005) analysed how hospitals responded to changes in DRG prices for 43 percent of Medicare admissions. The study identified DRGs, based on a 1998 policy reform that had changed the descriptions of the DRGs to which patients were to be assigned. More specifically, the change involved eliminating the distinction between patients “aged over 69 years” and “aged under 70 years”, so that the only qualifiers were “with complications” or “without complications”. This resulted in substantial changes in the DRG prices for the two groups of patients. There was little evidence that U.S. hospitals increased the volume of admissions for diagnoses that were subject to the price increases. The hospitals primarily responded by up-coding patients into diagnoses with the largest price increases. The effect was highest among for-profit hospitals.

Seshamani *et al.* (2006) look at whether different financial constraints for hospitals affect 30-day mortality rates and whether some patient groups are affected more than others. Their study investigates the reductions in Medicare payments that result from the Balanced Budget Act (BBA) of 1997. The authors found no significant changes in mortality rates between high- and low-BBA-impact hospitals. Lindrooth *et al.* (2007) examine whether exogenous change (cuts) in the average reimbursements for patient admissions affect how intensely patients are treated at the hospitals. They estimate the effect of the BBA by comparing treatment intensities in pre- and post-BBA periods. The study uses data from 11 states, for 16 disease categories for Medicare patients. The authors found that the intensity of treatment was reduced for the diagnoses that were more generously reimbursed before the cuts associated with the BBA, while there were no changes in treatment activity for unprofitable diagnoses.

The paper is organised as follows. Section 2 presents the institutional settings and Section 3 shows data and descriptive statistics. The methods are presented in Section 4, while the estimation results are provided and discussed in Section 5. Section 6 contains concluding remarks.

## 2. Institutional Settings

Specialised health care providers in Norway are predominantly publicly owned and, since 2002, have been organised as State-owned enterprises within five regional health authorities (north, mid, west, south and east).[3] A regional health authority has the responsibility for providing specialist health care to all patients within its region.[4] The provision of health care is organised through health enterprises that are owned and governed by the regional health authorities. The regional health authorities can also contract with private suppliers to provide treatment. However, this outsourcing is quite small compared to overall treatment activity, and is also confined to only a few diagnoses.

Patient access to specialised health care is either through a referral system (elective care) or through emergency care. Another important feature is the patient's right to free choice of

[3] The number of regions is four since June 2007, when south and east were merged.
[4] See Hagen and Kaarboe (2006) and Magnussen *et al.* (2007) for descriptions of the Norwegian hospital sector and the 2002 reform where hospital ownership was transferred from county councils to the central government.

hospital, which came into effect on a national level in 2001. However, relatively few patients have opted to receive treatment outside of their hospital catchment areas (Vrangbæk *et al.*, 2007).

The regional health authorities are financed by a mixture of block grants and a DRG activity-based system. The block grant is based on a risk-adjusted capitation formula. Together, the two types of funding are meant to cover the running cost of providing somatic hospital services.[5] The central government determines the relative shares of the two sources of funding (the activity-based and the capitation-based), on a yearly basis.

To calculate treatment costs within DRGs, the total costs accrued for somatic care are collected from a sample of Norwegian hospitals. These costs are allocated to the different DRGs, based on standardized rules. The national average cost for a specific DRG is calculated as the average costs for that DRG. Each DRG is then given a DRG weight (NATC), which is determined by the average cost of the DRG relative to the average cost of all hospital stays.

The DRG weights form the basis for the prices that are to be paid for future hospital treatments. More specifically, hospital prices are determined by the product of the average cost of all hospital stays, the DRG weights and the share of the ABF-grant. There is a two-year lag between the collection of the cost data and the year in which they are used to set prices for the respective DRGs.

Table 1 summarises the changes in the financing system for the years from 2003 through to 2007. Column II shows which year is used to calculate the cost-based DRG weights. These weights were updated every second year until 2006; from 2007 on, the weights were updated each year. Column III shows the reimbursement level for a hospital stay with a DRG weight of one (i.e., a hospital stay with the average cost of all hospital stays) for each year, in real terms. The cost-based reimbursement dropped in the first year, but remained relatively stable thereafter. Column IV shows the ABF shares. These dropped from 60 percent to 40 percent between 2003 and 2004, rose to 60 percent in 2005, then returned to 40 percent in 2006 and 2007. Column V in Table 1 shows the actual price for a hospital stay with a DRG weight of

[5] Mental health is financed by block grants.

one. This cost-based price is the product of the ABF share (Column IV) and the reimbursement per stay (Column III). Changes in ABF shares lead to substantial changes in cost-based prices per hospital stay. Indeed, in some years both the cost calculations and the ABF share change, while in other years either the cost calculations are updated or the ABF share is changed.

[Table 1 about here]

Table 2 shows the changes in activity over time, where activity is expressed in DRG points and in the number of patients treated.[6] We can see that the number of DRG-points increases every year. Also, the increases in DRG points are slightly higher when the ABF share is high: the increase in DRG points is 2.2 percent when the ABF share decreased from 60 to 40 percent (2003-2004). As the ABF share increased from 40 percent in 2004 to 60 percent in 2005, the number of DRG points increases by 3.9 percent. Furthermore, the table shows that when the ABF share fell to 40 percent in 2006, the increase in total DRG points produced is around one-percent lower than the year before. The same trend is observed for the number of patients treated. When the ABF share was kept at 40 percent (2006-2007), the increase in both DRG points and the number of patients treated is lower. These trends suggest that hospital output in aggregate may be responding to changes in prices. However, these changes cannot be distinguished from other factors that may be affecting aggregate hospital production. To identify whether hospitals are responding to price changes, we need to examine changes by DRG.

[Table 2 about here]

## 3. Data

The data are taken from the Norwegian Patient Register (NPR), which covers the entire population of patients receiving hospital treatment during the period from 2003 through 2007. Our main dependent variable is the total volume of hospital activity, including emergency, elective inpatient and day-case treatments.[7]

[6] A hospital stay's DRG point is equal to the DRG weight of the stay. Hence, total hospital activity is measured as the sum of the DRG weights from all hospital stays.

[7] Day cases are usually elective treatments, either as a separate treatment or as part of a treatment series. It is defined as treatments where duration at the hospital lasts for more than five hours, but the patient does not stay

Our key dependent variable is activity, defined as the number of patients treated within each DRG, hospital and year. Rehabilitations and other specific treatments, where additional reimbursements apply, are excluded from the sample. These procedures are partly financed on the basis of the patient's length of stay in hospital, not exclusively on a DRG basis. Such procedures amount to about nine percent of the volume and apply mostly to elective treatments. Some observations are also excluded because of missing information about the DRG, the DRG weight or the hospital where the treatment was provided (0.4 percent). Our final sample consists of 6,103,364 patients. Elective patients amount to 54 percent of the total volume. Emergency patients account for 42 percent, and four percent are births. A total of 46 percent of elective patients receive surgical treatment, while most of the emergency patients (85 percent) receive medical treatment.

The number of hospitals included in the analysis varies between 73 and 92, during the period.[8] The same DRG may be used for both inpatient treatments and day cases. We distinguish between DRGs for inpatients and day cases because different DRG weights apply for the latter. The total number of DRGs for the inpatients and day cases has increased from 921 in 2003 to 989 in 2007.

Descriptive statistics are presented in Table 3. The average patient age is about 50 years and, in terms of gender, the numbers are approximately the same for both. The average number of co-morbidities is 1.25 in 2003 and increases slowly over time to 1.4 in 2007. The average DRG weight also increases over time, from 0.92 in 2003 to 0.96 in 2007. The changes over time in average prices paid per admission are mainly driven by changes in the ABF share. The number of patients treated has increased over time: there were 1,133,241 patients in 2003 and 1,291,314 patients in 2007.

[Table 3 about here]

Table 4 provides more details about the changes over time in the DRG weights, across the whole distribution. Although the average DRG did not vary much from year to year, there

overnight. Outpatients are not included in the analysis since the DRG system did not apply for the outpatients during the analysis period.

[8] There are two reasons for variations in the number of hospitals: 1) ABF was introduced to more hospitals over time, 2) some of the hospitals were merged during this time period.

were significant changes within each year. For example between 2003 and 2004 the DRG weight *reduced* by more than 0.46 in one percent of the DRGs, by more than 0.12 in ten percent of the DRGs and by more than 0.05 in 25 percent of the DRGs. As previously mentioned, the average DRG weight is 0.92; therefore, a change of 0.12 for a specific DRG is substantial. Similarly, the DRG weight *increased* by more than 0.12 in ten percent of the DRGs and by 0.25 in five percent of the DRGs (a 27-percent increase compared to the average DRG weight). Similar changes in DRG weights also occurred between 2005 and 2006 and between 2006 and 2007. The changes were smaller between 2004 and 2005 (see again Table 4 for details). The changes in DRG weights correspond to the years in which all costs were updated (i.e. 2004, 2006 and 2007). There were also changes in 2005, but these were minor and were due to changes the Ministry of Health made to the DRG grouping system.[9]

[Table 4 about here]

## 4. Methods

We estimate a range of empirical models to examine the effect of DRG price changes on the volume of patients treated. The main explanatory variable is the price $p_{jt}$ paid to hospitals for each DRG *j* in each year *t*. The price is constructed in the following way. Define $g_{jt}$ as the weight attached to DRG *j* in year *t*; $z_t$ as the share of ABF (which varies from 0.4 to 0.6, see Column IV in Table 1) and $M_t$ as the cost-based price per DRG point for that particular year (see Column V in Table 1).[10] The price $p_{jt}$ is simply given by the product of the three items and can be written as:

$$p_{jt} = g_{jt} z_t M_t$$

There are three sources of variations in the price, $p_{jt}$. The first ($g_{jt}$) is the result of relative changes in DRG weights over time (which is different for different DRGs). The second ($z_t$) is because of national changes in the ABF component that apply to all treatments. The final one

[9] See Ministry of Health and Social Services, 2005.
[10] $M_t$ is based on the national average cost for producing a DRG-point.

($M_t$) is the cost-based price (i.e. the monetary converter) per DRG point. The last two components are absolute changes that affect all DRGs and vary only over time, while the first source of variation causes relative prices to change. As already shown in Table 4, and discussed at the end of Section 3, the changes in DRG weights are frequent and substantial. We exploit this variation in order to separate the effect of price changes on the volume of activity from other changes over time.

The models are estimated in log-log form, and the results are interpreted as elasticities.[11] To control for unobserved heterogeneity (for example, differences in management style in hospitals, as well as different levels of activity across DRGs), we include fixed effects for all hospital- and DRG combinations. Year dummies are also included in all the models and capture the time trend in a flexible way.

The first model we estimate is:

$$\ln(y_{jkt}) = \beta_0 + \beta_1 \ln(p_{jt}) + \alpha_{jk} + \alpha_t + \varepsilon_{jkt} \qquad (1)$$

where $y_{jkt}$ is the number of patients treated within DRG *j* at hospital *k* in year *t*, $p_{jt}$ is the price for DRG *j* at time *t* (and $p_{jt} = g_{jt} z_t M_t$), $\alpha_{jk}$ is a fixed effect for DRG *j* and hospital *k*, $\alpha_t$ is the year dummy for year *t*, and $\varepsilon_{jkt}$ is the error term. The effect of $z_t$ and $M_t$ is captured by the year dummies, since they are perfectly correlated (note that $\ln(p_{jt}) = \ln(g_{jt}) + \ln(z_t) + \ln(M_t)$). The only variation in price that we explore to estimate $\beta_1$ is, therefore, the one that is due to variation in the DRG weights $g_{jt}$. Model 1 is also estimated for pairs of consecutive years, to see whether the price effect is different from one year to another.

In our second model, we include additional interactions between each DRG and a linear time trend ($\alpha_j * t$), to allow for differential time trends across DRGs:

$$\ln(y_{jkt}) = \beta_0 + \beta_1 \ln(p_{jt}) + \beta_{2j}(\alpha_j * t) + \alpha_{jk} + \alpha_t + \varepsilon_{jkt} \qquad (2)$$

[11] Initial Box-Cox tests support the use of the log-log form.

In the third model, we explore whether the price effect is higher (in absolute value) when the DRG weight increases, rather than decreases. Define $i_{jt}$ as a dummy variable that is equal to one, if the DRG weight increases, i.e. if $(g_{jt} - g_{jt-1}) > 0$, but otherwise equal to zero. The model is:

$$ln(y_{jkt}) = \beta_0 + \beta_1 ln(p_{jt}) + \beta_2 ln(p_{jt}) * i_{jt} + \alpha_{jk} + \alpha_t + \varepsilon_{jkt} \quad (3)$$

where $\beta_1$ is the coefficient associated with a reduction in price, and $\beta_2$ is the additional effect associated with an increase in price.

Models 1-3 are also estimated in order to investigate whether price changes have different effects on different types of patients. More specifically, we first estimate the three models by splitting the patients between those admitted as electives and those admitted as emergencies. We further split the samples between elective inpatients and elective day cases, and between emergency inpatients and emergency day cases. We then look at all surgical patients, medical ones, inpatients and day cases.

Finally, we test whether changes in activity driven by variations in the DRG weights also lead to variations in the patients' characteristics. We concentrate on the patients' age, gender and number of co-morbidities. We run models that are analogous to Equation (1):

$$ln(m_{jkt}) = \beta_0 + \beta_1 (ln\, p_{jt}) + \alpha_{jk} + \alpha_t + \varepsilon_{jkt} \quad (4)$$

where $m_{jkt}$ is either: i) the mean patient age; ii) the mean number of co-morbidities; iii) the proportion of male patients within DRG $j$, hospital $k$ and year $t$.

As part of the sensitivity analysis, we estimate the effect of price variations on activity (as in Model 1), using two other samples. First, we include only patients who were admitted to the hospital during the last five months of each financial year. Our argument for selecting this patient group is that it might take time for hospitals to realise which DRGs are more profitable and to adjust activity accordingly. We should, therefore, expect a larger effect on this sample of patients. Second, as a falsification test, we run the analysis using a sample of women who gave birth.[12] As in Dranove and Wehner (1994), we do not expect to find behaviour responses on the number of births.[13]

# 5. Results

## 5.1. Price effect on the overall activity

We expect to find a positive effect of the price on the number of patients treated, since increases in price for a given DRG generate stronger incentives to treat patients.

The first column in Table 5 shows the results for Model 1. Changes in prices generated by variations in the DRG weights have a positive and significant effect on the number of patients treated. The overall price elasticity is 0.094: when the price increase by ten percent, the volume increases by 0.94 percent. We use 2003 as the reference year. The year dummies over the period 2004 to 2007 are positive and suggest that activity increased steadily over time (by 15.6 percent within a period of five years).

The following four columns in Table 5 look at the changes from one year to another (i.e. between 2003 and 2004; 2004 and 2005; 2005 and 2006; 2006 and 2007). The effect of the price generated by DRG variations on overall activity is in the range of 0.10-0.12, slightly higher than for Model 1, and it is statistically significant at the one-percent level for each period except for 2004 to 2005. The lack of significance for this period can be explained by the small variations in DRG weights between 2004 and 2005 (see third line in Table 4).

[Table 5 about here]

The last two columns of Table 5 show the results for Models 2 and 3. The price elasticity reduces to 0.077 when DRG-specific time trends are allowed for in Model 2. The first coefficient in Model 3 provides the price elasticity when DRG weights do not change or are reduced, and is equal to 0.103. The second coefficient in Model 3, however, provides the price elasticity associated with price increases, and is equal to -0.002. The total price effect on activity is, therefore, slightly lower for the DRGs with price increases (0.101). Both

[12] Hospitals could encourage or discourage home births, but it would still be less likely to find a significant effect for this sample. The mean DRG weight for this sample has increased from 2.23 in 2003 to 3.56 in 2007.

[13] Childbirths were used to test the validity of the two-stage least square approach when estimating physician-induced demand, see Dranove and Wehner (1994).

coefficients are statistically significant. Overall, the results provided in Table 5 support the hypothesis that increases in prices generated by variations in DRGs have a positive effect on overall activity.

### 5.2. Price effect on activity for different types of patients

We now investigate whether the price effect is uniform across different types of patients. We estimate Models 1-3 on different samples, starting by estimating the price effect for elective patients (inpatients and day cases). The results are presented in Table 6. The price effect is not statistically significant in any of the models for elective patients. Model 3 finds a negative price effect for the DRGs, where weights have increased, with a price elasticity of -0.002.

[Table 6 about here]

The analysis is also replicated for emergency patients. A positive and statistically significant price effect is observed for all models, except for emergency day cases. In Model 1 we find a price elasticity of 0.174. When we estimate Model 2, the price effect is still significant and positive, but lower than in Model 1 (elasticity is equal to 0.12). In Model 3, we found the price effect to be slightly lower for DRGs that experienced an increase in the DRG weight (-0.001), compared to those for which there was a reduction.

Table 6 also shows the results when Model 1 is estimated separately for surgical and medical patients, as well as for inpatients and day cases. We find that price has no significant effect on surgical patients, while there is a positive effect for medical patients: the price coefficient is larger compared to the previous models, and equal to 0.254. This is in line with the results presented above, since surgical patients are mostly elective while medical patients are primarily emergency.[14] The results also indicate that price has a positive effect on inpatients (elasticity of 0.074), but no significant effect on day cases.

Finally, we are interested in testing whether the price changes induced by variations in DRG weights also affect the composition of the patients who are treated. Table 7 shows the results

[14] Note that 85 percent of emergency patients are medical patients and around 80 percent of surgical patients are elective.

when we estimate the effect of price changes on the average patients' age, the number of co-morbidities and the proportion of male patients. We see that a 10-percent increase in price brought the age of the patients up by 0.37 percent. Given an average age, at the sample mean, of around 50 years, this implies an increase of 0.2 years. Also, over the five-year period the average age of the patients increased by four percent. A 10-percent increase in price also raised the number of co-morbidities by 0.43 percent. Both analyses suggest that providers may be admitting more severe patients as a result of the increase in activity. The proportion of male patients, however, does not respond to price changes and remains stable over the five-year period considered in the analysis.

[Table 7 about here]

### *5.3. Sensitivity analysis*

To check the sensitivity of our results, we estimate Model 1 on two different samples. The results are presented in Table 7. First, we only include the sub-sample of DRGs and hospitals for the last five months of each year. We could expect to find a higher price effects on activity, since it might take time for hospitals to realise which DRGs are more profitable. We found the price coefficient to be significant and positive (0.052), but lower compared to what we report in Table 5 (Model 1).

We then estimate the model on the sample of births, which we expect to be exogenous and, therefore, not influenced by changes in prices. The estimation was in line with our expectations and we found that the price effect was not significant.

### *5.4. Discussion of the results*

We found a significant positive effect for changes in the DRG prices on the number of patients treated. However, when investigating the different types of treatments, this price effect was present only for patients admitted as emergencies and/or for medical, rather than surgical, treatments. This may be considered somewhat surprising, since the demand for emergency care should not depend on price.[15] However, a hospital's decision about whether to admit a patient for emergency treatment is open to discretion in some instances.[16] For example, a patient may be sent to the hospital by a GP who has doubts about appropriate treatment. These cases will vary in seriousness, and it may be that when prices increase, the hospitals are willing to admit more emergency patients, instead of sending them back to their GPs. This uncertainty about patient status may also exist when deciding whether to allocate patients to elective treatment or to admit them as emergency cases. The fact that there is room for such discretion was recognised in a recent White Paper from the government (White Paper 47, 2008-09). The document argued that about 400,000 somatic inpatient days, or approximately 10 percent of all somatic inpatient days, in 2007, could have been avoided if around-the-clock (primary care) treatments were available at the municipality level, which is currently not the case. Therefore, organizational features, as well as medical considerations, would seem to have an effect on the admission of emergency patients into hospitals.

Documentation of unnecessary emergency hospital care indicates that there are cases where it is unclear whether or not patients need emergency hospital care. Furthermore, many patients show up directly at the hospital or casualty clinic without having visited their GPs. We believe that, in these cases, those making the decisions in the hospitals use a degree of discretion in determining whether the patient should be admitted or not. Our results show that hospitals respond to relative price changes and admit more patients when their relative prices (DRGs) are increased.

## 6. Concluding remarks

We investigate how relative changes in DRG prices affect activity in Norwegian hospitals. In most of the countries where health care services are publicly provided, the demand for health care exceeds their ability to supply it. It is, therefore, important to explore whether price mechanisms might be used as a way to increase activity in the hospitals. It might be argued that, because of fixed capacity in the hospitals, the price should not have an effect on the number of patients treated. However, with a prospective payment system, increased price per treatment gives incentives to increase the number of those treatments (Dafny, 2005).

[15] Analysing a cross section of southeastern hospitals in the U.S., Hegji (2007) also finds that emergency room visits generate profits for the hospitals.
[16] Overuse of supply sensitive care is also reported in Darthmouth Atlas Project (see darthmouthatlas.org).

The literature (Kjerstad, 2003; Biørn *et al*., 2003) shows that the introduction of ABF had a positive effect on activity in Norway. In this paper we investigate whether changes in DRG prices have any impact on the number of patients treated. Changes in prices are created by changes in DRG-weights and the ABF-share. If hospitals increase activity when prices increase, either through better use of their existing resources or by adjusting to the increased demand for some specific procedures, this finding might provide important information for policy makers.

We estimate the price effect on volume and find that higher prices lead to increased numbers of patients treated. A 10-percent increase in price leads to about a one-percent increase in activity. Different specifications support the positive price effect on activity. When the price effect is estimated on different samples, we found that the price has a larger effect on activity for emergency patients than for elective patients. This may be considered a somewhat surprising finding. We know there is excess demand for elective procedures and we would, therefore, expect an increase in the number of elective patients treated when the price increases. However, there is no significant price effect for this group of patients.

Emergency cases, on the other hand, show up at the hospital when urgent treatment is needed, and treatment of patients might, in these situations, be expected to be insensitive to prices. However, hospitals have some discretion about which patients to admit from among those who show up at the emergency department. This decision seems to be price sensitive. Our results suggest that price changes have a smaller effect on elective patients, mainly surgical patients, while admitting more emergency patients, mostly medical patients, may be a way to benefit from variation in prices.

Some limitations of the research should be mentioned. First, we do not have available information on costs at specific hospitals. Average reimbursements for some treatments might be more profitable for some hospitals than for others. Also, we have not examined the effect on the quality of the treatments provided. More research with better data is needed on these issues. Another important issue that needs to be addressed in the future is the price effect on waiting times. Using information on waiting times in Norway, Martinussen and Hagen (2009) found evidence of cream skimming during the first period after the introduction of ABF. In Norway, patients may choose a hospital where treatment is to be provided, and it would be useful to determine whether hospitals compete for patients. The main qualitative indicator for attracting patients is waiting time for the treatment. Thus, if hospitals attempt to attract more patients within specific diagnosis, they will try to have shorter waiting times for those treatments. If the increase in price leads to shorter waiting time for a treatment, it might be considered as prioritisation mechanism.

Nevertheless, our results have important policy implications. The price-sensitivity of hospital outputs suggests that policy-makers could set prices of particular DRGs purposively to influence the mix of treatments provided rather than relying on historical national average treatment costs. In addition, it is important to consider the distributional consequences of the behaviour we have identified. As the numbers of emergency patients admitted seem to be more responsive to price changes, it might be an indication that less severe cases are being admitted, indicating overuse of supply sensitive care. On the other hand, our results indicate that hospitals do respond to relative price changes. Hence, the price mechanism might be used as a prioritisation tool to allocation more resources to treatments that the hospital owner wants to prioritise.

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## Tables

**Table 1. Changes in reimbursement system**

| I | II | III | IV | V |
|---|---|---|---|---|
| Year | Cost Year | Cost-based reimbursement per DRG point (in NOK)[17] | Activity Based Funding share | Cost-based price per DRG point (in NOK) |
| 2003 | 2000 | 28,863 | 60% | 17,318 |
| 2004 | 2002 | 27,496 | 40% | 10,998 |
| 2005 | 2002 | 27,484 | 60% | 16,490 |
| 2006 | 2004 | 27,630 | 40% | 11,052 |
| 2007 | 2005 | 27,356 | 40% | 10,942 |

**Table 2. Changes in Activity**

| Years | 2003-2004 | 2004-2005 | 2005-2006 | 2006-2007 |
|---|---|---|---|---|
| Change in ABF share: | From 60% to 40% | From 40% to 60% | From 60% to 40% | Kept at 40% |
| Change in total DRG-points* | 2.15% | 3.91% | 2.76% | 2.26% |
| Change in total patients treated | 4.35% | 4.61% | 4.28% | 0.81% |

*Note: DRG-point is the sum of the DRG-weights from all hospital stays.

[17] Note: Real prices; deflator for municipality- and regional level was used, see http://www.regjeringen.no/Upload/KRD/Vedlegg/KOMM/TBU/H-2218mOmslag.pdf

**Table 3. Descriptive statistics. Sample means**

| Year | Age | Male | Co-morbidities | Length of stay | DRG-weight | Price | Number of patients |
|---|---|---|---|---|---|---|---|
| 2003 | 48.97 | 0.50 | 1.25 | 3.79 | 0.92 | 15,927 | 1,133,241 |
| 2004 | 49.52 | 0.49 | 1.28 | 3.71 | 0.95 | 10,416 | 1,176,607 |
| 2005 | 49.72 | 0.49 | 1.30 | 3.62 | 0.93 | 15,330 | 1,226,020 |
| 2006 | 49.61 | 0.49 | 1.37 | 3.51 | 0.93 | 10,289 | 1,276,182 |
| 2007 | 49.97 | 0.49 | 1.40 | 3.44 | 0.96 | 10,480 | 1,291,314 |

**Table 4. Distributions of the changes in DRGs in two consecutive years**

| Year | 1% | 5% | 10% | 25% | 50% | 75% | 90% | 95% | 99% | Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| 2003 | | | | | | | | | | |
| 2004 | -0.46 | -0.18 | -0.12 | -0.05 | 0 | 0.02 | 0.12 | 0.25 | 1.17 | 0.02 |
| 2005 | -0.10 | -0.01 | 0 | 0 | 0 | 0 | 0 | 0 | 0.51 | 0.01 |
| 2006 | -0.73 | -0.27 | -0.14 | -0.05 | 0 | 0.02 | 0.13 | 0.26 | 0.97 | 0.00 |
| 2007 | -0.68 | -0.18 | -0.10 | -0.03 | 0 | 0.02 | 0.1 | 0.22 | 1.17 | 0.01 |

**Table 5. Regression results of price effect on overall activity**

Dependent variable: ln($y_{jkt}$), log of number of patients treated within DRG $j$, hospital $k$ and year $t$

| | Model 1 | 2003-2004 | 2004-2005 | 2005-2006 | 2006-2007 | Model 2 | Model 3 |
|---|---|---|---|---|---|---|---|
| Ln(price) | 0.094** | 0.113** | 0.120 | 0.104* | 0.115* | 0.077** | 0.103** |
| | (0.014) | (0.034) | (0.084) | (0.032) | (0.035) | (0.015) | (0.021) |
| Price-increase | | | | | | - | -0.002** |
| | | | | | | - | (0.001) |
| 2003 | Ref | | | | | Ref | - |
| 2004 | 0.066** | 0.080** | Ref | - | - | 0.033 | Ref |
| | (0.008) | (0.017) | | | | (2.995) | |
| 2005 | 0.054** | - | -0.022 | Ref | - | 0.0001 | -0.034** |
| | (0.005) | | (0.034) | | | (5.989) | (0.010) |
| 2006 | 0.139** | - | - | 0.085** | Ref | 0.050 | 0.054** |
| | (0.009) | | | (0.014) | | (8.984) | (0.005) |
| 2007 | 0.156** | - | - | - | 0.012 | 0.035 | 0.068** |
| | (0.009) | | | | (0.005) | (11.978) | (0.005) |
| Number of FEs: | 41,179 | 32,736 | 33,617 | 33,543 | 33,461 | 41,179 | 33,035 |
| Adjusted $R^2$ | 0.889 | 0.909 | 0.914 | 0.911 | 0.913 | 0.8954 | 0.896 |
| Observations | 143,177 | 56,850 | 57,948 | 57,850 | 57,204 | 143,177 | 101,995 |

Robust standard errors in parentheses. * $p < 0.01$, ** $p < 0.001$

Note: Number of observations: the total number of DRG-hospital and year combinations.

All models contain DRG and hospital fixed-effects (not shown).

**Table 6. Activity analysis**

Dependent variable: ln($y_{jkt}$), log of number of patients treated within a DRG *j*, hospital *k* and year *t*

| | Coefficient on Ln(price) | Coefficient on Price-increase | Adjusted $R^2$ | Number of FEs | Number of observations |
|---|---|---|---|---|---|
| **Elective patients only:** | | | | | |
| Model 1 | 0.040<br>(0.021) | | 0.849 | 31,962 | 97,355 |
| Inpatient | 0.041<br>(0.027) | | 0.851 | 19,437 | 61,334 |
| Day cases | -0.050<br>(0.028) | | 0.847 | 12,565 | 36,021 |
| Model 2 | 0.022<br>(0.023) | | 0,905 | 31,962 | 97,355 |
| Model 3 | 0.040<br>(0.029) | -0.002*<br>(0.001) | 0.863 | 23,128 | 65,392 |
| **Emergency patients only:** | | | | | |
| Model 1 | 0.174**<br>(0.016) | | 0.891 | 32,421 | 109,045 |
| Inpatient | 0.108**<br>(0.016) | | 0.901 | 21,640 | 79,406 |
| Day cases | 0.034<br>(0.050) | | 0.756 | 10,911 | 29,639 |
| Model 2 | 0.121**<br>(0.018) | | 0.927 | 32,421 | 109,045 |
| Model 3 | 0.159**<br>(0.023) | -0.001<br>(0.001) | 0.893 | 25,418 | 76,623 |
| **Different samples (Model 1):** | | | | | |
| Surgical | 0.009<br>(0.024) | | 0.883 | 15,059 | 50,754 |
| Medical | 0.254**<br>(0.019) | | 0.891 | 25,313 | 89,911 |
| Inpatients | 0.074**<br>(0.015) | | 0.907 | 24,458 | 91,399 |
| Day cases | -0.054<br>(0.025) | | 0.853 | 16,866 | 51,778 |

Robust standard errors in parentheses. * $p < 0.01$, ** $p < 0.001$

Note: Number of observations: the total number of DRG-hospital and year combinations.

All models contain fixed-effects for DRG and hospital groups and year dummies (not shown).

**Table 7. Price effect on patients' characteristics and sensitivity analysis**

Note: *ln(age$_{jkt}$)*: mean age within DRG *j*, hospital *k* and year *t*.
(*ln(co-morbidities$_{jkt}$)*: mean number of co-morbidities within DRG *j*, hospital *k* and year *t*.
*ln(male$_{jkt}$)*: proportion of males within DRG *j*, hospital *k* and year *t*.

| | Coefficient on Ln(price) | Adjusted $R^2$ | Number of FEs | Number of observations |
|---|---|---|---|---|
| **Price effect on patients' characteristics (Model 4)** | | | | |
| ln(age$_{jkt}$) | 0.037** (0.008) | 0.902 | 41,179 | 143,177 |
| ln(co-morbidities)$_{jkt}$ | 0.043** (0.007) | 0.763 | 41,179 | 143,177 |
| ln(male)$_{jkt}$ | 0.001 (0.004) | 0.520 | 41,179 | 143,177 |
| **Sensitivity analysis (Model 1)** | | | | |
| Sub-sample of DRGs and hospitals in August-December | 0.052* (0.016) | 0.855 | 36,460 | 119,681 |
| Births only | -0.095 (0.097) | 0.937 | 558 | 1,741 |

Robust standard errors in parentheses. * $p < 0.01$, ** $p < 0.001$
Note: Number of observations: the total number of DRG-hospital and year combinations.
All models contain fixed-effects for DRG and hospital groups and year dummies (not shown).

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