The impact of activity based hospital financing on health care and mortality: evidence from hospital payment reforms in OECD countries

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Abstract

In the past three decades, many developed countries have changed the manner in which hospitals were financed. Although it has been hypothesized that the way in which healthcare providers are reimbursed may affect their performance and thereby population health, there is little empirical literature on this. This study uses aggregate level panel data coming from 20 OECD countries over 30 years to explore the impact of these reforms on indicators of healthcare output and mortality. We first classified hospital financing systems based on whether they depend purely on hospital characteristics (fixed budget) or also on the service they provide (activity based, AC). In a second step we tried to differentiate within activity based financing: a) fee-for-service (FFS), which is purely based on the quantity of services provided, or b) Patient-based payment (PBP), in which activities are linked to patients. The data is analysed using a difference-in-difference (DID) model with country and year specific fixed effects and a variant of it, which allows for a structural change in the outcome. We find evidence that activity based financing increases the growth rate of health care output and life expectancy at age 65. Differentiating between FFS and PBP did not yield any significant results in terms of health care output but indicated that the positive effect on life expectancy is probably caused by PBP.

Keywords: Hospital financing system reform, FFS, PBP, fixed budget, DID, structural change model

Introduction

Many developed countries have experienced reforms in hospital financing in the past decades. In the same period, alongside these reforms, both health care expenditures and life expectancy have been rising in many of these countries. As hospital expenditures form a substantial part of total health care spending (in 2008, the average share of hospital care of total health care spending among OECD members was 35.8 present (Donaldson e al. 1993))this has led researchers to link these reforms to changes in both health care expenditures and mortality. This is not that surprising for two reasons. First of all, an important driver of a country's hospital spending is the nature of hospital financing as different financing schemes create different incentives for hospital care provision (Cylus and Irwin, 2010).. Secondly, several studies using OECD country panel data estimated that there is a positive influence of health care expenditures on life expectancy after controlling for several confounders (Nixon and Ulmann, 2006, Nixon and Ulmann, 2006, Shaw, Horrace, et al., 2002, Shaw, Horrace, et al., 2002, Berger and Messer, 2002, Elola, Daponte, et al., 1995, Hitiris and Posnett, 1992, Lichtenberg, 2002, Miller and Frech, 2002, Or, 2000). If we combine these two streams of literature it could be hypothesized that hospital payment reform might induce increased health expenditures and hospital activities which in turn might increase life expectancy. In the Netherlands, for example, it has been hypothesized that the change from global budget to fee-for-services financing of hospitals may have caused an increase in both health care expenditures and life expectancy in elderly (Mackenbach, Slobbe, et al., 2012).

The economic literatures suggest that increases in health expenditures, due to the expansion and increased availability of medical technology, may have increased life expectancy (Cutler and McClellan, 2001). For instance, there is evidence suggesting that treatments for cardiovascular disease, while increasing health care expenditures, have contributed to the growth in life (Cutler, 2007). However, many questions remain unanswered. These questions pertain not only to the causal relationship between health care expenditures and life expectancy, but also to the mechanisms underlying this relationship. Especially evidence regarding the role of health care reforms such as changes in hospital financing is scarce. Hospitals, as healthcare providers, are paid in various ways. Payments can be based on provider characteristics (e.g. hospital size and etc) and/or quantities of services provided and patient characteristics (e.g. number of patient days and patient diagnoses) (Ellis and Miller, 2007). At one extreme, hospitals are financed through a

fixed budget which only depends on the provider's own characteristics without explicit regard to the number or type of patients seen. This fixed budget is a pre-determined amount of money for health-related activities in a hospital based on its size or type (e.g. academic vs non-academic). The second type of payment system is activity based payment which is based on service and patient characteristics. Under this system, hospitals are paid according to the services provided to the patients. Based on the information that is used to calculate hospitals payments, we can distinguish within activity based payment: a) a payment based on the quantity of the services provided which does not depend on the diagnosis of the patient, called fee-for-service, FFS; and b) a payment based on patient diagnostic characteristics, i.e., the hospital care services are linked to the key patient attributes and characteristics, called patient-based payment, PBP (Ellis and Miller, 2007). A typical example of PBP is Diagnostic-Related Grouping (pure DRG) payment system, whereby hospitals receive fixed amounts of money based on patients' diagnostic groups (Ellis and Miller, 2007). PBP financing can be seen as a refinement of FFS in the sense that PBP is also activity based, and these activities are coupled to patients and/or diagnosis. In practice life, it is often hard to classify a particular country or hospital into a certain payment system as hospitals are reimbursed according to a combination of two or three of the systems described above. Countries shift from one hospital financing system to another for variety of reasons. Two main reasons are a) to control healthcare spending; or b) to have stronger incentives on quality and quantity of the services provided. For example, in Netherlands the government decided to replace the open-ended or per diem hospital reimbursement system by a global budgeting system for hospitals' operating expenses in 1983. In 1990s, the growing waiting list challenged the principle of equal access to health services. Therefore, in 2001, the global budgeting system for hospitals was suspended, and for the time being, hospitals were being reimbursed for all the services provided (Schut and Van de Ven, 2005). Since 2005, for hospitals an elaborate diagnosis-related group (DRG)- type system (called DBC in Dutch) has been in place in order to have more control over the expenses and effectiveness of services (Schäfer, Kroneman, et al., 2010).

It has been hypothesized that hospital payment systems can have an impact on their performance, in terms of both quantity and quality that is delivered. If a hospital is given a fixed annual budget, their output may be different than it would be if the budget was determined by activity measures (e.g. production based). Obviously, the latter one offers hospitals a greater incentive to increase the quantity of their healthcare output (Ellis and Miller, 2007). Consequently, it has been hypothesized that if the chosen hospital payment

system changes hospital outcomes, this change may reflect in changes in health, namely inpatient mortality. Although there are many papers that have described the impacts of hospital payment system on hospital care outcomes, such as average length of stay, hospital admissions and/or health care expenditures, most of these studies focused on descriptive analysis with pre-post comparison. (Davis and Rhodes, 1988, Louis, Yuen, et al., 1999, Kroneman and Nagy, 2001, Kwon, 2003, Lang, Chi, et al., 2004). Studies that attempted to estimate a treatment effect of hospital payment reforms used outcomes measures at the regional level. The treatment effects in these studies were identified by exploiting differences in the timing of implementing hospital payment reforms. Studies using regional data found that compared to FFS, DRG payment resulted in a decrease in ALOS and health care expenditure but no evidence of increases in inpatient mortality (Cutler, 1993, Dismuke and Guimaraes, 2002, Frank and Lave, 1989, Yip and Eggleston, 2001). Moreno-Serra and Wagstaff (hereafter MSW) studied the impact of hospital payment reforms on health care outcomes in central and Eastern Europe and central Asia countries over longer time period. They estimated that FFS increased both health expenditure and inpatient admissions; PBP increased health care expenditures and decreased length of stay. Of the two methods, only PBP appeared to have any beneficial effect on amenable mortality (Moreno-Serra and Wagstaff, 2010). To our knowledge, this is the only paper that used country level panel data to estimate the impact of activity based hospital payment systems on health care output and mortality. MSW used a difference-in-difference (DID) model and two variations thereof. In the MSW paper, the reforms were assumed to have an additive effect formulated in terms of levels. This implies that the models estimated by MSW are 'memoryless' and reforms are assumed to only have a temporary effect, i.e., with a reform, it wipes out all the effects of the previous health care system. This is unlikely if we consider that decisions at the micro level of hospitals (e.g. introduction of new technologies, changes in personnel) which are influenced by macro level incentives may have a long lasting and thus permanent impact. A priori it is to be expected that reforms indeed would have a permanent effect which do not decay as there have been studies that have argued that trends in health care expenditures and also life expectancy can be characterized by a unit root process (MacDonald and Hopkins, 2002)(Lee and Miller, 2001).

Our study aimed to understand the impact of different hospital financing systems on healthcare output and mortality. Based on the criteria described before, we first compare the activity based payment to fixed budget payment; then we differentiate between FFS and PBP, and compare them separately to fixed budget payment. We followed the approach in

Moreno-Serra and Wagstaff paper (Moreno-Serra and Wagstaff, 2010, Wagstaff and Moreno-Serra, 2009) but allowing reforms to cause 'structural changes', i.e., assume a payment system can alter the growth rate of the outcome. The paper is organized as follows. In next section, we will describe the data, including the hospital reforms that have taken place in 20 OECD countries over 30 years (1980-2009). In section 3, we set out our hypothesis concerning the impacts of hospital payment reforms on the health (care) outcomes, as healthcare utilization, health spending, and mortality. Section 4 follows by a description of methods, including tests that we used to assess the validity of the method. Section 5 presents the results and alternative classification analyses. Finally, section 6 describes our main conclusions, the strengths and limitations of our research.

DATA

Hospital payment system classification

We constructed a data-set describing hospital payment system for 20 OECD countries covering the years 1980-2009 (table 1). We created two major categories to classify hospital payments: (i) Fixed-budget payment, (ii) activity based payment (AC) (Ellis and Miller, 2007). Within AC, we differentiate between fee-for-service (FFS) and patient based payment (PBP). Fixed budget indicates that in a given year in a particular country hospital payment have pre-fixed budget for their operation expenses that depends purely on provider characteristics, such as size of hospital or number of beds. The payment systems that fall into this broad category are line-up budgets (Donaldson, Gerard, et al., 1993) or global budgets (Donaldson, Gerard, et al., 1993). An activity based payment indicates that in a given year in particular country the hospitals are financed based on the overall service that they provided and/or patients' characteristics. Within activity based payment, a FFS payment indicates that hospitals are reimbursed based on the quantity of services they provide without depending on patient characteristics. FFS includes payment systems such as per diem (per day) or cost-base payment in which hospitals reimbursed for the overall services provided at hospital level. A PBP indicates whether hospitals get paid according to the diagnoses of patients, such as diagnostic-related grouping (DRG) payment mechanism. Based on the classification, we created 3 dummy variables, AC, FFS and PBP. Dummy variable AC_{it} takes value one if the hospitals in country i at year t reimbursed in any form of activity based payment, which means either a FFS or a PBP. Dummy variable FFS_{it} takes value one if the hospitals in country i at year t reimbursed with FFS as the payment method; dummy variable PBP_{it}

takes value one if the hospitals in country i at year t have PBP as the hospital payment method; when both dummies equal to zero, it indicates that hospitals are paid with fixed budgets.

Given that it is difficult to describe the exact type of hospital payment system for each country, our classification is rather crude, and within the three categories distinguished, there is heterogeneity. In all countries at least part of hospital payments are based on provider characteristics. Furthermore, in some countries the hospital payment reform developed gradually to whole nation over more than a year. In such cases, different part of the country has different hospital payment systems for certain years (Christiansen, Bech, et al., 2012). Regardless of the difficulties, we have to characterize countries' hospital payment systems in ways that are tractable to regression analysis. We classified a country in a particular year as fixed budget if hospitals did not depend in any way on the services provided. A country was classified as activity based payment if at least part of its hospital payments depended on activity based. Within activity based payment, the country classify as FFS if at least part of its hospital payments depended on the services provided; however, if the activity based payment to some extent linked to patient characteristics, we classified it as PBP. This means, even if PBP is coexist with budget system or FFS in a country at time t, we set the dummy variable PBP_{it} as one at time t, while FFS_{it} equal to zero. Table 1 shows the classification of payment systems for these 20 developed OECD countries in the period of 1980 to 2008. In 1980, all countries either had a FFS (in form of per diem) or a fixed budget payment system. The dark grey area represents activity based payment, and differentiated between FFS and PBP by adding initial letters (F or P). With 20 countries, Australia and Italy were the first countries that implemented PBP as hospital payment system in 1993 and 1995, respectively, and by 2008 most countries have switched to some form of PBP. Most reforms that have taken place were from fixed budget to PBP or FFS. Some countries went from fixed budget to PBP by first reforming from fixed budget to FFS.

To construct table 1, we used information coming from multiple sources. The main source was the World Health Organization's (WHO) Health System in Transition (HiT) series. Additionally, we looked into series of books related to health system and policies (Donaldson, Gerard, et al., 1993, Laschober, Wiley, et al., , Thomson, Foubister, et al., 2009), and other papers (Schut and Van de Ven, 2005, Christiansen, Bech, et al., 2012).

years	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
countries																														
Australia	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
Austria	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	P	P	P	P	P	P	P	P	P	P	P	P	P
Blegium	F	F	F	F	F	F	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	P	P	P	P	P	P	P	P
Canada	F	F	F	F	F	F	F	F	F	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB
Denmark	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	P	P	P	P	P	P	P	P	P	P	P
Finland	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	F	F	F	F	F	F	F	F	P	P	P	P	P	P	P	P	P
France	F	F	F	F	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	P	P	P	P	P	P
Germany	F	F	F	F	F	F	F	F	F	F	F	F	F	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	P	P	P	P	P	P
Greece	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	P
Iceland	F	F	F	F	F	F	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB
Irland	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
Italy	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
Luxemburg	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB
Netherlands	F	F	F	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	F	F	F	F	P	P	P	P	P
Norway	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	P	P	P	P	P	P	P	P	P	P	P	P	P
Portugal	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	P	P	P	P	P	P	P	P	P	P	P	P	P	P
Spain	F	F	F	F	F	F	F	F	F	F	F	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB
Sweden	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	P	P	P	P	P	P	P	P
Switzerland	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	FB	FB	FB	FB	FB	FB	FB	P	P	P	P	P	P	P
UK	F	F	F	F	F	F	F	F	F	F	F	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	FB	P	P	P	P	P	P	P	P

Fixed budget: FB	FB
Activity based_ fee-for-service	F
Activity based_ patient based payment	P

Table 1. Hospital payment methods in the 20 developed OECD countries, 1980-2009.

Outcome variables

The outcome measures included several aspects of health care outputs: total health care expenditure per capita (constant US$ 2005, corrected for PPP) estimated by OECD; hospital inpatient discharge and ALOS derived from the 'WHO European Health for All database and OECD Health Data 2011 (for non-Europe countries). The measure of inpatient discharge is standardized to number of discharge per 100 inhabitants. As indicators of health, we included age-standardized number of deaths (SDRs) for all causes of death, life expectancy at age 65 and infant mortality. SDR is the age-standardized death rate calculated using the direct method, i.e. represents what the crude rate would have been if the population have the same age distribution as the standard European population (World Health Organization. Regional Office for Europe, 2009). The standardized data is necessary for comparing the level of mortality across countries and over time, because they take into account the differences in age structure of the population. Number of death data collected from OECD Health Data 2011, and the data standardised using the total OECD population for 1980 as the reference population.

Covariates/confounders

According to the previous international comparative literatures in health economics (U.G.Gerdtham and B.Jonsson, R.M.Serra and Moreno-Serra, A. Wagstaff), we included GDP per capita (measured in constant 2005 dollars and adjusted for purchasing power adjustment) and the share of population aged 65 or above as confounders. MSW paper also included fraction of urban population. We assumed this confounder to be irrelevant, considering all the countries included in our study are developed countries, and therefore, the differences for the traveling cost to the hospitals are believed to be not significant. Data on these covariates came from OECD Health Data 2011.

All the outcome variables and the covariates, except for dummy variables, were transformed to natural logarithms to capture the non-linearity in the models and allow for easier interpretation.

Possible impact of hospital payment reforms

One of the important consequences of shifting from a pure provider based hospital payment to an activity based payment is that governments may exert less influence on total hospital output and expenditures. This implies that hospital financing becomes open ended instead of closed and that we can expect an increase of overall hospital expenditures. In a PBP system, compared to FFS, hospital activities are more strictly linked to patients and a fixed price is set for each diagnostic group, thus we can expect the growth of healthcare expenditure to be more controlled. Furthermore, one can also expect changes in hospital utilization to be reflected in health status as measured by mortality. Here, we listed our hypothesis with the possible incentives of three different categories on health care output and mortality.

Health expenditure: According o the definition fixed budget payment has strong incentives to contain the cost. A shift from budget system to activity based payment is a way to lose constraint with hospital budgets, thus may increase hospital expenditure. Compared to fixed budget, within a FFS system hospitals get reimbursed for the quantity of the service with no budget constrain, so that hospitals have strong incentives to treat more patients, as well as provide more intensive service and treatment (to receive more reimbursement) which may increase hospital expenditure. On the other hand, compared to fixed budget, PBP is also assumed to increase hospital expenditure because of no budget constrain and presumably, more patients. However, within PBP, there is a fixed price for each diagnostic group, therefore PBP have less strong incentive to increase hospital expenditure than FFS. Hospital expenditure covers around one-third of the total health expenditure (Thomson, Foubister, et al., 2009), and proportion has been increasing over the years. Hence, a shift from fixed budget to FFS or PBP may increase hospital expenditure and, therefore, reflect in total health expenditure.

Hospital discharge (hospital admission): Hospitals with fixed budget payment have no incentive to increase or decrease the hospital admission. Activity based payment are likely to increase the number of hospital admissions relative to fixed budget payment. Hospitals reimbursed with FFS receive additional revenue for additional patient by providing more service. Hospitals reimbursed with PBP receive fixed amount of money for additional patients according to their diagnostics groups. Hence, both payment systems have incentives to increase the number of inpatient to receive more reimbursement. As PBP payment have different price for diagnostics groups, the hospitals may intent to increase admissions for more expensive diagnostics groups patients only. So in general FFS may have stronger incentive to increase hospital admission than PBP.

Average length of stay (ALOS): Hospitals financed through fixed budget, spent less by keeping old patient for one more days, compare to admitting a new patient. Therefore, under budget constraint hospitals may intend to keep their patients longer rather than admitting new patient. It is unclear how activity based payment influence ALOS. If a hospital reimbursed with per diem (a form of FFS), there is a strong incentive to keep the patient more days; however, if a hospital reimbursed for all the services at hospital level (a form of FFS), it may gain more by admitting new patient rather than keep a patient one day longer (holding hospital size fixed). PBP is likely to lead a decrease in average length of stay (ALOS), because hospitals gain fixed amount according to the diagnostic group, and no extra revenue from keeping patient extra days compare the revenue they may earn from a new admission.

Table2: Expected impacts of hospital payment method

Outcome measures		**Expected signs of impacts (compared to GB)**		
	GB	**AC**	**FFS**	**PBP**
Health expenditure	0	+	++	+
Hospital discharge	0	+	++	+
ALOS	0	+/-	+ / -	-
Mortality	0	-	-	-

Mortality: Adequate healthcare supply may encounter health care demand by decreasing hospital waiting list or increasing the quality of service, and thus improve overall health status. Hence, one may expect the changes in hospital utilization and health spending may reflect in changes in health status. While activity based payment have incentive to improve the quality and quantity of service (relative to fixed budget), we may expect this improvement reflect in the health status and decrease inpatient mortality. FFS encourage hospitals to provide more intensive treatment than fixed budget. This may potentially increase the quality of health care and result in decreasing in amenable inpatient mortality. However, the actual effect relates to the efficiency and potential benefits of the additional treatments. By contrast, PBP set fixed budget for each diagnostic group, and even supply a standard treatment, so it may not result in an intensive treatment. However, PBP may increase the number of inpatient, and treating more patient may result in less health problems outside the hospital and decrease overall mortality. Compare to FFS, PBP may eliminate the additional treatment, which may either potentially harmful or beneficial.

Methods

We discussed the possible impacts of different hospital payment systems. According to our hypothesis, we expect reforms in payment system followed by certain increase or decrease with outcome measures. These hypothesized effects of the reforms may either be temporary or permanent. In order to test our hypothesis, we start with a basic difference-in-difference model (DID) model, which assumes that effects of the reforms are temporary. Then we extend this model to allow for structural changes in the trend and assume permanent impacts of reforms.

Basic DID model

Let y_{it} be the health outcome in country i at time (year) t, X_{it} be the vector of time varying country specific confounders (covariates that may influence the outcomes and possibly correlated with the hospital payment method in place, such as GDP and share of age 65 and older), AC_{it} , FFS_{it} and PBP_{it} be payment method dummy variables taking value 1 if the country i at time t has a AC, FFS or PBP as hospital payment method, respectively. The base category relative to AC, FFS and PBP is fixed budget. Consider the model:

(1) $y_{it} = \beta_0 + \beta_1 X_{it} + \pi AC_{it} + e_{it}$

(2) $y_{it} = \beta_0 + \beta_1 X_{it} + \delta FFS_{it} + \gamma PBP_{it} + e_{it}$,

where e_{it} (*iid* over i and t) denotes unobservable variables and noise. Equation (1) represents the model with first type of classification activity based payment and fixed budget; in equation (2), we differentiate within activity based payment into FFS and PBP. The main interest is in the coefficients π, δ and γ which capture the impact of AC, FFS and PBP on the level of outcome, y_{it} , respectively. OLS estimation would bias if the payment methods in place correlated with the unobservable term ε_{it} , i.e., the payment method dummy variables are endogenous. A way to capture the possible time varying unobservable and country specific characteristics is a fixed effect model with country and year specific effects. This type of model is also called a DID model and can be denoted as:

(3) $y_{it} = \beta_0 + \beta_1 X_{it} + \theta_t + \alpha_i + \pi AC_{it} + \varepsilon_{it}$,

(4) $y_{it} = \beta_0 + \beta_1 X_{it} + \theta_t + \alpha_i + \delta FFS_{it} + \gamma PBP_{it} + \varepsilon_{it}$,

where θ_t is a year-specific intercept and α_i is country-specific effect which captures time-invariant unobservable that potentially correlated with hospital payment method. θ_t and α_i can be modeled as dummy variables for each year and each country, respectively. Equation (3, 4) can be estimated in

first-difference, so that we will estimate the changes in explanatory variable that associated with changes in outcome variable. The estimating equation expressed as,

(5) $\Delta y_{it} = \beta_1 \Delta X_{it} + \xi_t + \pi \Delta AC_{it} + \Delta \varepsilon_{it}$,

(6) $\Delta y_{it} = \beta_1 \Delta X_{it} + \xi_t + \delta \Delta FFS_{it} + \gamma \Delta PBP_{it} + \Delta \varepsilon_{it}$,

where $\xi_t = \triangle \theta_t$. One can see after taking the first-difference, country specific effect α_i is eliminated. In basic DID model, we assume all the countries have the same time trend. If we relax this assumption, and allow countries to have its own time trend (include an interaction term of time and country-specific effects in equation (5) and (6)), then equation (7, 8) becomes: to have its own time trend (denoted, k_i) equation (5, 6) becomes:

(7) $\Delta y_{it} = \beta_1 \Delta X_{it} + \xi_t + k_i + \pi \Delta AC_{it} + \Delta \varepsilon_{it}$,

(8) $\Delta y_{it} = \beta_1 \Delta X_{it} + \xi_t + k_i + \delta \Delta FFS_{it} + \gamma \Delta PBP_{it} + \Delta \varepsilon_{it}$,

We call this model as *random trend model* (Moreno-Serra and Wagstaff, 2010). If $k_i$are jointly significant, the equation collapse to basic DID model.

Incorporating structural changes

The DID model with country and time fixed effect models assume the trend is linear, and that the trend is assumed not to be modified by the change of the hospital payment method in place. After taking first-differences with fixed effect model, the coefficients π, δ and γ represent the effect on the levels of the outcome. However, it could be the case that a hospital payment reform permanently alters the growth rate, thus, have a structural change within the trend of the outcome. The previous model has 'memoryless' property, i.e. do not allow reforms to cause structural changes. Suppose we have 2 countries (countries A and B) reform to PBP in year 11 that are identical (with identical GDP, population structure and other unobservable) except for their hospital financing system history. Assume country A had 10 years of FFS, while country B had fixed budget for last 10 years. Basic DID model predicts that country A and B have identical value for $Y_{i,t}$ in year 11. To allow for structural changes one can alter the DID model in the following manner:

(9) $y_{it} = \beta_0 + \beta_1 X_{it} + \theta_t + \alpha_i + \omega Z_{AC,it} + \varepsilon_{it}$

(10)$y_{it} = \beta_0 + \beta_1 X_{it} + \theta_t + \alpha_i + \tau Z_{FFS,it} + \varphi Z_{PBP,it} + \varepsilon_{it}$

where, Z is counting the years implemented AC, FFS or PBP. For example, $Z_{AC.it}$ starts counting as one from the first year that AC payment implemented in country i; when country i experience a

reform in hospital payment system at year m (m=2…T), $Z_{AC.im} = m$, and stays constant till the hospital payment system reform back into AC payment again, at year n for example; then the counting process continues counting from $Z_{FFS.in} = m + 1$. With such a model, one can capture the length and type of the history payment system. For example, if a country i shift from five years of FFS into PBP at year t, the value of y_{it} would be different if country i experience five years of fixed budget and then shift into PBP at year t. Besides, the model also relax the assumption that the reform only have temporary impact in levels, but not a permanently alters the growth rate.

If we take the differences of the equation (9, 10) and adding country specific growth rates, the model becomes:

(11) $\Delta y_{it} = \beta_1 \Delta X_{it} + \xi_t + \omega AC_{it} + \Delta\varepsilon_{it}$,

(12) $\Delta y_{it} = \beta_1 \Delta X_{it} + \xi_t + \tau FFS_{it} + \varphi PBP_{it} + \Delta\varepsilon_{it}$,

where, ω, τ and φ are the coefficients of interest. They capture the impact of payment system dummies on the growth rate of the outcome. If we relax the assumption that all country follow the same trend and allow countries to have their own time trend (include an interaction term of time and country-specific effects in equation (9, 10)), then equation (11, 12) becomes:

(13)$\Delta y_{it} = \beta_1 \Delta X_{it} + \xi_t + k_i + \omega AC_{it} + \Delta\varepsilon_{it}$,

(14) $\Delta y_{it} = \beta_1 \Delta X_{it} + \xi_t + k_i + \tau FFS_{it} + \varphi PBP_{it} + \Delta\varepsilon_{it}$,

If the country specific effect, k_i, are jointly insignificant, the equations automatically collapse to equation (1, 12). In the results, we will estimate equations basic DID model in equations and the DID model incorporated with structural changes in equations.

Model specification tests and sensitivity analysis

To test for serial correlation in the errors term, we used Breusch-Godfrey (Wooldridge) test for serial correlation in panel models (Wooldridge, 2001). To test for heteroskedasticity across country and/or years we have used Breusch-Pagan (BP) test. If heteroskedasticity is detected, we calculated heteroskedasticity robust standard errors. As we built up models to describe causal impact of hospital payment system on health sector outcomes, we assumed the causality goes from hospital payment method dummies to the outcome variable. To test this assumption we used the test proposed by Gruber and Hanratty (Gruber and Hanratty, 1993). We included two additional dummy variables in each model indicating whether FFS or PBP will be adopted next year, and zero otherwise, i.e. the original dummy variables will be shifted a year early. If the passage of AC (FFS or PBP) is an

endogenous response to other changes in the environment, or is even simply correlated with other changes, then these terms should be non-zero.

Results

Activity based financing vs fixed budget

The estimates from the basic DID model and the DID model incorporates structural change are presented in table 3. The country specific effects in equation (7) and equation (13) are jointly insignificant in most of the outcomes and only significant at 10% level with hospital discharge. Therefore, the model is collapse to equation (5) and (11) respectively. All the results are corrcted for heteroskedasticity over the countries. In the table, $\Delta \mathrm{AC}$ indicates the temporary effect of activity based payment on the outcomes. In basic DID model, the results show that AC payment does not have any significant impact in any of the outcomes. The signs of the coefficients are difficult to interpret as they sometimes conflict with our hypotheses in table 2. A possible explanation is that a new payment system (after the reform) may only start its effect after some time it implemented. We will have further discussion in the conclusion sections. In table 3, the last column shows the results from the model incorporate structural change, in which AC is assumed to have impacts on the growth rate of health outcomes. The results show that activity-base payment, relative to fixed budget, increases the growth rate of health care expenditures at 10% level and significantly increase hospital discharge and life expectancy at age 65 (at 5% level). For example, compared to fixed budget, AC payment increases the growth rate of health care expenditures by 0.67%. All signs of the coefficients are in line with what we have hypothesized for activity based payment (relative to fixed budget).

Table 3: Estimated impact of hospital payment methods on health sector outcomes with activity based payment and fixed budge (p-value in the bracket)

	Basic DID model	**Structural change model**
Dependent variable	**With country and calendar year fixed effects**	**With country and calendar year fixed effects**
	$\Delta \boldsymbol{AC}$	$\boldsymbol{AC}$
Health expenditure per capita	-0.0091 (0.1889)	0.0067 (0.0772)
Hospital discharge	-0.0018 (0.6864)	0.0085 (0.0331)
ALOS	-0.0063 (0.1978)	0.0006 (0.8698)
Number of death	0.0015 (0.7459	-0.0024 (0.1177)
Infant mortality	-0.0047 (0.5409)	-0.0057 (0.2029)
Life expectancy at age 65	-0.0015 (0.5493	0.0015 (0.0337)

Differentiating between fee-for-service and patient-based financing

Here we differentiate between FFS and PBP within activity base payment, and estimate their impact relative to fixed budget payment. The results are reported in table 4. Similar with table 3, basic DID model do not show any significant results which indicate that the payment system in place have no temporary effect on healthcare outcomes. Besides the coefficient signs are difficult to interpret, given our hypotheses. In the structural change models the signs are consistent with what we hypothesized, except for the sign of coefficient of PBP on infant mortality. Both FFS and PBP show positive signs on health expenditure, but the p-value is higher than 10%. Neither of them seems to affect the average length of stay. Compared to fixed budget, FFS payment significantly increases hospital discharges and infant mortality (at 5% level). FFS payment has strong incentive to provide more intensive treatment and higher hospital admission. This may potentially harmful for general population health, however the results show more intensive treatment decrease infant mortality. By contrast, relative to fixed budget, PBP significantly decrease the number of death and significantly increase life expectancy at age 65.

Table 4: Estimated impact of hospital payment methods on health sector outcomes with FFS, PBP and fixed budget

Dependent variable	**DID model**		**Structural change model**	
	With country and calendar year fixed effects		**With country and calendar year fixed effects**	
	ΔFFS	ΔPBP	FFS	PBP
Health expenditure per capita	-0.0152 (0.1859)	-0.0038 (0.5542)	0.0066 (0.2278)	0.0067 (0.1331)
Hospital discharges	-0.0080 (0.2087)	0.0048 (0.4357)	0.0121 (0.0031)	0.0024 (0.7205)
ALOS	-0.0034 (0.6914)	-0.0092 (0.1549)	0.0031 (0.5706)	-0.0058 (0.3209)
Number of death	0.0063 (0.1473)	-0.0039 (0.5339)	-0.0018 (0.4264)	-0.0033 (0.0332)
Infant mortality	-0.0093 (0.4440)	-0.0002 (0.9909)	-0.0151 (0.0004)	0.0085 (0.2818)
Life expectancy age 65	-0.0040 (0.1763)	0.0014 (0.6323)	0.0011 (0.2946)	0.0019 (0.0029)

The idiosyncratic error term ε_{it} shows highly positive serial correlation in structural change models, namely number of death, infant mortality and life expectancy at age 65. We would still have a biased OLS estimate with positive serial correlations, however OLS estimates of the standard errors will be smaller than the true standard errors and leads to reject the null hypothesis when it should not be rejected.

Robustness of the results

Table 5 presented the reverse causality for two models. The test reassures the assumption that causality of the model goes from hospital payment method to the outcome variable. The assumption is rejected for one outcome variable: average length of stay. The result can be due to mere chances.

Table 5: Reverse causality test result

Dependent variable	**Basic DID model**	**DID model include structural change**
	F test	**F test**
Hosp discharge	0.0945	0.2677
Length of stay	0.9843	3.5073
Health expenditure per capita	0.9038	0.5998
Public health expenditure per capita	0.4725	0.2092
Number of death	1.2746	0.5187
Infant mortality	1.1201	0.1883
Life expectancy at age 65	0.4499	0.1102

* Statistical significance at the 5% level

Conclusion and discussion

This paper focused on the impact of hospital payment reforms on health sector outcomes and mortality with a country level panel data for 20 OECD countries over the period 1980-2009. First we had two broad classifications: activity based payment and fixed budget payment; in second stage, we differentiated activity based payment into a) FFS (service-base payment, including per diem and cost-base payment) and b) PBP (patient character based payment, mainly DGR-based payment). We estimated basic DID model, in which reforms are assumed to have temporary effects on levels of health care output; besides, we incorporate structural changes in DID model which assumes payment methods permanently alter the trend of the outcome. The basic DID model did not yield any significant impact which indicate the payment system in place have no temporary or one-time shock effect on the healthcare outcome. Besides, the signs of the estimates are not consistent with our hypothesis. This could be the resulted from our identification of country payment system. In most of the countries, such reforms are gradually implemented from one region to another over more than one year; however, given the restricted source of data and difficulties with classification, we classify a country into FFS, if there is FFS payment exist in there payment system, regardless of extension of the payment method. If we classify a country into FFS and the extension of FFS in that country is not enough to cause any changes in health care outcome at national level, we cannot expect significant coefficient. Moreover, according to the assumptions with basic DID model, the effect of reform does not depend on the previous payment method, which means it does not matter from which payment method it shifts from, as long as the reform involves the payment system of interest (FFS or PBP). In reality, if a country shift from fixed budget to PBP, the trend of health expenditure may increase, while if a country shift from FFS to PBP, the trend to health expenditure may decrease for the first year. Therefore, it is logical to account for the history of payment system. Furthermore, hospital payment reforms may have a lag effect on outcomes.

By contrast, the result from DID model incorporated structural changes showed activity based payment permanently increases the growth rate of hospital discharge, health expenditure per capita and life expectancy at age 65. Within activity based payment we could not discriminate between the effects of FFS and PBP. FFS significantly increased hospital discharge and significantly decrease infant mortality. This may resulted from the possible intense treatments that FFS may offer. PBP on the other hand, increase the life expectancy at age 65 and decease mortality. The results from structural change model show that the payment methods in place have a permanent impact with health care outcome and mortality.

Out paper have several limitation.

A more general limitation of our study is the data collection for hospital payment method dummies. Our classification, activity based payment and fixed budget payment, or further classification with FFS, PBP and fixed budget, may not accurately describe the real world application of hospital payment systems. There are more than three hospital payment systems in OECD countries these 30 years. However, the sample size is limited to estimate the impacts all the classification. Besides, if the payment methods are very similar in mechanism, or if they share similar expected incentives, there will be colinearity between the payment dummies and lead to bias estimation. Therefore, we choose to classify the payment method only into three categories. Besides the difficulties with general categories, the coverage of PBP payment method could be too low to achieve an individual impact on health (care) outcomes. Moreover, specialist payments are likely to have high impacts on hospital activity since specialists are key decision makers about admissions and treatment in hospitals. This is no problem if incentives for hospitals and medical specialists are aligned, but this may not be the case in various OECD-countries. For example, in Netherlands, the payment for medical specialists is not included in hospital budget (Schut and Van de Ven, 2005). In this case, even if hospitals have a fixed budget, specialists may still have strong incentives to increase the hospital activities by admitting more patients or doing more tests. Not including specialist payment method may have impact on accuracy in our estimates. However, as we do not know the changes in payment system for medical specialist in these 20 countries over 39 years, we had the time constraint to construct data set for this variable. This may leave for future research. Furthermore, after taking first differences of the models, the error term still show serial correlation. A positive serial correlation, the OLS estimates of the standard errors will be smaller than the true standard errors. This leads our models have a tendency to reject the null hypothesis when it should not be rejected. Therefore, we should be careful with interpretation of these point estimates.

Our findings shed a new light on findings from studies that found a positive relation recent between increases in health care expenditures and life expectancy (e.g. Heijink et al. 2012). Our findings indicate that it might not be the additional health care expenditures caused by hospital reforms that have increased life expectancy. Other mechanisms such as the availability of new medical technologies that have increased health care expenditures independently of the reforms might have decreased mortality. We therefore tentatively conclude that although activity based financing increases hospital output and thereby health care expenditures at the macro level, there is no strong evidence that hospital financing reforms have decreased mortality in OECD countries.

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