Implications of global budget payment system on nursing home costs

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Published in *Health Policy* (2014), **115**: 237-248,
http://dx.doi.org/10.1016/j.healthpol.2014.01.017

Abstract

Pressure on health care systems due to the increasing expenditures of the elderly population is pushing policy makers to adopt new regulation and payment schemes for nursing home services. We consider the behavior of nonprofit nursing homes under different payment schemes and empirically investigate the implications of prospective payments on nursing home costs under tightly regulated quality aspects. To evaluate the impact of the policy change introduced in 2006 in Southern Switzerland - from retrospective to prospective payment - we use a panel of 41 homes observed over a 10-years period (2001-2010). We employ a fixed effects model with a time trend that is allowed to change after the policy reform. There is evidence that the new payment system slightly reduces costs without impacting quality.

Keywords: nursing homes, prospective payment, quality of care, policy change

JEL classification: I18, C23, J33.

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1 Introduction

Increasing health care expenditures for the elderly population is a major concern for society and policymakers. In Europe, the percentage of people over 64 rose rapidly in the past decades and is expected to increase between two and six times by 2060, ranging from 22-25% in Belgium, Denmark, Ireland, and the United Kingdom, to 33-36% in Bulgaria, Germany, Latvia, Poland, Romania, and Slovakia (Eurostat, 2012; European Union, 2012). Accordingly, the demand of nursing home care is expected to increase rapidly raising the burden on public resources generally used to cover nursing home costs or to subsidize prices of nursing home services (Karlsson et al., 2006).

In the past 30 years hopes have been pinned on the possibility to control healthcare expenditures by replacing Retrospective (RPS) with Prospective Payment Systems (PPS), mainly in the hospital sector. Under PPS, a predetermined, fixed amount of resources is paid for the service. The rationale is that reimbursement based on ex-ante costs prevents health care providers from giving unnecessary care (Jegers et al., 2002). In the U.S., the use of PPS has been extended from hospitals to the nursing home sector in 1997 through the Balanced Budget Act. Similarly, many European countries have recently incorporated more incentivizing payment systems into their existing funding systems.

Although the health economics literature is rich of studies on the impact of PPS in the U.S. nursing home sector (e.g. Chen and Shea, 2002; Norton, 1992; Zhang et al., 2008), there is little empirical evidence in Europe. A number of studies have been published on the impact of PPS in the hospital sector in different European countries, for instance Finland (Linna, 2000), Norway (Biorn et al., 2006), and Portugal (Dismuke and Sena, 1999). To our knowledge, the only study on the impact of PPS to finance nursing home services is the recent analysis by Dormont and Martin (2012) based on a hypothetical scenario. The authors investigate the costs-efficiency trade-off in French nursing homes (NHs) to predict possible implications of a switch in the payment system.

In this paper, we provide evidence on the impact of PPS on the costs of a sample of NHs operating in one Swiss canton (Ticino) by exploiting data before and after the introduction of PPS. Switzerland is a federal state in which the provision and regulation of nursing home care for elderly people is organized at the regional level (cantons). As consequence, institutional and organizational aspects of nursing home care vary across the 26 cantons. In 2006, the cantonal authority in Ticino substituted the previously-in-force payment system based on acknowledged financial needs (RPS) with an ex-ante determined budget (PPS). To evaluate the impact of this policy change we use an econometric model with fixed-effects (FE) with a time trend that is allowed to change after the policy reform. We will provide evidence that the new payment system reduced costs growth for NH care, after controlling for the quality of services.

The remainder of the paper is organized as follows. Section 2 provides an overview of recent studies analyzing the impact of PPS on costs, quality and access to health care services. Section 3 describes the regulatory reform and the potential effects of the new payment system. Data and identification strategy for the policy change are discussed in section 4. The econometric estimations are presented in section 5, and section 6 concludes the paper.

2 Previous research on the impact of PPS in nursing home care

The empirical evidence regarding the impact of PPS on costs, quality and access in NH care is not conclusive. The literature mostly relies on studies conducted during the 90s in the U.S. where PPS were firstly introduced. Some of these studies focus on the financial consequences of PPS by looking at changes in costs (e.g. Ohsfeldt et al., 1991; Sexton et al., 1989). More recently, attention has been devoted to the understanding of cost reduction achievements. Improved methods to control for changes in quality and to cope with the potential endogeneity of output and/or quality in cost functions have been proposed (Gertler and Waldman, 1992; Chen and Shea, 2002). Also, direct assessment of the impact of PPS on quality (Konetzka et al., 2004; Konetzka et al., 2006) and access to nursing care (Coburn et al., 1993) have been carried out.

Regarding the effects on costs, Sexton et al. (1989) use a two steps strategy to regress efficiency scores calculated using Data Envelopment Analysis on changes in the payment system occurred in the State of Maine in 1982. They find a decrease in technical efficiency. Quality variations are assumed to be negligible. Ohsfeldt et al. (1991) exploit variations in the payment systems of 47 U.S. states over a 12-years period using a random effects model. After correcting for endogeneity in the reimbursement system by means of instrumental variables, the authors find a reduction of 20 per cent in per diem costs due to PPS.

Coburn et al. (1993) extend the traditional cost analysis by looking at the consequences of PPS on quality and access for Medicaid patients in the State of Maine. The analysis shows that PPS reduces growth in per-patient variable costs. During the first three years after the introduction of PPS, the average savings and losses per patient day decreased substantially. Afterward, the authors observed a remarkable increase in the number of NHs experiencing losses. Only the percentage of room and board costs relative to the total variable costs decreased over time, suggesting that cost savings were not achieved through reductions in quality. Finally, the percentage of Medicaid patients decreased, which can be interpreted as a negative impact on access for most severe patients.

Concerns about the evidence obtained during the 90s are raised by Chen and Shea (2002), who question the methodology used. In particular, they point at the inadequate measures of quality and output/quality endogeneity in cost functions. To cope with the endogeneity issue, the authors construct instrumental variables for both output and quality, and investigate the impact of PPS on short-term operating costs. The analysis is performed on a one-year data set of different U.S. states grouped into three different payment systems. The authors show that NHs with PPS are no longer significantly cheaper than facilities subject to cost-based retrospective payments, after controlling for quality differences.

More recently Zhang et al. (2008) assessed the impact of PPS on the cost efficiency of 8361 NHs in the U.S. over the period 1997-2003. During this period, three major policy changes occurred. In 1997, the Balance Budget Act (BBA) ratified the introduction of PPS. Afterward, the Balanced Budget Refinement Act (BBRA, 2000) and the Benefit Improvement and Protection Act (BIPA, 2001) increased the baseline payments in consequence of the financial difficulties reported by NHs. DEA calculated efficiency scores are regressed on policy change variables identified with time markers and a truncated random effect model is applied. The results show a negative relationship of all policy change variables with efficiency scores. The authors capture quality differences by weighting the output with a score calculated using the number of deficiency citations.

To our knowledge, only Crivelli et al. (2002) consider the relationship between costs and financing mechanisms using data from Switzerland in year 2008. The authors do not find any significant impact of different payment systems on the efficiency of NHs. The main limitation of this study is that different nursing home care systems exist which are hardly comparable. The cross sectional setting of the study does not allow to control for unobserved characteristics of the 26 systems.

A growing strand of literature investigates the impact of PPS on quality aspects of nursing home care. Using data on U.S. NHs over the period 1996-2000, Konetzka et al. (2004) study the impact of PPS on quality by applying a difference-in-difference approach and a negative binomial model. The authors use changes in the professional staffing and the number of regulatory deficiencies as proxies for quality. As expected, PPS is found to significantly reduce the professional staff. The negative impact of PPS is partially corrected by the introduction of the Balanced Budget Refinement Act. As with respect to regulatory deficiencies, only weak evidence is reported. Also, no differences between for-profit and nonprofit NHs are found.

Finally, Konetzka et al. (2006) investigate the spillover effects of introducing PPS in Medicare residents on quality for Medicaid patients. Since facilities cross-subsidize part of the costs of Medicaid residents with the higher margins of Medicare and high private-pay residents, the cuts in revenue due to the introduction of PPS may also have affected quality of long-stay residents. Using a quasi-experimental approach in four U.S. states over the period 1995-2000, the authors show that PPS has an adverse effect on urinary tract infections and pressure scores.

To conclude, the literature remains inconclusive as with respect to the impact of PPS in nursing home care. Also, it is worth pointing out that most of the studies mentioned are conducted in the U.S. where private for-profit facilities represent a large share of total NHs and the environment is increasingly competitive. It is not clear whether this leads to different behavioral responses as compared to nonprofit institutions, which are largely present in Europe. In competitive environments, the expected negative impact of cost reductions on quality may be mitigated by the need to maintain a high reputation. As suggested by Grabowski and Town (2011), NHs facing greater competition are more responsive to quality improving projects. However, competition can also have a negative effect on quality if it pushes prices down (Forder and Allan, 2012). Conversely, in a non-competitive, nonprofit environment with highly regulated prices and quality, such as the Swiss NH sector, the possible negative impact of cost reductions on quality is expected to be limited.

3 The regulatory reform

In Ticino, nursing home care is provided primarily by regulated public and private nonprofit organizations. The provision of NH care is further decentralized at local level (municipalities) and elderly people are commonly assigned to the NH in the community of residence. Therefore, NHs operate as local monopolies with virtually no competition. Price and quality are regulated by the authority, i.e. the Regional Department of Public Health (RDPH). Prices are subsidized and defined by the RDPH as a function of residents' income (pension payments) and wealth, and do not vary across NHs. Quality is regulated in many structural and procedural aspects. Because of tight regulation the production process is highly homogeneous.

In 2006, the authority in Ticino introduced global budgets for nursing home care. Prior to the introduction of global budgets, subsidies to providers of long term care were allocated by the authority based on acknowledged financial needs. Subsidies were defined at the end of the year as the actual costs incurred by the NH minus the revenue obtained from residents fees. More precisely, the payment system consisted of two parts: an ex ante defined component and an upward adjustment based on actual costs at the end of the year. The ex ante component was an estimation of the costs for the following operative year based on a combination of historical costs and benchmarking parameters at the sector level. At the end of the year, more financial resources to cover the deficit were paid if the NH was able to justify additional expenses. Conversely, service providers with year-end costs below the initially estimated financial need were not allowed to retain the "savings". In practice, the system was retrospective because additional expenses were generally recognized. The authority viewed this system as inflationary and poorly incentivizing. The low flexibility of the system due to the detailed control over all cost items made it almost impossible for the management to make decisions on the cost structure, and led to low responsibility as with respect to budget decisions and financial performance. The funding system had the adverse incentive to spend the whole amount of resources provided.

In the early 2000s, to respond to the need of improving transparency and efficiency in long term care, the RDPH modified the payment system. Subsidies based on cost reimbursement were replaced by prospectively defined global budgets. A pilot phase was lunched in January 2003. Five NHs were selected to participate in the pilot phase over a three-years period. Information collected during these years were used to define the list of services provided, an analytical accounting system, and a package of modern managerial tools. Since January 2006, the system has been applied to all NHs.

The current payment system net of resident fees is composed of two elements: a standardized part and an individual component. The standardized part includes four main service categories: residential, animation, care and therapies. This part is calculated by multiplying standard costs for each service (also called prospective rates in the literature) by the expected volume of each service. Standard costs stem from the analytical accounting register and reflect median costs in the nursing home industry classified into nine categories, according to size, to capture economies of scale. Also, standard costs are calculated to implicitly define the level of productive efficiency and quality desired by the authority. Quantities (days of residence) are given by the number of beds times the expected occupancy level and number of days in a year. The individual component, that represents a minor part of the global budget, mainly covers NH-specific extra costs such as rents and expenses for education trainings.

The starting prospective rate was determined for the year 2005, while the prospective payment rates for the following years were adjusted for inflationary changes of some cost items only (e.g. wages). An adjustment based on savings achieved in the previous years is planned to occur on a medium-term perspective depending on the financial stability of the NHs and has not been applied yet.

The final budget does not depend on the actual costs generated by the residents. NHs with end-year costs lower than the global budget are entitled to retain a share (25%) of the savings. The main part (75%) are saved as mandatory reserves to cover previous or future deficits.

This new system is expected to ensure financial stability of NH care providers in the medium-term and to reduce average costs, through the change in the level of cost sharing. The rich theoretical literature on provider behavior under different payment systems can help to understand the possible effect of the policy change on costs. There is strong evidence that providers respond to economic incentives (McGuire, 2012). However, several authors suggest that a prospective payment system placing full responsibility on nursing home care providers does not represent a first-best solution. Ellis and McGuire (1986) show that mixed reimbursement systems, such as the one analyzed in this study, are superior to fully prospective payments and cost reimbursement systems as they reduce risk to providers and incentivize them to offer an efficient level of services. Similarly, Zweifel et al. (2009) identify the restrictive conditions under which full responsibility of providers represent a first-best solution. These include risk neutrality of providers, symmetric information about residents severity, verifiable quality and known expected cost of treatment. An analogous conclusion is drawn by Ma (1994): when patients can be refused or discriminated by quality, mixed payment systems are desired. The new payment system in Ticino increases cost responsibility without asking NHs to bear full financial risk.

The net income of all NHs before the introduction of PPS was zero because all NHs showed a deficit that was covered by the authority. After the introduction of PPS we observe: 1) a positive net income in the first two years (2006-2007) for the majority of NHs; 2) a lower positive net income in the last three years (2008-2010), where approximately half of the NHs show a positive income and the other half show a negative net income. The plausible explanation of this evolution is that the introduction of PPS initially increased uncertainty over the availability of financial resources. Consequently, most NHs improved their effort to reduce costs. In the following years financial resources remained unchanged and NHs adapted to the new system, which reduced the level of positive net income on average.

A possible consequence of the new payment system is the negative impact on quality of NH services. NHs may reduce costs by lowering quality since the demand for NH care does not reflect quality (Chalkley and Malcomson, 1998) for at least two reasons. First, patients may not be able to assess the multidimensional nature of quality. Second, quality is partially an experience good and is observable only after receiving care. Nevertheless, this effect is unlikely given the existing regulation of structural and procedural aspects of the production and provision of nursing home care in Switzerland.

4 Empirical specification

4.1 The cost function

To empirically investigate the impact of global budget payments in nursing home care, we exploit data from a natural experiment in Switzerland where the payment system recently changed from RPS to PPS. We assume that NHs transform three inputs - capital, labor and material - into a single output, measured by the number of patient-days of nursing home care. Since the production process is highly homogenous among NHs, the number of resident-days can represent a good indicator of the level of production. Consequently, we specify a total costs function which depends on output (Y), price of labor, capital, and material (P_l, P_k, P_m), some output characteristics (Q_1,...,Q_n), and a general time trend (τ):[1,2]

$$C = f(Y, P_k, P_l, P_m, Q_1, ..., Q_n, \tau). \quad (1)$$

Total costs include capital, labour and material. The price of labor is calculated as the weighted average wage of different professional categories employed in the NH (doctors, nurses, administrative and technical staff).[3] The amount of staff as well as the skill level are defined by the RDPH as a function of residents' case-mix.

[1] In a non-competitive environment such as the Swiss one, there is no reason to assume that NHs minimize costs. In this case, the cost function is a *behavioral cost function* (Evans, 1971) and can still be used to make a comparison among firms. Moreover, by estimating a total cost function instead of a variable cost function we avoid the risk related to a high correlation between capital stock and output, which leads to a positive relationship between variable costs and capital stock. A similar approach is used, for instance, by Farsi and Filippini (2004).

[2] In order to estimate a cost function, either the output is assumed to be homogenous or we need to control for service intensity and patients' characteristics (Birnbaum et al., 1981).

[3] Unfortunately, labor prices for different labor categories cannot be used due to lacking data. However, we should consider that for all NHs a collective labor agreement exists. Therefore, the inclusion of several labor prices in the cost equation is expected to generate multicollinearity problems.

This rules out almost completely the possibility of increasing cost efficiency by hiring less professional nurses.[4] The price of capital is calculated as the sum of mortgage costs, amortization and costs related to capital purchases divided by the capital stock, which is approximated by the number of beds. The price for material is computed by taking the remaining costs and dividing them by the number of meals provided each year. This item mainly includes costs for food and residency. Other costs included are energy, water and administrative costs.

The first characteristic of output, Q_1, is the patient severity index which measures the average patients assistance by means of normal daily activities such as eating, personal care or physiological activities. This index is based on an instrument called Paillard grid and measures the number of daily hours needed by the patient for personal and medical care on average. The Paillard grid considers 12 categories of personal and medical care, such as preventive care, therapeutic treatment, psychological status and mobility. Because of the relatively large number of categories, the patient severity index includes aspects that capture well the need for professional services. The index is calculated on a yearly basis by the authority. A value between 0 and 4 is assigned where higher values indicate more severe cases.

The second characteristic of output, Q_2, is the nursing staff ratio, that is the ratio between the number of nurses employed in a NH and the optimal number of nurses that should be employed according to the guidelines of the authority. Our measure differs from quality indicators commonly used in the nursing home literature as the theoretically optimal number of nurses is usually not calculated. Because nursing home care is a labor-intensive service, the nursing staff ratio can be considered as a good indicator of quality (see for example Johnson-Pawlson and Infeld, 1996; Schnelle et al., 2004). Labor costs represent the main costs of a NH and make about 85 per cent of total costs. Consequently, a small change in the nursing staff ratio may affect total costs considerably. The nursing staff ratio is, therefore, a key variable in our analysis since NHs with relatively high costs may decide to decrease the number or quality of workers to save money. If this

[4] The monetary compensation of the staff is also a function of age. Therefore, there exists the possibility to reduce costs by hiring younger staff members. Due to lack of data, we cannot rule out this strategy.

is the case, then the estimates could suffer from endogeneity bias. To test the endogeneity of this regressor, we perform the robust Durbin-Wu-Hausman test.[5]

U.S. studies have shown that the ratio of professional nurses to patient or to total nursing staffing are the strongest predictors of quality. We then consider additional measures of quality by separately including in the cost function the nurse-to-patient ratio (Q_3), the professional nurse-to-patient ratio (Q_4) and the ratio of professional to total nursing staff (Q_5). From equation (1) we finally derive four model specifications: a baseline model (Model 1) with one quality indicator (Q_2) and three "extended" models (Models 2, 3 and 4) with two quality indicators (Q_2 and either Q_3, Q_4 or Q_5). See section 4.2 for further details on these quality indicators.

In order to impose as few restrictions as possible to (1), we adopt a flexible translog functional form approximated at the median value. Input prices and total costs are divided by the material price in order to satisfy the homogeneity condition in input prices.[6] The translog approximation to (1) can be written as:

$$\begin{aligned} \ln\left(\frac{C}{P_m}\right) &= \delta_Y \ln Y + \delta_{P_l} \ln\frac{P_l}{P_m} + \delta_{P_k} \ln\frac{P_k}{P_m} + \sum_{j=1}^{n} \delta_{Q_j} \ln Q_j \\ &+ \frac{1}{2}\delta_{YY}(\ln Y)^2 + \frac{1}{2}\delta_{P_lP_l}\left(\ln\frac{P_l}{P_m}\right)^2 + \frac{1}{2}\delta_{P_kP_k}\left(\ln\frac{P_k}{P_m}\right)^2 \\ &+ \delta_{YP_l}\ln Y \ln\frac{P_l}{P_m} + \delta_{YP_k}\ln Y\ln\frac{P_k}{P_m} + \sum_{j=1}^{n}\delta_{YQ_j}\ln Y\ln Q_j \\ &+ \delta_{P_lP_k}\ln\frac{P_l}{P_m}\ln\frac{P_k}{P_m} + \sum_{j=1}^{n}\delta_{P_lQ_j}\ln\frac{P_l}{P_m}\ln Q_j \\ &+ \sum_{j=1}^{n}\delta_{P_kQ_j}\ln\frac{P_k}{P_m}\ln Q_j + \frac{1}{2}\sum_{j=1}^{n}\sum_{i=1}^{n}\delta_{Q_jQ_i}\ln Q_j\ln Q_i + \delta_t\tau + \varepsilon \end{aligned} \quad (2)$$

where ε is the error term. We check for the concavity condition in input prices after the estimation.

[5] The test is robust to arbitrary violations of conditional homoskedasticity and clustering, and consists in estimating the model by a Generalized Method of Moments (GMM) estimator and applying the Sargan statistic. We perform this test using the lagged value of Q_2 as an instrumental variable. The test statistic is χ^2 distributed with a robust score $\chi^2(1) = 0.55$. The null hypothesis of exogenous Q_2 cannot be rejected at any standard level of significance.

[6] The cost function is linear homogenous of degree 1 in input prices when a 10% increase in all input prices leads to a 10% increase in total costs.

4.2 Data and descriptive statistics

Our study builds on data extracted from annual reports delivered to the authority by all regulated NHs scattered in canton Ticino. The initial data set contains 50 NHs observed over a 10-years period (2001 – 2010). This period includes 5 years before the implementation of the global budget and 5 years following its adoption. From this initial sample, we exclude 5 NHs either because a considerable share of their output (patient-days) is produced in foyers or because they show unreasonable values for some variables of interest and are therefore dropped.[7,8] Finally, we exclude the NHs selected for the pilot phase of global budget adoption for three main reasons. First, the pilot phase was mainly intended to set down the rules of the new payment system and to understand its functioning. Second, pilot NHs are few and are observed for a too short period (3 years) to be used as control group. Finally, these NHs were not randomly selected.[9]

The final sample consists of an unbalanced panel of 41 NHs observed for 10 years (400 observations). The minimum number of observations per cluster is 7, while on average information is available over the whole period (9.8 years). In Table 1 we report some descriptive statistics of the characteristics of NHs, which include the mean, the standard deviation, and the first and third quartiles. On average, NHs have 67 beds and provides services for 23735 resident days yearly, each of which costs about CHF 248. The nursing staff ratio is 0.95 indicating that, on average, the personnel employed by NHs is close to the amount suggested by the authority. On average there are 3 nurses per patient (Q_3) and the large majority of nurses (about 83%) are certified professional nurses (Q_5). The average price of labor is about CHF 82000 per year, while the price of capital is CHF 5771 per bed and the price per meal is CHF 9.23.

A considerable variation is observed across NHs in almost all variables. The

[7] Foyers are external residential apartments where the healthiest patients get NH care. Therefore, the production process of these NHs might differ a lot as compared to the others.

[8] These are private for-profit institutions that were placed under the authority control and largely subsidized. This implied a change in the production process and hardly comparable data.

[9] In Table 5 in the Appendix we show that pilot NHs are relatively cheaper than non pilot NHs. Also, in Table 6 (see Appendix) we show that also the cost evolution over time differs between the two groups: pilot NHs experienced a more important cost increase before the pilot phase, while from the introduction of the new payment system their costs decreased relative to non pilot NHs.

Variables	Description	Mean	Std. Dev.	1^{st} q.	3^{rd} q.
AC	Average cost per resident day	247.63	23.42	232.15	262.50
Y	Total resident days per year	23735	8533	17595	27768
K	Number of beds	67	24	50	80
P_l	Average labor price per employee per year	82051	4526	79456	85091
P_k	Average capital price per bed	5771	2600	4103	7040
P_m	Average material price per meal	9.23	4.92	8.15	9.74
Q_1	Average dependency index	3.12	0.35	2.90	3.38
Q_2	Nursing staff ratio	0.95	0.08	0.90	0.98
Q_3	Total nursing staff to patient ratio	0.35	0.08	0.32	0.40
Q_4	Professional nursing staff to patient ratio	0.28	0.08	0.25	0.34
Q_5	Professional to total nursing staff ratio	0.83	0.12	0.77	0.92

Notes: All monetary values are in 2005 Swiss francs (CHF) adjusted by the national Consumer Price Index.

Table 1: Descriptive statistics of costs, inputs and output characteristics over the whole period.

average cost per resident day of the first quartile is around CHF 232, and increases to CHF 262 in the third quartile. The size of NHs also varies remarkably: three-quarters of NHs provide less than 81 beds, and the biggest NH has 145 beds. This sizable variation can be read also in the number of resident days.

As with respect to input prices, we recognize that variation in average costs per employee is relatively small (around CHF 4500 per year), whereas average price of capital in the third quartile is about 70% higher than in the first quartile. This heterogeneity in the price of capital is mainly due to differences in depreciation policies, donations and/or capital structure. In addition, NHs vary in output characteristics, i.e. the dependency index and the nursing staff ratio. Note, however, that 50% of NHs have a nursing staff ratio between 0.94 and 1. This is because the authority allows NHs to deviate from the value of reference by 10% only. Beyond this threshold, the RDPH intervenes to ask for an adjustment in the number of employees. This tight regulation is also generally reflected in the total nurse to patient ratio (Q_3) and in the professional nursing staff to patient ratio (Q_4), which vary by less than 9 percentage points between the first and the third quartile. More variation is observed in the professional to total nursing staff ratio (Q_5) where the difference between the values of the first and the third quartile is about 15 percentage points.

In Table 2 we provide some descriptive statistics for the variables of interest, calculated separately for the period before the change in the payment system (PRE) and the following period (POST). The fourth column specifies whether the variable mean has increased (+) or decreased (−). Finally, we report the results of a t-test on the probability of equal means across the two periods. Since cost savings can be achieved through a reduction in the number of staff, for the nursing staff ratio (Q_2) as well as for the other quality indicators (Q_3, Q_4, Q_5) we test whether the mean value has decreased (one-sided t-test). The pre-post

Variables	PRE (195 obs.)	POST (205 obs.)	Variation	H_0	p-value
AC	244.67	250.46	+	$\mu_{PRE} = \mu_{POST}$	0.013
Y	23153	24287	+	$\mu_{PRE} = \mu_{POST}$	0.184
K	66.06	68.94	+	$\mu_{PRE} = \mu_{POST}$	0.229
P_l	80763	83277	+	$\mu_{PRE} = \mu_{POST}$	0.000
P_k	5364	6158	+	$\mu_{PRE} = \mu_{POST}$	0.002
P_m	8.38	10.04	+	$\mu_{PRE} = \mu_{POST}$	0.000
Q_1	3.09	3.16	+	$\mu_{PRE} = \mu_{POST}$	0.004
Q_2	0.96	0.93	−	$\mu_{PRE} > \mu_{POST}$	0.000
Q_3	0.35	0.34	−	$\mu_{PRE} > \mu_{POST}$	0.070
Q_4	0.28	0.29	+	$\mu_{PRE} > \mu_{POST}$	0.849
Q_5	0.81	0.84	+	$\mu_{PRE} > \mu_{POST}$	0.995

Notes: all monetary values are in 2005 Swiss francs (CHF) adjusted by the national Consumer Price Index.

Table 2: Comparison of means (pre and post reform) for the main variables of interest.

analysis shows a small but statistically significant increase in average costs (AC), from about CHF 245 per resident day to around CHF 250. The number of beds and the number of resident days remained pretty constant. As for output characteristics, the analysis shows that the dependency index has slightly increased while the nursing staff ratio decreased by 3 percentage points. The increase in the dependency index may be due to the increasing demand of nursing home care over time and the shift of less severe residents to home care services. As expected, it shows that NHs did not respond to the change in the payment system by selecting healthier patients. Conversely, NHs may have responded to the change in the payment system by reducing the number of nurses per resident. Note that the nurse-to-patient ratio (Q_3) slightly decreased after the implementation of the global budget although this drop is not mirrored in the professional nurse-to-patient ratio (Q_4) and the ratio of professional to total nursing staff (Q_5). The issue will be discussed in more detail in section 5.2.

4.3 Identification strategy

As pointed out by Blundell and Dias (2009), the choice of the most appropriate policy evaluation method relies on the nature of the policy change, as well as the research question and data availability. In our study, the policy change concerns all NHs in the sample at the same time. For this reason we can just observe the treated group before and after the policy change. Therefore, to measure the impact of global budget payment we exploit the panel properties of the dataset. The underlying idea is to use information on different points in time for the same individual as own group of control (individual effects). We use a panel data model that controls for unobserved heterogeneity and includes a temporal dummy variable to capture the impact of the policy change. This strategy assumes that no other major event occurred over the period considered which affected the production costs of NHs. We are confident that, in our case, this assumption is not too restrictive. Firstly, because the NH sector is highly regulated and no other policy reforms have occurred in the same period. Secondly, the resulting homogenous production process makes it relatively easy to compare NHs and reduces unobserved heterogeneity to negligible levels.[10] Consequently, time varying unobserved factors are not expected to have remarkable effects on the results. Finally, input prices and costs have been deflated with the Consumer Price Index (CPI). Hence, reduction in costs due to the recent economic recession should not be confounded with cost savings generated by the new payment system. The international economic crisis affected real GDP growth in Switzerland only in year 2009 and with a negligible impact. Looking at the occupancy rate we note that the demand of NH care remained constant over the entire period of the analysis.

We capture the impact of PPS on costs with a dummy variable equal to 1 for the years $2006 - 2010$, the period where the PPS was in force, in addition to a general time trend capturing the impact of technical change on costs throughout the whole period. This is the approach adopted in many policy evaluation studies when the policy change affects all firms/individuals at the same time (e.g. Hat-

[10]This is also confirmed by the similarity between fixed effects and random effects estimates.

ton, 2005; Nakahara et al., 2010; Narayana and Pengb, 2006; Rotte and Vogler, 1999).[11]

When adopting this identification strategy, particular attention needs to be devoted to the specification of the time trend. In fact, a mispecified time trend may partially capture the impact of the policy change. Hence, to explore the pattern of NH care costs over time, we estimate a cost model where we replace the time trend with time dummies and drop the policy change dummy. The base year is 2001. The estimated coefficients for time dummies show that from 2001 to 2005 total costs increase linearly. Afterward, i.e. during the the introduction of PPS, total costs remain pretty constant. This pattern suggests modelling the time trend with a linear function.[12]

Assume the following general specification of the dummy variable in the total costs function in (2):

$$\ln\left(\frac{C_{it}}{P_{kit}}\right) = \delta_i + X_{it}^T\ \delta_T + \delta_d D + \delta_t t + \delta_{td} tD + v_{it}, \tag{3}$$

where X_{it}^T is the vector of explanatory variables, D is the dummy that assumes value equal to 1 in the period of policy implementation ($2006 - 2010$), and 0 otherwise, and the error component ε has been splitted into an individual effect δ_i and a stochastic error term v_{it}.

The impact of the policy reform can now be measured in two ways, depending on how the dummy variable is allowed to enter the cost function. By imposing $\delta_{td} = 0$, we restrict the attention to policy changes that affect only the constant term of the total cost function. In this case, dummy variable shifts are interpreted as the average impact of PPS on costs during the whole period $2006 - 2010$. Alternatively, if we allow $\delta_{td} \neq 0$, the impact of PPS can change over time, and additional information can be provided on the rate of costs increase. We refer to these two time trend specifications as the *restricted* fixed-effects model and the *unrestricted* model.[13] These will be estimated and compared in the following

[11] Remind that the pilot group cannot be used to apply a DID approach for three main reasons. First, treatment was not randomly assigned. Second, the treated group (pilot NHs) includes only few observations. Finally, the pilot phase was used to set up the new payment system and some rules changed afterwards.

[12] A different specification of the time trend shows that the inclusion of a squared term leads to overspecification and does not allow us to identify the impact of the policy change.

[13] A battery of specification tests was also performed. First, we checked whether the reform

section. Since the cost model is in log-log form, the estimated coefficient of the policy dummy variable is interpreted as percentage change in total costs for small values of the coefficients, and semi-elasticity for higher values.

By identifying the policy change with a time dummy, we implicitly assume that in the absence of reform, total costs in the period $2006 - 2010$ would have increased at the same rate as in the period $2001 - 2005$. As stated above, to control for changes in costs related to variations in the economic cycle, we adjust cost and input prices for the CPI.[14]

5 Econometric estimation and results

5.1 Estimation approach

In order to choose the most adequate panel data model, we perform a series of tests on our NHs dataset. Since the likelihood ratio test rejects the null hypothesis of homoskedasticity ($\chi^2(40) = 149.84$, p-value $= 0.000$), heteroskedasticity-robust tests and estimation methods are considered. We examine the fixed-effect model (FE), the random effect model (RE), and the first difference model (FD) discussed in Nichols (2007) to create the counterfactual using observations on the same unit over time. These methods remove the bias due to unobserved characteristics that remain constant over time by adding individual-specific effects. Nevertheless, it is still necessary to control for the panel structure of the dataset, namely for errors correlated within groups (Cameron and Miller, 2010). If part of the bias is due to unobservable time-varying factors, our results may still be biased.

affected other coefficients by building interaction terms of each explanatory variable with the policy dummy (D) and did not find significant evidence. An alternative approach would consist of estimating two different models, one before the reform and one after the reform, and compare the estimated coefficients. However, this strategy allows individual effects to differ between the two periods, which is not desirable. Finally, we used a stochastic frontier approach to estimate several models, such as the pooled frontier with Mundlak correction (Farsi at al., 2005) and the true random effect model. The impact of the reform was analyzed in two ways: first, we introduced the policy dummy into the deterministic part of the frontier, and second, we compared the calculated mean inefficiencies using the non parameteric Kruskal-Wallis test. All the model specifications and approaches used confirm the evidence that the new payment system reduced total costs.

[14] According to the cantonal law (RL 2.5.4.5), salaries and indemnities for public employees are adjusted using the national Consumer Price Index. Since labor costs represent the largest proportion of total costs (up to 81%), to deflate total costs and input prices seems an appropriate choice.

The difference between the FE estimator and the FD estimator consists mainly in the underlying assumption about the speed at which the policy reform affects the outcome. The FE estimates compare the mean outcome before the policy reform with the mean outcome in the period after the reform. Instead, the FD model assumes that the reform has a one-shot effect at the moment of its introduction. Therefore, the impact is fully captured by a jump in outcome in the year 2006. We rule out the FD model for two reasons. First, from a policy point of view the relevant question is what are the implications of the new payment system in the medium term. Second, the introduction of PPS involves a series of changes that need time to be understood, implemented and optimized.

Both the FE and the RE models include individual-specific effects that allow to control for any constant unobserved heterogeneity, but they differ in the way they consider these effects. The FE model treats the individual-effects as fixed parameters and allows them to be partially correlated with regressors, accommodating a limited form of endogeneity (Cameron and Trivedi, 2010). In a policy evaluation study this property is of particular relevance. The sufficient condition for consistency of the FE model is $E[X_{it}^T(\varepsilon_{it} - \overline{\varepsilon}_i)] = 0$, i.e. the policy variable is allowed to be correlated with the persistent component of the error term - the unobserved heterogeneity - but not with deviations from the mean, $(\varepsilon_{it} - \overline{\varepsilon}_i)$ (Wooldridge, 2002). Three main requirements need to be satisfied when a FE model is applied. First, to avoid the so called incidental parameters problem, the time length should increase with the number of firms included in the sample. Second, the main variable of interest has to vary over time since the FE precludes the estimation of time-invariant regressors. Third, the percentage within variation of the variables of interest as with respect to the overall variation should be large enough to avoid imprecise estimates (Cameron and Trivedi, 2005). Instead, the RE model assumes that the unobservable individual effects are random variables distributed independently of the regressors, that is: $\delta_i \sim (\delta, \sigma_{\delta^2})$ and $v_{it} \sim (0, \sigma_{v^2})$, and the coefficients are estimated with the Generalized Least Square (GLS) method. Therefore, no correlation between the individual effects and the error term is permitted. The main disadvantage of the RE model is that the estimates are affected by the heterogeneity bias when the exogeneity assumption is not satisfied, and are, therefore, inconsistent.

In order to choose between the FE and the RE models we perform the robust version of the Hausman test using the artificial regression approach originally described in Arellano (1993).[15] The null hypothesis of regressors uncorrelated with the group specific effects is rejected at the 99% level ($F(20, 399) = 698.33$, p-value = 0.000). Also, the analysis of the within variation of each variable of the cost function shows that the percentage within variation over total variation is satisfactory for all variables of interest.

Standard errors are corrected using the cluster robust estimator based on Stock and Watson (2006).[16] The authors show that the cluster-robust estimator is preferred in FE models if serial correlation is expected, and it is reasonable to rely on asymptotic theory. In our sample, the number of clusters is satisfactory in order to rely on asymptotic theory for accurate inference (Kézdi, 2004). Also, each cluster contains a sufficient number of observations.[17]

5.2 Results

Through our regression analysis we are able to control for factors explaining variation in costs over time not related to changes in the payment system. As a consequence, we disentangle the general increase in costs from the impact of policy change. In Table 3 we present the estimated coefficients of the *restricted* and *unrestricted* FE models with two output characteristics (Q_1 and Q_2) specified in equation (3). In this baseline model (Model 1) we control for quality of NH care by means of the ratio between the number of nurses and the optimal number of nurses per patient (Q_2). The number of observations (N) and the model fit statistic $R^2 - within$ are also provided in the table. The models explain about 97% of the variation in the data. We focus the discussion on the unrestricted FE model

[15] The standard Hausman test assumes that the RE model is efficient. A comparison of the clustered and non clustered standard errors show that this assumption is violated in our case. When this is the case, the robust Hausman test should be used. This approach consists in re-estimating the RE model augmented with the original regressors transformed into deviations from the mean.

[16] When dealing with panel data, the assumption of independently and identically distributed errors (iid) is mostly violated due to three main reasons: heteroskedasticity, within-cluster correlation and serial correlation.

[17] Kezdi (2004) states that a sample of 50 clusters is close enough to infinity for accurate inference if the number of observations for cluster is not too small. A cluster is considered small if it contains less than five observations per cluster (Rogers, 1994).

Estimated coefficients	Restricted FE	Std. Err.	Unrestricted FE	Std. Err.
δ_Y	0.889****	0.049	0.877****	0.045
δ_{P_l}	0.727****	0.023	0.749****	0.021
δ_{P_k}	0.099****	0.008	0.094****	0.007
δ_{Q_1}	0.228****	0.040	0.239****	0.038
δ_{Q_2}	0.395****	0.034	0.496****	0.037
δ_{YY}	0.474****	0.099	0.432****	0.092
$\delta_{P_lP_l}$	-0.112	0.070	-0.067	0.067
$\delta_{P_kP_k}$	0.095****	0.019	0.108****	0.020
$\delta_{Q_1Q_1}$	0.307****	0.060	0.226****	0.059
$\delta_{Q_2Q_2}$	0.504	0.351	0.329	0.354
δ_{YP_l}	0.099**	0.048	0.084*	0.045
δ_{YP_k}	0.016	0.026	0.016	0.024
δ_{YQ_1}	-0.188	0.122	-0.053	0.110
δ_{YQ_2}	0.257*	0.142	0.305**	0.137
$\delta_{P_lP_k}$	-0.051	0.036	-0.076**	0.032
$\delta_{P_lQ_1}$	0.345**	0.150	0.301**	0.127
$\delta_{P_lQ_2}$	-0.351*	0.190	-0.121	0.264
$\delta_{P_kQ_1}$	-0.136**	0.057	-0.089	0.055
$\delta_{P_kQ_2}$	-0.056	0.068	-0.069	0.069
$\delta_{Q_1Q_2}$	-0.266	0.257	-0.121	0.264
δ_t	0.008****	0.001	0.018****	0.002
δ_d	-0.012*	0.006	0.090****	0.022
δ_{td}	-	-	-0.018****	0.003
δ_0	15.457****	0.008	15.423****	0.009
N	400		400	
R^2	0.964		0.970	

Notes: Significance levels: * = 10%, ** = 5%, *** =1%, **** = 0.1%.

Table 3: Results of the *restricted* and *unrestricted* fixed-effects models with one quality indicator (Model 1).

because it is more flexible than the restricted model and the first-order coefficients are similar in both specifications. The output coefficient (δ_Y) measures the total costs elasticity with respect to output. A value lower than 1 suggests the presence of unexploited economies of scale in the NH sector. In our case it indicates that an increase by 10% in the number of resident-days would increase total costs by about 8.88%.

The parameter estimates of output characteristics (δ_{Q_1} and δ_{Q_2}) show a positive and highly-significant value meaning that total costs increase with patients severity and our quality indicator for the service provided, i.e. the nursing staff ratio. These coefficients can also be interpreted as cost elasticities. The case-mix coefficient (δ_{Q_1}) indicates that a 10% increase in patients severity increases costs by about 2%. More important, a 10% increase in the nursing staff ratio (δ_{Q_2}) leads to a total costs increase of 5%. The input price coefficients (δ_{P_l} and δ_{P_k}) are positive and significant, meaning that the costs function is monotonically increasing in the vector of input prices. These coefficients provide information on the percentage of labor and capital costs over total costs of a representative NH. The estimated share of labor costs is around 73%, which is not far from the actual sample median (81%). Capital costs represent around 10% (sample median is 6.2%) of total costs, while the costs of material account for about 17% (sample median is 12%).

The estimated parameter (δ_t) is highly significant and indicates that, on average, total costs increase by 1.8% each year (0.8% in the *restricted* model). Increasing costs can be explained by increasing wages not associated to augmented productivity (Baumol and William, 1966), the adoption of more costly technologies or new procedures implemented in the whole sector due to regulation. The second-order coefficients show the percentage variation in first-order coefficients in response to a percentage variation in the regressors. We observe that the second-order coefficient of output (δ_{YY}) is statistically significant, meaning that there is some evidence of decreasing economies of scale. Total costs grow at increasing rates with patients severity ($\delta_{Q_1Q_1}$) and capital price ($\delta_{P_kP_k}$).

Our main coefficients of interest are those related to the impact of the reform. In the restricted FE model, the impact of the policy change is captured by the dummy variable coefficient (δ_d), which measures the average impact of PPS over the whole period considered. As discussed above, costs increased by roughly 1% yearly from 2001. However, the negative and significant coefficient of the policy dummy suggests that the reform reduced mean total costs by 1% from its introduction in 2006. Concerning the unrestricted FE model, the impact of the policy reform is allowed to vary in each year and is given by the combination of changes in the intercept and slope coefficients of the time trend (δ_d and δ_{td}). The intercept of the time trend increases by 8.9%. However, the slope coefficient decreases by 1.8%. The effect of the reform on costs in different years is given by $\Delta TC = 0.089 - 0.018(t - 2000)$, where $t \geq 2006$. The effect is -0.02 in 2006, -0.037 in 2007, -0.055 in 2008, -0.073 in 2009 and -0.091 in 2010. Hence, in five years the new payment system led to a reduction in costs of roughly 9%.

It is worth noticing that we estimated the impact of the policy change after controlling for quality, measured by the nursing staff ratio. As shown in the descriptive statistics, the nursing staff ratio slightly decreased after the reform. This may suggest that cost savings derived from the introduction of PPS were obtained at some quality expenses. Though, the relationship between the nursing staff ratio and quality may not be straightforward. Although the number of nurses has decreased, it might be that their productivity has increased to preserve the quality of services provided to the residents. Improved managerial/organizational practices induced by the reform and hardly measurable, for instance, may have offset the small reduction in the nursing staff ratio. We remind the reader that the nursing staff ratio is periodically controlled by the authority who forbids NHs falling below a given threshold. Therefore, small reductions in Q_2 could be interpreted as positive, cost-reducing effects of PPS.[18] This may also explain why our endogeneity test fails to reject the exogeneity hypothesis.

The above results were obtained controlling for the nursing staff ratio defined as the number of nurses over the theoretical optimal number of nurses. Concerns arise as to whether the new payment system may generate cost savings by substituting away more expensive professional nurses with less expensive non-professional nurses at the expenses of the patient or by reducing the number of nurses per patient. To further explore this issue, we report the estimates of three extended models (Model 2, 3 and 4) where the nursing staff ratio (Q_2) is included in the regression together with either the nurse-to-patient ratio (Q_3), the professional nurse-to-patient ratio (Q_4) or the ratio of professional to total nursing staff (Q_5). The results are summarized in Table 4 for the *unrestricted* model specification.[19] The number of observations in Model 3 and Model 4 drop to 326 since data for quality indicators Q_4 and Q_5 are limited. We note that the results of the baseline model are generally confirmed. In particular, the policy coefficients are stable across all specifications of quality. The impact of Q_2 on costs is still

[18] We performed some sensitivity analysis. We included a dummy variable for the organizational form. Although the coefficient was statistically significant, it did not affect the estimates of the policy dummy. We also performed the analysis without controlling for the nursing staff ratio. The estimated coefficient of the dummy variable was larger, as expected. We then included Q_2 in the cost function to provide more conservative estimates of the impact of PPS.

[19] Overall these results are confirmed in the restricted model specification.

remarkable but more detailed nursing staff ratios do not seem to generate significant effects on costs. As mentioned above, we believe the tight cantonal regulation on nursing staff requirements did not provide much margins for significant cost savings through quality (nursing staff) adjustments.

6 Conclusions

Because of increasing healthcare costs and continuous pressure on public expenditures to provide healthcare and residential services to the elderly population, prospective payment systems may represent a promising way to enhance efficiency in nursing home care. Few empirical studies investigated the effects of PPS in nursing home care, mostly relying on U.S. data. Literature in the U.S. has shown that PPS reduces overall costs to government but quality of care deteriorates as well.

In 2006, Southern Switzerland introduced global budgets to finance NHs. Through this paper we provided new evidence on the impact of PPS in the form of global budgets on the performance of NHs. Among important differences as with respect to the NH sector in the U.S., our context is characterized by NH services mainly provided by nonprofit firms as local monopolies subject to tight quality regulation by the authority in the form of number and type of nurses in relation to residents need. We investigated the impact of PPS on the costs of providing NH care using a panel data set of 41 NHs observed for a 10-years period from 2001 to 2010 controlling for quality aspects.

The analysis showed that the new payment system had a mild impact on costs after controlling for quality aspects using different measures of the nursing staff ratio. The new payment system reduced costs by about 9% after five years of policy implementation. This relatively small effect could be explained by three main reasons. First, as suggested by the theoretical literature, the real change in the level of cost sharing between the old and the new payment systems was too small to affect providers' incentives. Second, incentives to reduce costs were low since NHs were free to use only part of savings (25%). Finally, NHs were probably quite conservative in reorganizing work - including the reduction of working time or increased work intensity - that would have improved cost efficiency.

Still, concerns arise as to whether some cost savings were achieved through a reduction of quality, i.e. the number and type of nurses. We observed that the nursing staff employed over the theoretical nursing staff defined by the regulator slightly decreased after the implementation of the new payment system. Nevertheless, we did not find evidence of a similar drop in the professional nurse-to-patient ratio and the ratio of professional to total nursing staff. Therefore, PPS seems to have attained mild improvements on costs without a remarkable decrease in quality. Likely, the tight Swiss regulation was successful in avoiding negative effects on quality after the introduction of PPS.

One shortcoming of this work is that more time may be necessary to observe the full effects of the prospective global budget. Our data covered a span of five years after the introduction of the new regime. Also, our findings rely on the assumption that changes in costs over time are attributable only to the new payment system. Clearly, it is not possible to totally exclude that other factors played a role. We provided evidence of the strength of our identification strategy by considering the main economic and political changes that could potentially impact on costs. We are encouraged by the observed stability of nursing home care demand over time and the tight quality regulation.

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Appendix

Average costs per resident-day in pilot NHs are significantly lower than in non-pilot NHs in the period before the full implementation of the reform (Table 5). In Table 6 we report the average costs of NHs in three different periods: the period prior the pilot phase ($2001-2002$), the pilot phase ($2003-2005$), and the period of full policy implementation ($2006-2010$). Average costs increased in both groups between the first and the second period, about CHF 20 (9.3%) for pilot NHs and CHF 10 (4.2%) for non-pilot NHs. Average costs for non-pilot NHs increased slightly also between the second and the third period (+0.8%), whereas average costs for pilot NHs dropped by 2.5%. Since pilot NHs experienced a more remarkable increase in costs between the first period and the second period, the subsequent decrease in costs suggests that they reacted more strongly to the new payment system than non-pilot NHs.

	Model 2: Q_2 and Q_3		Model 3: Q_2 and Q_4		Model 4: Q_2 and Q_5	
Coefficients	Estimates	Std. Err.	Estimates	Std. Err.	Estimates	Std. Err.
δ_Y	0.858****	0.047	0.789****	0.059	0.801****	0.057
δ_{P_l}	0.751****	0.021	0.758****	0.031	0.765****	0.030
δ_{P_k}	0.096****	0.007	0.101****	0.009	0.095****	0.011
δ_{Q_1}	0.244****	0.051	0.271****	0.060	0.236****	0.052
δ_{Q_2}	0.477****	0.038	0.493****	0.057	0.490****	0.060
δ_{Q_i} i={3,4,5}	0.020	0.019	0.006	0.026	-0.016	0.062
δ_{YY}	0.452****	0.107	0.390**	0.145	0.339**	0.128
$\delta_{P_lP_l}$	-0.043	0.089	-0.204*	0.113	-0.175	0.115
$\delta_{P_kP_k}$	0.103****	0.022	0.078***	0.028	0.087***	0.026
$\delta_{Q_1Q_1}$	0.148	0.125	-0.039	0.135	0.058	0.111
$\delta_{Q_2Q_2}$	0.372	0.384	0.262	0.479	0.424	0.475
$\delta_{Q_iQ_i}$ i={3,4,5}	0.102***	0.035	0.031	0.047	-0.032	0.149
δ_{YP_l}	0.128***	0.046	0.031	0.059	0.010	0.064
δ_{YP_k}	0.004	0.027	0.003	0.032	0.014	0.032
δ_{YQ_1}	-0.032	0.143	0.210	0.127	0.234*	0.120
δ_{YQ_2}	0.309**	0.150	0.260*	0.147	0.283*	0.148
δ_{YQ_i} i={3,4,5}	-0.060*	0.035	-0.073	0.051	0.015	0.115
$\delta_{P_lP_k}$	-0.065*	0.031	0.004	0.032	-0.009	0.052
$\delta_{P_lQ_1}$	0.281*	0.159	0.301**	0.052	0.069	0.134
$\delta_{P_lQ_2}$	-0.207	0.241	-0.306	0.292	-0.162	0.288
$\delta_{P_lQ_i}$ i={3,4,5}	-0.062	0.078	-0.008	0.060	0.179	0.146
$\delta_{P_kQ_1}$	-0.136*	0.059	-0.045	0.106	-0.066	0.094
$\delta_{P_kQ_2}$	-0.074	0.071	0.002	0.098	-0.043	0.100
$\delta_{P_kQ_i}$ i={3,4,5}	0.024	0.028	0.008	0.022	-0.056	0.047
$\delta_{Q_1Q_2}$	-0.014	0.380	-0.266	0.396	-0.167	0.419
$\delta_{Q_1Q_i}$ i={3,4,5}	0.038	0.081	0.075	0.063	0.014	0.181
$\delta_{Q_2Q_i}$ i={3,4,5}	-0.134	0.115	-0.000	0.113	0.006	0.169
δ_t	0.017****	0.002	0.019****	0.004	0.020****	0.005
δ_d	0.080****	0.019	0.082***	0.027	0.089***	0.031
δ_{td}	-0.017****	0.003	-0.018***	0.005	-0.190***	0.006
δ_0	15.421****	0.008	15.424****	0.020	15.442****	
N	400		326		326	
R^2	0.972		0.973		0.972	

Notes: Significance levels: * = 10%, ** = 5%, *** =1%, **** = 0.1%.

Table 4: Results of the *unrestricted* fixed-effects models with two quality indicators (Q_2 and Q_3, Q_2 and Q_4, Q_2 and Q_5).

Group	Mean costs (2001-2005)	Std. dev.	t-statistic on mean difference
Pilot (N=20)	232.81	27.23	1.97
Non pilot (N=195)	244.67	25.44	

Notes: All monetary values are in 2005 Swiss francs, adjusted by the national Consumer Price Index.

Table 5: Average costs comparison between pilot and non-pilot NHs for the whole period.

	2001-2002 (1)	Δ (2)-(1)	2003-2005 (2)	Δ (3)-(2)	2006-2010 (3)
Pilot NHs	220.51	20.50	241.01	-6.01	235.00
	(N=8)	9.3%	(N=12)	-2.5%	(N=20)
Non pilot NHs	238.41	10.08	248.49	1.97	250.46
	(N=74)	4.2%	(N=121)	0.8%	(N=205)

Notes: All monetary values are in 2005 Swiss francs, adjusted by the national Consumer Price Index.

Table 6: Average costs comparison between pilot and non-pilot NHs in different periods.