THE IMPACT OF THE INSTITUTIONAL FORM ON THE COST EFFICIENCY OF NURSING HOMES

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SUMMARY

In Switzerland nursing home services are mainly provided by regulated public and private not-for profit organizations. Some of them are created by local government as foundations or associations. This situation provides a unique framework to study the impact of institutional form on the efficiency of not-for profit nursing homes. While the literature so far has mainly focused on the impact of ownership, the aim of the present study is to analyze from a theoretical and an empirical point of view the impact of the institutional form on the performance of nursing homes. It first models the behavior of managers working in highly regulated nursing homes operating as local monopolies under different institutional forms. The latter is thought of as an "legal constraint" which affects the manager in pursuing the efficient effort choice. It then estimates different stochastic frontier models and tests through different empirical approaches the impact of the institutional form on the cost efficiency. The empirical analysis is based on data of 44 skilled Swiss Italian nursing homes over a 7-years period from 1999 to 2005. In particular, the empirical analysis proposes an approach in order to disentangle time-invariant firms' inefficiency from latent heterogeneity. Finally, we also provide a test for systematic differences in managerial skills. The results suggest that the institutional form does affect the cost efficiency of nursing homes: public-law nursing homes provide the service to higher costs. However, no systematic difference is found in managerial skills. The results are consistent across all model specifications.

1. Introduction

In Switzerland nursing homes (NH) services are mostly provided by regulated public and private not-for profit (NFP) nursing homes while for profit institutions serve only a small minority of the elderly population[1]. Of the NH subsidized by the regulator, 46% is run as privately owned foundations, 43% are governmental[2] NH while the remaining 10% is represented by publicly-owned nursing homes that have been created by the local governments as foundations or associations (therefore called municipality-owned foundations or associations). Since the provision of nursing care services is organized al the local level, NH operate as local monopolies and face an excess demand due to the subsidized prices.

Our hypothesis is that the institutional form within the not-for profit sector affects the efficiency of nursing homes through differences in the governance structure. Therefore we distinguish between NFP nursing homes subject to private working contracts and NH under public-law working contracts. Hereafter we refer to those two forms of institutions as *private-law NH* and *public-law NH* respectively. Public-law NH correspond to governmental NH, while private-law NH include privately owned foundations as well as municipality-owned foundations and associations.

The issue of the most efficient ownership form in the provision of nursing care is an interesting one to whom the economic literature has not given a conclusive answer so far (Frank & Salkever, 1994). Based on the property right theory, the literature focused mainly on the effect of ownership comparing for-profit privately-owned and State-owned organizations (Vitaliano & Toren, 1994; Chou, 2002; Crivelli et al, 2002; Santerre & Vernon, 2005, etc.), while the majority of nursing home industry is characterized by NFP organizations (public and private). Within the NFP sector there is no accepted theory of organizational behavior and little empirical work has been done on the impact of ownership on the productive efficiency (Malani, Philipson, and David, 2003). In this paper we are mainly interested in analyzing, from a theoretical and en empirical point of view, the impact of the institutional form on the performance of not-for profit nursing homes. To our knowledge, only few studies (Farsi & Filippini, 2004) were carried out on this topic in the NH industry. However, there is an increasing interest in the literature about this issue. For example, Cambini et al (2010) published a study on the corporatization process occurred in the Italian bus industry; while Yan & Oum (2011) are looking at the effect of institutional choice on the efficiency and quality of U.S. airports.

We believe that the institutional form affects the managerial behavior through the way in which the governance within the nursing homes is organized. In public-law nursing homes the governing body is taken on by local politicians (council of the commune) and the executive arm is left to the municipality, which

[1] For-profit nursing homes serve only 5% of the market and are characterized by luxury resident services. Stock companies are not recognized by the contracting authority, therefore we do not have access to their data.

[2] Public nursing homes do not have a own juridical status and are directly integrated in the local public administration.

delegates to a manager. In private-law nursing homes the governing body is represented by the foundation council. The resulting decision-making process differs a lot among the institutions[3]. In particular, it emerged[4] that managers in public-law homes are much more limited in their decision power than mangers working in private-law homes[5]. In addition to that, private-law firms are expected to face a lower probability to be bailed out or a higher punishment of the management for "bad work". We expect that the regulation system strongly reduced the behavioral differences between the two forms of organizations. Therefore, the results found in this study can be considered as a lower bound.

This research question is interesting also from a political point of view. First, due to the increasing pressure to contain public social and health care spending and their expected increase as population ages, cost saving may be achieved by adopting the "best" organizational structure. Second, this would support the creation of health care services providers by governments and their governance in private form.

2 Theoretical model

Many previous studies on the effect of ownership type on the firm's performance follow the principal-agent adverse selection (Kessler & Lülfesmann, 2001; Pint, 1991). Other studies use a bargaining approach and focus on the degree of bargaining between the management and the ownership (Schmitz, 2000) or the workers (Glaeser, 2002; Haskel & Sanchis, 1995). We follow the second approach. We sketch a theoretical model to capture the behavior of public-law and private-law NH where in a neo-classical view low effort levels translate into low efficiency levels (Haskel & Sanchis, 1995). NH institutional form is usually represented by a council (governing body) (C). A Manager (M) is appointed to run the organization. The council may take different institutional forms (i). The two main types considered are public-law (i=G) or private-law (i=F). NH total costs can be described by the following function:

$$C_i = \theta - \alpha_i e. \tag{1}$$

The first term to the right hand side of eq. (1), θ, is a structural parameter that describes costs which are independent from managerial effort and are only partially observable by the regulator. This parameter depends, for instance, on the severity mix of patients, on the number and the quality of the professional staff members or on the nursing home location. The costs include a fixed remuneration for the manager (*W)*. For simplicity, we assume that θ is a random variable which can take only two values: $\underline{\theta}$ and $\overline{\theta}$ with

[3] Worthington and Dollery (2000) speak of local government managers being "constrained by a host of non-discretionary factors in arriving at efficient outcomes" (p. 14). Hart, Schleifer and Vishny (1997) provide a theoretical model that in some ways reproduces the hypothesis of public managers being constrained in their work. In an incomplete contracts perspective, they assume that the firm's performance is determined by the fact that in order to implement any cost- or quality innovation, the manager of a public firm requires an agreement of the government, while the manager of a private firm can implement a cost innovation without having a particular permission.

[4] In order to understand the decision-making process, many managers of public and private nonprofit nursing homes were interviewed.

[5] In religious private nonprofit nursing homes this may not be true. However, the sample considered in this analysis includes only a minority of religious private nonprofit homes.

$\overline{\theta} > \underline{\theta}$ and $\Pr[\theta = \underline{\theta}] = q, \Pr[\theta = \overline{\theta}] = (1 - q)$. The last term in eq. (1), *e,* is the effort that the manager can exert in order to reduce total costs. The parameter $\alpha_i \in (0,1)$ reflects the "effectiveness" or the marginal impact of effort in reducing costs. This parameter varies with the institutional form and represents the constraint that defines the manager's autonomy in making decisions. The parameter α_i can also be interpreted as difference in the complexity of agency-relationships: if more complex agency relationships translate into more bureaucratic decision-making processes, then these are captured by this parameter. The population of patients is normalized to one and demand is assumed to be exogenous since Swiss NH are local monopolies. Therefore eq. (1) can also represent average costs.

Total costs are observed ex-post by the regulator. However, the regulator cannot disentangle the components of the cost function, θ and *e.* A uniform budget is applied to finance nursing homes based on the following rule:

$$B = q\,\underline{\theta} + (1 - q)\,\overline{\theta} = \hat{\theta}. \tag{2}$$

The main actors of the model are therefore the council and the manager. The utility function of the council C_i is given in the following eq. (5):

$$U_{C_i} = S_i - \psi_i(B - C) = S_i - \lambda_i(B - C)^2 \tag{3}$$

where S_i are the exogenous benefits from production and ψ_i is the disutility function for an unbalanced budget. Benefits vary with the institutional form[6]. The disutility function ψ_i is a quadratic function equal for all councils and weighted with an institutional form specific parameter $\lambda_i \in (0,1)$. This basically captures the cost related to the fundraising activity. Alternatively, this parameter can be interpreted as punishment of the management for "bad work". To note is that the difference between the budget and the costs decreases the utility of the owner, independently on its sign. The Swiss Italian budgeting system until the year 2006 provides for a repayment to the regulator of resources not spent during the operative year. In this case, the council may feel "frustrated". The underlying assumption made in eq. (5) is that the disutility is concave and does not depends on whether the nursing home has to give money back or if makes a loss. Alternatively, this term can be though as if the utility of the owner would be at the maximum when the budget is balanced, as previously modeled in the literature (cf. for example Zweifel, 1997).

The manager maximizes his utility U_{M_i}defined in eq. (4):

[6] The commune council may value the preferences of the whole voters' community while the foundation council those of the donors or of particular group of interest.

$$U_{M_i} = W - \phi(e) + \gamma_i(-\lambda_i\ |B - C|)$$
$$= W - \frac{\eta}{2}\ e^2 - \frac{\beta_i}{2}\ (q\ \underline{\theta} + (1-q)\ \overline{\theta} - C)^2 \quad (4)$$

where W is the income, $\phi(e)$ the disutility from effort, γ_i the degree to which he internalizes the goals of the owner and β_i=$\lambda_i\ \gamma_i$ reflects the marginal impact of an unbalanced budget on his utility function. We assume an additive separable utility function with: $\phi'(e) > 0$, $\phi''(e) > 0$, $\gamma_i\ \epsilon\ (0,1)$. In particular, the disutility from effort takes the form $\phi(e) = \frac{\eta}{2}\ e^2$. The parameter $\eta > 0$ captures the marginal impact of effort on the utility of the manager. Finally, the effort level is bounded to take a value in the interval $e\ \epsilon\ \left(0,\ \frac{q}{\propto_i}\left(\overline{\theta} - \underline{\theta}\right)\right)$[7]. The reservation utility is assumed to be zero so that any positive wage is a sufficient condition to appoint the manager. The optimal effort choice of the manager is derived for two financing situations. The solutions are called $e_{\underline{\theta}}$, $e_{\overline{\theta}}$ respectively.

Over financing ($\theta = \underline{\theta}$) $\qquad e_{\underline{\theta}} = 0$ (5)

Under financing $\left(\theta = \overline{\theta}\right)$ $\qquad e_{\overline{\theta}} = \frac{\beta_i \alpha_i q\ (\overline{\theta} - \underline{\theta})}{\eta + \beta_i {\alpha_i}^2}$

How do the parameter of interest affect the optimal effort choice? In case of under financing, the optimal level of effort does not depend on the parameters of the model. In case of over financing, we get:

$$\frac{\vartheta e_{\overline{\theta}}}{\vartheta \alpha_i} > 0\ <=>\ \alpha_i < \sqrt{\frac{\eta}{\beta_i}} \quad (6)$$

The optimal level of effort exerted by the manager increases with higher values of α_i when α_i satisfies condition (6). Note that η can take any positive integer number. Divided by a decimal number, it results in a bigger number. Since α_i is a decimal number, this condition is virtually always satisfied. Similarly:

$$\frac{\vartheta e_{\overline{\theta}}}{\vartheta \beta_i} > 0\ <=>\ \alpha_i q\ \left(\overline{\theta} - \underline{\theta}\right)\eta > 0 \quad (7)$$

This condition (7) is always satisfied. Therefore, higher levels of β_i lead to higher effort.

The model predicts a different behavior depending on the cost situation of the nursing home. This result is not due to the existence of two "cost-types nursing homes" in the sample considered but rather to the fact that the funding system seems to hide the behavioral differences between the two institutional forms

[7] This means that the manager can decrease costs up to the point where B=C. Beyond this point, a higher effort would reduce his utility.

in situations in which effort choice does not matter from the point of view of the council, since extra resources are given back to the regulator. We concentrate therefore on the effort choice for the cases of potential loss: in this case, we expect a loss or a balanced budget (5), depending on the magnitude of the parameters of interest. Based on the following expectations about the parameters:

$$\begin{aligned} &\blacksquare \quad \lambda_G < \lambda_F \\ &\blacksquare \quad \alpha_G < \alpha_F \\ &\blacksquare \quad \gamma_G \leq \gamma_F \end{aligned} \tag{8}$$

The model predicts that: the behavior of nursing homes is expected to differ with institutional form when the funding system does not destroy the relative incentives. In a situation of under financing, the optimal effort choice of managers working in private-law nursing homes is expected to be higher so that a higher level of efficiency is reached.

3 Model specification and data

3.1 Specification of the cost function

For the empirical part we adopt the specification defined in Farsi and Filippini (2004) of the behavioral cost function[8] which defines the nursing home as a firm that transforms two inputs[9], capital and labor, into a single output, measured by the number of patient-days of nursing care. The latter is exogenous since strategic behavior of the NH with respect to patients demand is ruled out. The sample includes all skilled facilities included in cantonal nursing home planning, therefore being very homogenous in the production process. Hence, controlling for differences in quality, the number of patient-days is a good indicator of the production level. Formally, the total cost function is expressed as:

$$TC = f(Y, Q1, Q2, T, P_k, P_l) \tag{12}$$

where the dependent variable *TC* represents total cost[10] of each nursing home, *Y* is the output and (P_k, P_l) are the fixed prices for capital and labor respectively.

The price of labor is calculated as the weighted mean of the average wage rate of different professional categories employed in the nursing home (doctors, nurses, administrative and technical staff) while the

[8] In a non-competitive environment such that in the nursing home in Switzerland, there is no reason to believe a priori in a cost-minimizing behavior of nursing homes. In these cases, the estimated empirical cost function is called the "behavioral cost function" (Evans, 1971) and can still be used to make a comparison among firms. For a detailed discussion, see Farsi and Filippini (2004, p. 350).

[9] The same analysis was performed with a different specification of the cost model which included a third input, called material, as production factor. Its price was calculated by dividing the cost for meals, drugs and expenses due to treatments provided by doctors not working in the facility by the number of meals consumed during the year in the nursing home. In this case, capital cost are not calculated by the residual method but include all direct cost entered in the yearly nursing homes' book (cost for purchasing, renting, leasing, depreciation, interests and maintenance of properties and vehicles). The resulting material price showed reasonable values (mean price: 8.30 Sfr per meal). However the analysis of the OLS residuals did show that this specification does not support stochastic frontier models (skeweness value: -0.087). For this reason, this specification was abandoned.

[10] By estimating a total cost function we avoid the risk related to a possible high correlation between capital stock and output which would lead to a positive relationship between variable cost and capital stock (Filippini, 1996).

price of capital is derived from the residual approach. Labor costs are subtracted from total cost and the difference is divided by the capital stock (Friedlaender & Wang Chiang, 1983; Filippini & Maggi, 1993) which is approximated by the number of beds. Because of data unavailability, the capital inventory method cannot be implemented. Input prices and total cost are divided by the capital price in order to satisfy the homogeneity condition.

Additionally, we control for some output characteristics that may explain cost differences across nursing homes[11]: *Q1* is an index that measures the required average assistance of each nursing home's patients with normal daily activities such as eating, personal care or performing physio-logical functions and is calculated yearly by the RDPH. Patients are classified according the their severity in one out of five classes taking a value between 0 and 4, where higher values indicate a more severe case mix. *Q2* is the nursing staff ratio, that is the ratio between the number of nurses employed in a nursing home and the number of nurses that should be employed according to the guidelines of the RDPH. Due to the fact that nursing care is a labor-intensive service, this variable should provide a (partial) measure of quality (Farsi & Filippini, 2004, p.348) [12]. Finally, a linear time trend is included to capture changes in the technical progress.

The flexible translog functional form is adopted in this study in order to impose as few restrictions as possible and is approximated around the median value. This statistic is less sensible to outliners than the mean. The concavity condition is checked after estimation of the parameters.

3.2 Data and descriptive statistics

The present study is based on a panel data set of 44 skilled nursing homes operating in canton Ticino over the 7-years period 1999- 2005[13]. The data are extracted from the annual reports that subsidized nursing homes deliver to the RDPH. Nursing homes with foyers[14] are excluded from the sample, as well as information on three houses showing unreasonable values. The final sample contains 287 observations of 24 private-law and 20 public-law NH.

The rest of the chapter is dedicated to some descriptive statistics. In Table 1 are provided information on the mean, standard deviation (S.D.), median, minimum (Min) and maximum (Max) values for the main

[11] As Birnbaum et al (1981) suggest, in order to estimate cost functions either the output is assumed to be homogenous, or one should at least control for the service intensity and the patients characteristics (p.1099).

[12] Since labor cost make up about 85% of total cost, a small change in this variable may affect total cost considerably. For this reason, nursing homes with too high cost may decide to decrease the working percentage of the personal while efficient homes may hire new personal/increase the working time in order to justify additional cost and not having to give money back to the RDPH at the end of the year. This endogeneity issue is checked performing the robust Durbin-Wu-Hausman test (Cameron & Trivedi, Ch.6.3.7, p.190). We performed the test in Stata 11 using the lagged variable of q2 as instrumental variable. The test statistic is chi-squared distributed with a robust score chi2(1) =0 .49 (or: F(1,234) =0 .395). The null hypothesis of q2 being exogenous cannot be rejected at any percentage level.

[13] Data until year 2009 are also available. However, in 2006 a new funding system has been introduced. Since we suppose that it may have affected the relative efficiency of the institutions, the period 2006-2009 is excluded from the present analysis.

[14] Foyers are external residential apartments in which nursing care is provided to the most "in-health" patients. Since the production process may differ substantially, when a consistent share of patient-days is spent in foyers (>10%), the observations were dropped.

variables of interest. All input prices, total costs and variable costs were inflated to 2005 constant Swiss francs using the national Consumer Price Index.

Table 1 - Descriptive statistics of the main variables (287 observations)

	Mean	S.D.	Median	Min	Max
Average cost (SFr/resident day)	227.77	27.66	225.02	160.92	309.23
Total annual resident days (*Y*)	23227	9398.50	21656	9925	58324
Average dependency index (*Q1*)	3.048	0.363	3.08	0.8	3.8
Nursing staff ratio (*Q2*)	0.99	0.12	0.97	0.49	2.05
Average labor price in SFr per employee per year (*Pl*)	78854.98	5273.99	79282	63603.81	93236.75
Average capital price in SFr per bed (*Pk*)	13103	3263.42	12636	6370.32	33171.2
Number of beds	66.43	26.41	62	28	162

All monetary values are in year 2005 Swiss Francs (SFr), adjusted by the national consumer price index.

As it emerges from Table 1, the average cost per resident day in the most expensive home is twice that of the less expensive one, with an average of about 228 Sfr. This difference is at least partially explained by the high heterogeneity in the nursing homes' characteristics. In particular, facilities vary over their size: the number of beds ranges from a minimum of 28 to a maximum of 162 and leads to a high standard deviation also in the total annual resident days. The two variables capturing output differences also show a high variation: patients' average dependency index ranges between 0.8 and 3.8, while the nursing staff ratio between 0.49 and 2.05. If the nursing home follows the guideline of the RDPH and employs as many nurses as suggested, this variable takes value 1. Finally, consider the input prices: the highest variation is to find in capital price, where the highest price for each bed is five-times more expensive of the lowest one. This high heterogeneity may be explained by the investments made during the 90's in order to increase the number of beds available. Due to the long panel considered, part of the increase is also due to the variation associated with a technology change.

In order to get some first insights about the differences between public-law and private-law NH, we provide mean and standard deviation of the characteristics presented in Table 1, separated for each subsample. In the last column of Table 2 are reported the results of a two-sided t-test and the respective significance levels. The null hypothesis states that the two groups have equal means in the following characteristics:

Table 2 – Means of the main variables by institutional form

Variable	Foundations	Governmental	Foundations vs. Governmental (t-value)
Average cost (SFr/resident day)	233.685	221.389	3.852***
	(29.964)	(23.422)	
Total annual resident days (*Y*)	20103.05	26599.89	-6.225***
	(7046.662)	(10425.21)	
Average dependency index (*Q1*)	3.079	3.014	1.506
	(0.366)	(0.359)	
Nursing staff ratio (*Q2*)	0.992	0.981	0.774
	(0.154)	(0.078)	
Average labor price in SFr per employee per year (*Pl*)	79014.65	78682.59	0.532
	(5092.768)	(5476.3)	
Average capital price in SFr per bed (*Pk*)	14353.95	11752.38	7.346***
	(3790.485)	(1780.969)	
Number of beds	58.087	75.427	-5.873***
	(20.556)	(29.031)	
No of homes	24	20	-
No of observations	149	138	-

Standard deviations are given in brackets. All monetary values are in year 2005 Swiss Francs (SFr), adjusted by the national consumer price index. Significance levels: *10%, **5%, *** 1%.

Unexpectedly, the statistics show that on average foundations spend more money for each patient's resident day than do public homes and the difference is highly statistically significant. However, public-law homes have access to cheaper capital and are on average bigger. While the average number of beds in foundations is around 60 beds, the average in public homes is of 15 units higher, suggesting that public homes may enjoy from decreasing average cost. With respect to the output characteristics, nursing homes do not show any difference on average: mean dependency index and nursing staff ratio are very close. Similarly, the average labor price per employee shows equivalent values.[15]

[15] In addition to these descriptive statistics, an analysis of the skeweness of the OLS residuals was performed. As Waldman (1982) has shown, when the OLS residuals are skewed in the "wrong" direction, the results from the maximum likelihood estimator are not those of a "frontier", but simply OLS. The normality test shows that the OLS residuals are right skewed (0.216) and the null hypothesis of normally distributed residuals is rejected at 99% significance level. Therefore, data and model specification support the adoption of stochastic frontier models.

4 Empirical methodology

The effect of institutional form on the firms' performance is studied applying two different econometric approaches[16]. Both methods estimate a benchmarking cost frontier against which the actual performance of the firms in the sample is compared. The main difference between the two lies in the way "exogenous influences" are treated in the analysis of efficiency[17]. The first approach relies on the assumption that the institutional form affects the degree of inefficiency directly. The performance of each nursing home is measured relative to a single best practice frontier and the impact of institutional form on inefficiency is tested afterward by means of the non-parametric Kruskal-Wallis test.

The second approach refers to the literature on «environmental characteristics» and includes a dummy for the institutional form directly into the main cost equation. The argument is that if nursing homes with different institutional forms face different operating environments or objectives, they may employ different technologies (Grosskopf & Valdmanis, 1987). In this case, by introducing the dummy variable into the cost function, two distinct best practice frontiers can be estimated. The resulting inefficiencies are "net of environmental characteristics" and can be interpreted as primarily indicators of managerial performance (Coelli et al, 1999). The distance between actual cost and the own group-specific best practice frontier provides information about the within group inefficiency, while between group inefficiency is measured as the distance between the two frontiers (the coefficient of the dummy variable) (Grosskopf, 1987). By re-evaluating the traditional inefficiency predictor with the formula applied by Coelli et al (1999), all firms are compared to the most favorable best practice frontier. This is achieved by multiplying the usual predictor with the exponential of the estimated coefficient related to the dummy variable, here called θ:

$$CE_{it} = E\left[\exp(u_{it} + \theta)\,|\varepsilon_{it}\right] = E[\exp(u_{it})\,|\varepsilon_{it}] * \exp(\theta)$$

In this way it is possible to get a measure for "gross inefficiencies". In particular, the inefficiency of public-law NH is calculated with respect to the best practice frontier of private-law nursing homes. We get the inefficiency level of public-law nursing homes under the assumption that they face the same technology and objectives as private-law homes. This approach has already been applied to the literature on hospital efficiency in order to study the impact of ownership (Grosskopf & Valdmanis, 1987) and size (Ozcan, Y.A., Wogen, S.E., and Mau, L.W., 1998); both finding evidence of different best practice frontiers for different groups of hospitals.

For each approach we present the results of the pooled frontier and the true random effect model (TRE) recently developed by Greene (2005). The pooled frontier estimator considers the sample as series of cross sectional observations and assumes that the firm-specific effects are zero and that everything is observable. If this is not the case, the estimates are biased.

[16] We also estimate a cost function by regression models (OLS, RE) where the institutional form is captured by a dummy variable. The resulted are presented in appendix (A.1) and support the results of stochastic frontier models.

[17] See Simar, L., Lovell, C:A:K. and Vanden Eeckaut, P. (1994) for a review of the approaches available.

The TRE somewhat improves on the situation by including firm-specific effects that allow us to control for unobserved heterogeneity. However, if part of the inefficiency is constant, this is captured by the individual effects and therefore interpreted as heterogeneity and not inefficiency. It follows that the overall inefficiency is underestimated and the term interpreted as inefficiency is not capturing the effect of the institutional form. This is a limitation we can overcome with the second approach. In the present case, disentangling time-invariant inefficiency from latent heterogeneity is of major interest.

5 Results

In the following Table 3 we report the estimated coefficients and their associated significance levels of the first order coefficients and when available of the dummy variable for the institutional form for each approach and each model specification. Standard errors are given in brackets. All the coefficients are all highly significant and positive. Interaction terms are not displayed but many of them were also statistically significant. The estimated coefficients are quite robust across the different specifications. In particular, the pooled frontier model and the TRE model are comparable to the OLS and RE model shown in appendix (A.1) so that the similarity between the estimates is not surprising.

By comparing the coefficients, we can find some evidence of unobserved heterogeneity related to patients' case-mix severity. However, the bias in the estimates is very small and the TRE model seems to address this issue. In fact, the coefficient related to the case-mix variable decreases in magnitude in the TRE and it approaches the coefficient estimated with fixed effect model[18].

The output coefficient is smaller than one suggesting the presence of economies of scale. The coefficients of the two output characteristics show that more severe patients lead to higher costs. Similarly, employing more nurses per patient is also a reason for higher production costs. The estimated labor cost share is about 80% and is given by the coefficient on input prices. The actual labor cost share is about 85%. Finally, the dummy for the institutional form is positive and highly statistically significant meaning that, at the median point, public-law NH are on average more costly than the private-law NH by about 3.0%. This result is consistent with both the regression approach and the frontier approach.

In the last rows of the table are provided the statistics for lambda (λ) which is defined as the ratio between the standard deviation of the inefficiencies and the standard deviation of the stochastic term. Since the value of lambda defines the relative contribution of the inefficiency term with respect of the stochastic term, a positive and statistically significant number proves the existence of the two error

[18] In order to test the presence of unobserved heterogeneity, the fixed effect model is also estimated. The estimated coefficients (results not shown) are very close in magnitude to the results of the TRE model. Only the coefficient of patients' case mix differs substantially and is estimated around 0.17.

components. The difference in lambda in the two models arises from the model specification. Finally, the concavity condition is not satisfied since the Hessian Matrix, $\frac{\vartheta \ln C_{it}}{\vartheta w_j \vartheta w_i}$, is not negative semi-definite[19].

Table 3 – Estimated first-order coefficients (287 observations)

	2. Stochastic frontier models (Approach 1)		**3.** Stochastic frontier models with dummy variable (Approach 2)	
	Pooled frontier	TRE	Pooled frontier	TRE
$\boldsymbol{\alpha_y}$	0.927*** (0.008)	0.905*** (0.007)	0.913*** (0.009)	0.898*** (0.007)
$\boldsymbol{\alpha_{q1}}$	0.430*** (0.009)	0.233*** (0.024)	0.444*** (0.029)	0.291*** (0.025)
$\boldsymbol{\alpha_{q2}}$	0.459*** (0.029)	0.391*** (0.023)	0.473*** (0.037)	0.414*** (0.019)
$\boldsymbol{\alpha_{pl}}$	0.820*** (0.038)	0.791*** (0.010)	0.800*** (0.016)	0.775*** (0.011)
$\boldsymbol{\alpha_{PublicLaw}}$	-	-	**0.027*** (0.007)**	**0.033*** (0.005)**
$\boldsymbol{\lambda = \frac{\sigma_u}{\sigma_v}}$	1.040*** (0.156)	2.062*** (0.347)	1.386** (0.183)	1.813*** (0.298)

Significance levels: *10%, **5%, *** 1%.

Finally, consider the results of Kruskal Wallis test on the null hypothesis of equal means inefficiency between the two institutional forms. P-values are reported in brackets. The first two columns of Table 4 show the results based on the first empirical strategy where the institutional form is not controlled for in the main cost equation. The test rejects the null hypothesis at the 5% level in both model specifications. The higher P-value in the TRE model may be explained by the fact that part of the inefficiency is captured by the individual effects. The other columns report the results based on the second empirical strategy where the KW-test is applied to the gross inefficiencies and the inefficiencies "net of the institutional form

[19] Our results indicate that the Hessian matrix of the estimated cost function with respect to input prices (labor and capital) is not negative semi-definite, thus the concavity condition is not satisfied in any of the specifications meaning that firms' strategies are not responsive to changes in input factor prices. This can be explained by the fact that the input choices in Switzerland's nursing homes are rather constrained by regulation (Filippini and Farsi, 2004). Results are interpreted according to the behavioral cost framework proposed by Bös (1986).

effect" respectively. The results on gross inefficiencies in columns 3 and 4 confirm that public-law and private-law NH differ. The p-value in the TRE model becomes smaller, possibly due to the fact the this approach is able to disentangle constant inefficiency due to the institutional form from latent heterogeneity. Finally, by comparing the net inefficiencies based again on the institutional form, it is possible to shed further light on the kind of differences between private-law and public-law homes: the p-values in the last two columns suggest that the managerial skills do not differ between private-law and public-law institutions. A possible explanation is that high skilled managers may be attracted by public-law NH for the higher benefits but also by private-law NH for the higher flexibility in the decision making process. Managers are randomly distributed among the houses.

Table 4: Results of the Kruskal-Wallis test

Kruskal Wallis test on:	Gross inefficiencies (Empirical strategy 2)		Gross inefficiencies (Empirical strategy 3)		Net inefficiencies (Empirical strategy 3)	
H0: Pub=Pr (P-Value)	Pooled	TRE	Pooled	TRE	Pooled	TRE
	NO (0.000)	NO (0.045)	NO (0.000)	NO (0.000)	SI (0.168)	SI (0.559)

6 Conclusions

The theoretical model developed in the present research project predicts that in situation of over financing, no behavioral difference is expected between private-law and public-law institutions. On the contrary, in situation of under financing, the managerial behavior depends on their institutional form through three paths: first, the fundraising costs when actual costs exceed the allocated resources. Second, the legal constraints faced by the management in his decision-making process. And third, the degree to which the management internalizes the objectives of the board, e.g. the altruistic motives. Based on these assumptions, the model predicts a higher efficiency level of private-law institutions, both public and private.

The empirical analysis shows a strong evidence that institutional form matters: private-law nursing homes are on average less costly than public-law nursing homes. This result is consistent with all econometric approaches and model specifications. The presence of latent heterogeneity related to patients' severity of illness suggests that the TRE model improves on the approaches applied in the past by avoiding biased estimates. However, the TRE model suffers from the limitation of interpreting persistent inefficiency as latent heterogeneity. This may have led to under-rejection of the null hypothesis in the Kruskal-Wallis test in past studies applying the TRE model. An alternative approach in order to address this

issue consists of including a dummy variable for the institutional form in the deterministic part of the frontier. The latter approach allows to get further information of the nature of the inefficiency by interpreting the skewed term as a primarily indicator of managerial skills.

If evaluated in the present context, the results of the empirical analysis are quite strong. One might expect that nursing homes with different institutional forms but same financial and regulatory incentives perform identically. However, despite the impressive regulation system limiting and controlling the behavior of the nursing homes, a clear pattern emerges: public-law nursing homes are ceteris paribus more costly. It is possible to expect that these differences would be exacerbated if the regulator would leave more decision freedom to the nursing homes. The change in the funding system started in January 2006 and introducing some financial incentives for efficient managers may provide an interesting framework to test this hypothesis.

The main shortcoming of the present study is that it is not possible to really disentangle the impact of the "bailing out" probability from the effect of the higher flexibility of the person doing the management on the efficiency. We model institutional form by using these two elements. Therefore, the efficiency difference between public-law and private-law institutions is assumed to be the result of both elements. In general, we do not have data to directly test the parameters developed in the theoretical model. Moreover, a better indicator for properly controlling for differences in quality would be worthwhile. The indicator included into the cost function, the nursing staff ratio, does not control for example for differences in the quality of the personal hired or the working experience. Moreover, quality may be defined in different way depending on the final goal and should include many dimensions, such as patients' satisfaction. Even though we partially control for unobserved heterogeneity with the TRE model, it is possible that part of the cost differences is explained by differences in the quality of the service provided.

Despite the limitation discussed so far, the present work has the advantage of providing a systematic analysis of the impact of different governance structures on the cost efficiency of nursing homes. To our knowledge this is the first study seeking at studying the impact of the institutional form from both a theoretical and an empirical point of view. If our results are confirmed by other studies, a new debate on the couple private-public would arise. These findings suggest that the creation of organizations that provide health care services by governmental units and let be run as private-law firms may be an efficient solution from an economic point of view.

Further research is necessary in order to be able to generalize our results. The present analysis studies institutional differences within the nursing home industry, but similar results are expected in other industries. Form a methodological point of view, the approach proposed here combining the TRE model with the dummy variable in the deterministic part of the frontier need to be tested in industries characterized by high heterogeneity bias.

REFERENCES

Aigner, D., C. A. K. Lovell and P. Schmidt (1977). Formulation and Estimation of Stochastic Frontier Production Function Models, *Journal of Econometrics*, 6, 21-37.

Birnbaum, H., Bishop, C., Lee, A. and Jensen, G. (1981). Why Do Nursing Home Costs Vary? The Determinants of Nursing Home Costs. Medical Care, 19(11), 1095-1107.

Bös, D. (1986). *Public Enterprise Economics*, North-Holland: Amsterdam.

Cambini C., Filippini M., Piacenza M., Vannoni D. (2010). Corporatization and Firm Performance: Evidence from Publicly Provided Local Utilities. *Review of Law & Economics,* 2(2), 1-27.

Cameron, A. C. and Trivedi, P. K. (2005). Microeconometrics. Methods and Applications. Cambridge University Press: New York.

Cameron, A. C. and Trivedi, P. K. (2010). *Microeconometrics Using Stata. Revised Edition.* Texas: Stata Press. Chambers, R. G. (1988). *Applied Production Analysis*. Cambridge: Cambridge University Press.

Coelli, T., Perelman, S. and Romano, E. (1999). Accounting for Environmental Influences in Stochastic Frontier Models: With Application to International Airlines. *Journal of Productivity Analysis*, 11, 251-273.

Crivelli, L., Filippini, M. and Lunati, D. (2002). Regulation, Ownership and Efficiency in the Swiss Nursing Home Industry. *International Journal of Health Care Finance and Economics*, 2(2), 79-97.

Farsi, M. and Filippini, M. (2004). An empirical analysis of cost efficiency in non-profit and public nursing homes. *Annals of Public and Cooperative Economics*, 75(3), 339-365.

Filippini, M. and Prioni, P. (2003). The influence of ownership on the cost of bus service provision in Switzerland – an empirical illustration. *Applied Economics*, 35, 683-690.

Friedlaender, A.F. and Wang Chiang, S.J. (1983). Productivity Growth in the Regulated Trucking Industry. *Research in Transportation and Economics*, 1, 149-184.

Greene, W. (2005). Reconsidering heterogeneity in panel data estimators of stochastic frontier model. *Journal of Econometrics*, 126, 269-303.

Grosskopf, S. and Valdmanis, V. (1987). Measuring hospital performance . A Non-parametric Approach. *Journal of Health Economics*, 6, 89-107.

Hart, O., Schleifer, A. and Vishny, R.W. (1997). The Proper Scope of Government: Theory and an Application to Prisons. *The Quarterly Journal of Economics*, 1127-1160.

Haskel, J. and Sanchis, A. (1995). Privatization and X-Inefficiency: A Bargaining Approach. *The Journal of Industrial Economics*, 43 (3), 301-321.

Jondrow, J., Lovell, C.A.K., Materov, I.S. and Schmidt, P. (1982). On the Estimation of Technical Inefficiency in the Stochastic Frontier Production Function Model. *Journal of Econometrics, 19(2/3)*, 233-238.

Malani, A., Philipson, T. and David G. (2003). Theories of Firm Behavior in the Nonprofit Sector. A Synthesis and Empirical Evaluation. In Glaeser, E.L (Ed.), *The Governance of Not-for-Profit Organizations, The* University of Chicago Press, Chicago, 181-215.

Oum, T., Yan, J. (2011). Effects of Government Quality and Institutional Choice on Efficiency of Airports in the United States. *Working Paper,* School of Economic Sciences.

Ozcan, Y.A., Wogen, S.E. and Mau L.W. (1998). Efficiency Evaluation of Skilled Nursing Facilities. *Journal of Medical Systems*, 22(4), 211-224.

Santerre, R.E. and Vernon, J.A. (2007). Ownership Form and Consumer Welfare: Evidence from the Nursing Home Industry. *Inquiry*, 44, 381-399.

Simar, L., C.A. Knox Lovell and Ph. Vanden Eeckaut. (1994). Stochastic frontiers incorporating exogenous influences on efficiency. *UCL and CORE Discussion paper,* 9403, Institut de Statistique: UCL.

Vitaliano, D. F. and Toren, M. (1994). Cost and efficiency in nursing homes: a stochastic frontier approach. *Journal of Health Economics*, 13, 281-300.

Waldman, D.M. (1982). A Stationary Point for the Stochastic Frontier Likelihood. Journal of Econometrics, 18, 275-279. In Green, W. H. (Ed.), *LIMDEP-Version 9.0. Econometric Modeling Guide*, Volume 2, New York, E33-14.

Worthington, A. and Dollery, B. (2000). Efficiency Measurement in the Local Public Sector: Econometrics and Mathematical Programming Frontier Techniques. *School of Economics and Finance Discussion Papers and Working Papers Series*, 078, Queensland.

Zweifel, P. and Breyer, F. (1997). *Health Economics*. New York: Oxford University Press.

APPENDIX

A.1 Regression analysis

A.1 – Results of regression models with dummy variable

	OLS	RE
α_{y}	0.914***	0.903***
	(0.010)	(0.014)
α_{q1}	0.433***	0.315***
	(0.030)	(0.040)
α_{q2}	0.469***	0.433***
	(0.038)	(0.034)
α_{pl}	0.801***	0.777***
	(0.016)	(0.017)
α_{T}	0.012***	0.013***
	(0.002)	(0.001)
α_{yy}	-0.050	-0.113**
	(0.040)	(0.054)
α_{q1q1}	0.658***	0.577***
	(0.111)	(0.118)
α_{plpl}	0.130	0.130
	(0.100)	(0.089)
α_{q2q2}	-0.283	-0.193
	(0.198)	(0.177)
α_{yq1}	-0.018	-0.128
	(0.081)	(0.091)
α_{yq2}	0.532***	0.588***
	(0.089)	(0.087)
α_{ypl}	0.003	0.025
	(0.039)	(0.040)
α_{plq1}	0.252	0.208
	(0.158)	(0.146)
α_{q2q1}	-1.296***	-0.845***
	(0.234)	(0.223)
α_{plq2}	-0.375**	-0.429***
	(0.170)	(0.145)
$\alpha_{PublicLaw}$	**0.024*** **	**0.030*** **
	(0.007)	**(0.011)**
Constant	15.346***	15.341***
	(0.009)	(0.010)
R-Square	0.988	0.987