

# Factors' Affecting the Hospital's Cost Structure: the Case of a Greek University Hospital

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**Abstract** This paper analyzes the data that compose the cost structure of Greek Public Hospitals. Moreover, an attempt is made to explore the main operating factors that affect the total cost of public hospitals. This study, tries to contribute to literature in order to group into categories the expenses of public hospitals, while also it provides information to users on the cost structure of those hospitals. In order to do so, a big Public University Hospital of Greece was taken into account, for the period 2005-2009 in a quarterly basis for both financial and operative factors. Eleven cost categories which constitute the cost structure of the Hospital and four operative factors were taken into account for this analysis. The results show the cost factors who significantly affect the cost structure of this particular University Hospital.

**Keywords** Operative Costs, Cost Structure, Public Hospitals, Greece

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## 1. Introduction

During the last century, several changes have been made in health sector in various countries of the world. The aim was to reorganize the units providing health services to provide better and high quality care. In this reorganization, significant role has the Accounting Science. Accounting, through its theory, has promoted the fact that it is not a neutral science, but is a highly flexible and changeable science, which shape by social relevance (Arnold and Oakes, 1995, Hopwood, 1987, Cooper and Sherer, 1984, Tinker and Neimark, 1987). Within the organization either it is a private enterprise or public sector organization, accounting developments are increasingly seen to be associated with both the administration and financial decision making (Becker and Neuheuser, 1975).

A global phenomenon nowadays is the rising costs of health care services that the governments have to face. This trend has gained momentum in the developed as well as the developing countries, thus leading to encourage control of

operating costs and the efficiency of hospitals (Hsihui et al., 2004, Scott, 1999, Weil, 1992). Although changes in health sector started from Australia (Willis, 1988) and USA (McKinlay and Arches, 1985), the literature suggests that these changes were an international trend which embraced countries like Canada (Fried et al., 1987), Sweden (Heidenheimer, 1980), Norway (Riska, 1988) and the UK (Ham et al., 1990). Australia and the USA were the first countries that adopted Accounting within hospitals, in order to monitor their economic efficiency, expecting more information for the costs of health care services.

Developed countries have introduced accounting within their hospitals, because they wished to know the constant and increasing economic and social efficiency of their services (Bowe, 1977, Haber 1964). The use of accounting in hospitals provides information about the management of the financial resources and therefore leads to a more efficient production (Ellwood, 1996). The efficiency will occur from lower costs due to economies of scale (Wagstaff, 1989) and through decreases of inflows (Bartlett and Le Grand, 1992). The introduction of accounting in health sector brought undeniable changes. Jones and Mellett (2007) summarized these changes into three categories: First of all accounting is a tool within an institutional framework. Secondly, accounting was the tool for changes, aimed to reduce operating costs and providing information to stakeholders. Finally, accounting emphasized the role of separate actions in the hospital.

## 2. Literature Review

The introduction of accounting in hospitals, aimed to the identification and control of the operating costs of hospitals. Like any other business, the health units should take into serious consideration their operational costs. Private Hospitals have taken important steps to this goal, as they are forced to operate independently (without government grants), covering their expenses from their earnings (Danzon, 1982). However, Public Hospitals operate under a different philosophy than the Private ones. Public Hospitals are free of

the profit motive for the continuation of their business, because their funding sources are from grants from the government. The effectiveness of the Public Hospitals cannot be measured by the profit, since the services they provide are paid through taxation of citizens. For this reason, in the literature, the economic indicators are based on the cost of these units.

The cost of health units is a tool with which measure the diachronic efficiency of a unit. Furthermore, there is the possibility of comparing one unit to another and record the most efficient. Finally, the cost can be used as a tool to cut expenditures and increase efficiency (Wu, 2010). The data that built the operating cost of a hospital are the basis for the budgeting of that hospital and help in determining the participation of each department to the total cost of hospital.

The operational cost of hospitals is the sum of all expenditures carried out by the hospital in order to offer its services. This cost can be divided in direct and indirect cost (Bellas et al., 2009). The direct costs include expenses for raw materials, direct labor and direct expenses.

The costs for raw materials include the catering of patients, medications, laboratory materials, cost of laboratory reagents, and generally all those consumable items that are used daily by the various clinics or departments of a hospital for the production of health care services (Bellas et al., 2009, Johannesson and Jonsson, 1991). The cost for direct labor consist the salary and the bonuses of the personnel that involved for the production of health care services. Finally, the direct costs are those that directly contribute to the provision of a service from a clinic or a hospital department, but do not fit into any of the above two categories, like electricity or the heating, etc. (Bellas et al., 2009). On the other hand, indirect cost includes all the costs that are not direct involve to the provision of health care service. These kinds of costs are the expenditure of auxiliary functions that exist in a hospital, such as the technical service and the administrative department.

As mentioned above, apart from financial factors, there are some operational factors as well, that affect on the cost structure of a hospital. According to Haslam (2005), in order to calculate the cost may take into account various factors related to the patient and include features such as gender, age, race, socio-economic profile of the patient and the general characteristics of the episode. Moreover, Evans et al. (1995), take into account the length of stay of a patient, indicated that a decrease in days of hospitalization may decrease the total cost. Finally, Thanasis (2012), indicated that the larger a hospital is (measured by the number of beds), the more operational cost faces.

The need to determine the operational cost of hospitals was the last four decades the primary goal for health policy-makers of the developed countries. Since the 1970s, several studies (Brooks, 1971, Ginsburg, 1972, Berry, 1974, Gaitanides, 1979, Karger and Vora, 1979) have been carried out with a view to costing approach of hospitals. During the 1970s decade, it has become imperative to try to reduce the operating costs of health units, by establishing the control of

expenditures of hospitals (Sloan, 1982).

Nowadays, the need of governments worldwide is to cut expenses from their budgets. In order to do so, a new trend has emerged, called New Public Management (Hood, 1995). New Public Management highlights the accurate measurement of the cost and revenues of public institutions, while leads to the efficient use of resources and the achievement of the results (Venieris and Cohen, 2004). New Public Management has increased the responsibility of the public administration and control; outcomes became more compelling, since it leads to improved performance by reducing bureaucracy (Ossege, 2012). The public sector's restructuring affected the health sector as well. According to Levaggi (2005) in most development countries, half of total expenditures on health occur by hospital care accounts.

This study reports the data that compose the cost structure of a public hospital in Greece. Furthermore, an attempt is made to explore all those factors that affect the total cost of a public hospital. It should be noted here, that the Greek National Health System consists mainly public hospitals, which have the same cost categories, while offer their services to the entire population of the country. It is more than obvious that public hospitals in Greece have the same characteristics and therefore are comparable.

Moreover, since 2009 Greece faces a big economic crisis that resulted in an increasing concern over public debt. One of the most costly sectors of Greek Public is the one of public health. Therefore it is more than necessary to rationalize the costs that arise by hospitals. Until now, no other study has record the cost categories of Greek Hospitals, so that one can accurately know the costs faced by public hospitals. This gap is trying to cover the current study.

### 3. Research Methodology

The purpose of this study is to explore the factors that influence the cost structure of a Public University Hospital. In order to do so, we use some operational factors of the Hospital, like the number of beds, the inpatients, the patient days and the average length of stay. These factors examined for the period 2005 – 2009 in quarterly basis as well as the financial data of the Hospital.

The costs that were measured for the model include the below cost categories: the cost of consumables, the cost of pharmaceutical supplies, the cost of orthopedic materials, the cost of laboratory reagents, the cost of cleaning, the cost of catering, the cost of electromechanical equipment, the cost of repairs and maintenance, the cost of third party services, the cost of salary and finally the other costs. All the above cost categories refer to cost per bed.

First of all we have to mention that the cost categories are the key variables of the model used in this analysis, while the operational factors of the hospital are the explanatory variables. Initially, we check whether there is correlation between the explanatory variables by the coefficient of Pearson. The Pearson coefficient indicates strong positive

linear correlation (0.822) between patient days and the number of inpatients. According to the above, we removed from the model the variable representing the number of inpatients since the knowledge of the effect of patient days is sufficient for the interpretation of the model.

Moreover, before the multiple regression technique is used, the variables are converted to the same scale (each variable is measured by bed) so they can be compared, thereby avoiding large differences between the values of variables in the model. So for each cost category we will construct a forecasting model with the following independent variables: i) the number of beds, ii) the patient days and iii) the average length of stay. The aim is to estimate the above parameters of the model by multiple regressions. Below are the results of multiple OLS with depended variables the various cost categories and the total cost as well.

### 4. Empirical Research

Considering all the above, the analysis starts by checking which of the explanatory variables affect significantly the costs of medical supplies. Applying a multiple regression, the results show that the model explained 35.9% of the total variance; the only variable which ultimately participates in the interpretation of the model is the number of beds. The multiple coefficient of determination  $R^2$  is a measure of how well the model explains the data.

In the Table 1 below, we observe that the P-value control is small ( $0.01 < 0.05$ ), therefore the null hypothesis that the parameter values are equal to zero is rejected, thus the model appears in the first stage well suited to our data.

**Table 1.** ANOVA Analysis

Model	Sumof Squares	df	Mean Square	F	Sig
Regression	6.81	1	6.81	10.065	0.01
Residual	12.19	18	0.68		
Total	19.00	19			

Dependent: Consumables

From the Table 2 of coefficients, we conclude that an increase in the number of beds increases the cost of consumables by 0.6 units or 60% or alternative, a decrease in the number of beds leads a reduction in costs of medical supplies by 0.6 units or 60%.

**Table 2.** Coefficients

Coefficients	Standardized Coefficients Beda	t	Sig
(Constant)		0.000	1.000
No of Beds	0.599	3.772	0.005

Dependent: Pharmaceutical Consumables,  $R^2 = 15\%$ , Adjusted  $R^2 = 32.3\%$

This time we repeat the multiple regressions with dependent variable the cost of pharmaceutical consumables. The results in Table 3 indicate that the model is not well suited to our data, as explained only 15% volatility of the cost, by the independent variables. Additionally, F-test suggests that our data cannot be adequately described by the linear model ( $p > 0.05$ ).

**Table 3.** Multiple Regressions of Pharmaceutical Consumables

Modal	Sum of Squares	df	Mean Square	F	Sig
Regression	2.78	3	0.93	0.913	.457a
Residual	16.22	16	1.01		
Total	19.00	19			

Dependent: Pharmaceutical Consumables,  $R^2 = 15\%$ , Adjusted  $R^2 = 32.3\%$

The explanatory variables in cost of orthopedic consumables, explains 41.7% of the total variance. Furthermore, we confirm by the F-test, the model is well adjusted. All these are shown in the Table 4 below.

**Table 4.** Multiple Regressions of Orthopedic Consumables

Modal	Sum of Squares	df	Mean Square	F	Sig
Regression	7.91	3	2.64	3.808	.031a
Residual	11.09	16	0.69		
Total	19.00	19			

Dependent: Orthopedic Consumables

The coefficients that are statistically significant are the patient days and the average length of stay (LOS). As shown in Table 5, with all other factors constant, an increase in patient days leads to an increase in costs of the orthopedic consumables by 0.626 or 62.6%, while a reduction of patient days leads to a reduction in costs of the orthopedic consumables by 0.626 or 62.6%. Moreover, if all the other factors are constant, an increase in the average length of stay leads to increased costs of orthopedic consumables by 0.702 or 70.2%, while a decrease in the average length of stay leads to a reduction in costs of the orthopedic consumables by 0.702 units or 70.2%.

**Table 5.** Results of Coefficients

Coefficients	Standardized Coefficients Beda	t	Sig
(Constant)		-3.039	1.000
No of Beds	0.057	0,299	0.005
Patient Days	0.626	2.737	0.015
LOS	0.702	3.057	0.008

Dependent: Orthopedic Consumables,  $R^2 = 41.7\%$ , Adjusted  $R^2 = 30.7\%$

According to the multiple regressions of the explanatory variables, the cost of the laboratory reagents, the cost of cleaning, and the cost of the electromechanical equipment revealed that these variables cannot interpret the linear models.

The results of the multiple regressions with independent variable the cost of catering indicates in Table 6, that the model is adjusting well, as explained the 68.1% of the total variance. The number of beds and the average length of stay significantly affect the interpretation of the model. To understand whether the variables contribute to the impact of cost of catering, we take into consideration the standardized coefficients; all the variables have been converted on the same scale to be compared. The coefficient Beta of the number of beds is 0.609; indicates that the number of beds contributes more to the interpretation of the model compared with the average length of stay (0.452).

**Table 6.** Standardized Coefficients

Coefficients	Standardized Coefficients Beda	T	Sig
(Constant)		-2.977	0.008
No of Beds	0.609	4.050	0.001
LOS	0.452	3.004	0.008

Dependent: Cost of Catering,  $R^2=61.8\%$ , Adjusted  $R^2=57.3\%$

Similar results (Table 7) arise from the linear regression with independent variable the cost of repairs and maintenance. The model is interpreted sufficiently, due to small percentage volatility of the cost (21.8%), while the F-test confirms the well adjustment of the model.

**Table 7.** Linear Regression of Cost of Repairs and Maintenance

Modal	Sum of Squares	df	Mean Square	F	Sig
Regression	4.15	1	4.15	5.025	.038a
Residual	14.85	18	0.83		
Total	19.00	19			

  

Coefficients	Standardized Coefficients Beda	t	Sig
(Constant)		0.000	1.000
No of Beds	-0.467	-2.242	0.038

Dependent: Cost of Repairs and Maintenance,  $R^2=21.8\%$ , Adjusted  $R^2=17.5\%$

The linear regression of dependent variable the other costs indicated that the model is interpreted 26.1% of variance in costs (Table 8). The standardized coefficient indicates that an increase in the number of beds leads to a reduction in

other costs by 0.511 or 51.1%, while a decrease in the number of beds increases the other costs by 0.511 units or 51.1%.

**Table 8.** Linear Regression of Other Costs

Coefficients	Standardized Coefficients Beda	t	Sig
(Constant)		0.000	1.000
No of Beds	-0.511	-2.523	0.021

Dependent: Other Costs,  $R^2=26.1\%$ , Adjusted  $R^2=22\%$

Repeating the linear regression of dependent variable the cost of third party services, the model is interpreted by 22.2% of the total variance and the F-test indicates that none of the model parameters is not zero ( $0.036 < 0.05$ ). From the table of coefficients we observe that the only variable that ultimately involved the interpretation of the model is the average length of stay. The results of the standardized coefficient in the Table 9 below indicate that an increase in the average length of stay increases the cost of third party services by 0.472 or 47.2%, while a decrease in the average length of stay leads to a reduction in costs of third party services by 0.472 or 47.2%.

**Table 9.** Linear Regression of Cost of Third Party Services

Coefficients	Standardized Coefficients Beda	t	Sig
(Constant)		-2.249	0.037
LOS	0.472	2.269	0.036

Dependent: Cost of Third Party Services,  $R^2=22.2\%$ , Adjusted  $R^2=17.9\%$

Finally the results of the linear regression of dependent variable the cost of salary (Table 10) indicate that the model is interpreted by 54.4% of the total variance of the coefficients, while only the number of beds remains finally to the model and is statistically significant. An increase in the number of beds increases the cost of salary by 0.737 or 73.7%, while a decrease in the number of beds leads to a reduction in costs of salary by 0.737 or 73.7%.

**Table 10.** Linear Regression of Salary

Coefficients	Standardized Coefficients Beda	t	Sig
(Constant)		0.000	1.000
No of Beds	0.737	4.631	0.000

Dependent: Cost of Salary,  $R^2=54.4\%$ , Adjusted  $R^2=51.8\%$

While previously we examined which factors affect the structure of the hospital cost separately, now the analysis concerned about the effect of these factors on the total cost of the hospital. The total cost of the hospital is the sum of the

different cost categories presented above, for each quarter for 2005-2009.

From the Table 11 below we can see that applying the linear regression, 44% of the volatility of the total cost is interpreted by the number of beds and the results of the F-test indicates that the model fits well to the data ( $0.001 < 0.05$ ). The standardized coefficient Beta (0.663) indicates that the number of beds affects quite strongly to the interpretation of the model. An increase in the number of beds increases the total cost by 0.663 or 66.3%, while a decrease in the number of beds leads to reduced total costs by 0.663 or 66.3%.

**Table 11.** Linear Regression of Hospital's Total Cost

Coefficients	Standardized Coefficients Beda	t	Sig
(Constant)		0.000	1.000
No of Beds	0.663	3.762	0.001

Dependent: Total Cost,  $R^2=44\%$ , Adjusted  $R^2=40.9\%$

## 5. Conclusions

In this paper, an analysis was made to examine the cost structure of a Greek Public University Hospital. The purpose of this study was to investigate the cost factors who significantly affected the structure of the cost of a Public University Hospital. In order to examine that, financial and operating data in quarterly basis of a Public University Hospital were taken into account, for the period 2005 – 2009.

Initially, various tests were carried out (e.g. Test of Normality, coefficient determinations, ANOVA etc.) and some factors that correlate were excluded from the survey. After that, we found those variables that are statistically significant and contribute to the impact of the hospital's cost. In addition the OLS method was held, with depended variables each cost category and the total cost as well.

The results of the various tests indicate that from all the variables, those of the cost of the laboratory reagents, the cost of cleaning and the cost of the electromechanical equipment cannot interpret the linear models.

Regarding to all the other cost categories, the results of the tests show that an increase/decrease in the number of beds, lead to an increase/decrease in costs for consumables by 60% and to an increase/decrease by 51.1% to the other cost. Additionally, an increase/decrease in the number of beds leads to an increase/decrease of the cost of salary by 73.7% and an increase/decrease in patient days leads to an increase/decrease in the cost of orthopedic materials by 62.5%.

Moreover, if all the other factors are constant, an increase/decrease in the average length of stay leads to an increase/decrease in the cost of orthopedic materials by 70.2% and an increase/decrease in the average length of stay, results in an increase/decrease by 47.2% in the cost of third party

services. In conclusion, the research show that an increase/decrease in the number of beds leads to an increase/decrease of the total cost by 66.3%.

## REFERENCES

- [1] Arnold, P.J., Oakes, L.S. (1995). Hospitals in the United States: A study of the entity assumption in accounting, *Critical Perspectives on Accounting*, 6: 105 – 123.
- [2] Bartlett, W., Le Grand, J. (1992). The impact of NHS reforms on hospital costs, *Studies in Decentralization and Quasi – Markets*, No.8, University of Bristol, SAUS.
- [3] Becker, S.W., Neuheuser, D. (1975). *The Efficient Organization*, North Holland.
- [4] Bellas, A., Thanasas, G.L., Giotopoulos, I. (2009). Health Services in Greece: An Approach to their Operational Cost, *ICOAE 2009: International Conference on Applied Economics*, Kastoria (Greece), May 27 – 30.
- [5] Berry, R.E. (1974). Cost and efficiency in the production of hospital services, *Milbank Memorial Fund Quarterly*, 52 (3): 291 – 313.
- [6] Bowe, C. (1977). *Industrial Efficiency and the role of Government*, H.M.S.O., London.
- [7] Brooks, R. (1971). A cost benefit analysis of the treatment to rheumatic diseases, *Applied Economics*, 3 (1): 35 – 53.
- [8] Cooper, D.J., Sherer, M.J. (1984). The Value of Corporate Accounting Reports, *Accounting Organization and Society*, 9: 297 – 332.
- [9] Danzon, P. M. (1982). Hospital “Profits”: The effects of reimbursement policies, *Journal of Health Economics*, 1: 29 – 52.
- [10] Ellwood, S. (1996). Full cost pricing rules within the National Health Service internal market – accounting choices and the achievement of productive efficiency, *Management Accounting Research*, 7: 25 – 51.
- [11] Evans, J., Hwang, Y., Nagarajan, N. (1995). Physicians' response to length – of – stay profiling, *Medical Care*, 33(11): 1106 – 1119.
- [12] Fried, B., Deber, R., Leatt, P. (1987). Corporization and deprivation of health services in Canada, *International Journal of Health Services*, 17 (4): 567 – 584.
- [13] Gaitanides, M. (1979). Cost accounting for hospital planning, *Management International Review*, 19 (2): 99 – 108.
- [14] Ginsburg, P.B. (1972). Resource allocation in the hospital industry: The role of capital financing, *Society Security Bulletin*, 35 (10): 20 – 30.
- [15] Haber, S. (1964). *Efficiency and Uplift*, University of Chicago Press.
- [16] Ham, C., Robison, R., Benzeval, M. (1990). *Health Check: Health reforms in an international context*, Kings Fund Institute, London.

- [17] Haslam, C. (2005). The NHS Plan: Accounting for investment and reform in twenty acute hospital trusts in England (1998 – 2003), *Accounting Forum*, 29: 437 – 453.
- [18] Heidenheimer, A. (1980). Conflict and compromises between professional and bureaucratic health interests 1947 – 1972, in Heidenheimer, A. and Elvander, N. (eds.), *The Shaping of the Swedish Health System*, Croom Helm, London.
- [19] Hood, C. (1995). The “New Public Management” in the 1980’s: Variations on a theme, *Accounting, Organization and Societies*, 20: 93 – 109.
- [20] Hopwood, A.G. (1987). The archaeology of accounting systems, *Accounting Organization and Society*, 12: 207 – 234.
- [21] Hsuhui, C., Wen – Jing, C., Somnath, D., Shu – Hsing, Li. (2004). Health care regulation and the operating efficiency of hospitals: Evidence from Taiwan, *Journal of Accounting and Public Policy*, 23: 483 – 510.
- [22] Johannesson, M., Jonsson, B. (1991). Economic evaluation in health care: Is there a role for cost – benefit analysis?, *Health Policy*, 17: 1 – 23.
- [23] Jones, M.J., Mellett, H.J. (2007). Determinants of changes in accounting practices: Accounting and the UK Health Service, *Critical Perspectives on Accounting*, 18: 91 – 121.
- [24] Levaggi, R. (2005). Hospital Health Care: Pricing and Quality Control in a Spatial Model with Asymmetry of Information, *International Journal of Health Care Finance and Economics*, 5, 327-349.
- [25] McKinlay, J., Arches, J. (1985). Towards the proletarianization of physicians, *International Journal of Health Services*, 5 (2): 161 – 195.
- [26] Ossege, C. (2012). Accountability – are we better off without it?, *Public Management Review*, 14 (5), 585-607.
- [27] Riska, E. (1988). The professional status of physicians in the Nordic countries, *Milbank Quarterly*, 66 (2): 133 – 147.
- [28] Scott, J.S. (1999). *Universal Health Care Revisited*. *Healthcare Financial Management*, 53 (6).
- [29] Sloan, F.A. (1982). Government and the regulation of hospital care, *The American Economic Review*, 72 (2): 196 – 201.
- [30] Thanasas, G.L. (2012). The cost structure of Greek hospitals: The effect of teaching impact factor in the operating cost of Greek University hospitals, PhD Thesis, University of Patras.
- [31] Tinker, T., Neimark, M. (1987). The role of annual reports in gender and class contradictions at General Motors: 1917 – 1976, *Accounting Organization and Society*, 12: 71 – 88.
- [32] Venieris, G., Cohen, S., (2004). Accounting reform in Greek Universities: A slow moving progress, *Financial Accountability and Management*, 20 (2): 183 – 204.
- [33] Wagstaff, A. (1989). Econometric studies in health economics: A survey of the British literature, *Journal of Health Economics*, 8: 1 – 51.
- [34] Weil, T.P. (1992). A Universal Access Plan: a step toward National Health Insurance. *Hospital and Health Services Administration*, 37 (1): 37 – 51.
- [35] Willis, E. (1988). Doctoring in Australia: A view of the bicentenary, *Milbank quarterly*, 66 (2): 167 – 181.
- [36] Wu, Y.V. (2010). Hospital cost shifting revisited: new evidence from the balanced budget act of 1997, *International Journal of Health Care Finance and Economics*, 10, 61-83.