Does waiting times decrease or increase operational costs? Evidence from Portuguese Public Hospitals.

(versão final após defesa)

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Dissertação para obtenção do Grau de Mestre em

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Resumo

O Sistema Nacional de Saúde (SNS) português é composto por todas as entidades públicas que prestam serviços de saúde. Tem-se verificado um aumento sucessivo de gastos nos últimos anos devido a vários factores, o que tem gerado uma elevada incerteza quanto à evolução das despesas operacionais nos Hospitais Empresariais Públicos (EPE). Neste contexto de custos operacionais consideramos a problemática dos tempos de espera, quer nas consultas quer nas cirurgias hospitalares, pelo que o principal objetivo para a realização deste trabalho de investigação constitui no estudo do nexus entre custos e tempos de espera, entre os diferentes hospitais. Pretendemos também avaliar empiricamente se esta relação apresenta um comportamento em forma de U. Nesta investigação analisámos 38 EPE considerados no SNS, numa análise temporal mensal durante o período de Janeiro de 2015 a Dezembro de 2019, divindo o painel em 5 grupos. Aplicámos o modelo painel Autoregressivo com Desfasamentos Distribuidos (ARDL). Os resultados deste estudo salientam que os tempos de espera mais longos têm efeitos significativos nos custos hospitalares e sugerem e que tempos de espera mais longos não simplesmente aumentam as taxas de ausência enquanto os pacientes esperam pela consulta externa e ou cirurgia. Em vez disso, parece haver efeitos significativos de longo prazo que duram além do período de espera de curto prazo.

Palavras-chave

SNS; Portugal; Tempos de Espera; Custos Operacionais; ARDL; Hospitais Públicos Empresariais;

Resumo alargado

O Sistema Nacional de Saúde (SNS) português, em termos de fundação histórica reporta ao ano de 1979, com a Lei n.º 56/79, de 15 de setembro, cuja estrutura foi composta por todas as entidades públicas que prestam serviços de saúde primários e secundários sem fins lucrativos. Nesta fundação, a Administração Central do Sistema de Saúde (ACSS) ficou responsável por planear e coordenar os recursos financeiros do SNS, recursos estes tributados aos contribuintes.

A afetação e alocação de recursos pelo provedor é prospectiva e depende de um conjunto de recursos, por exemplo, dimensão e gama dos serviços prestados, complexidade dos pacientes atendidos, eficiência e eficácia do custo-benefício gerado no volume de serviços prestados, entre outros; pelo que, podemos considerar em termos gerais que o SNS português deva garantir em simultâneo um equilíbrio financeiro sustentável, principalmente nos hospitais que consomem mais da metade das despesas públicas de saúde. No entanto, esses gastos têm aumentado nos últimos anos devido às mudanças demográficas, evolução da tecnologia e avanços na saúde, introdução de tecnologias de informação que levam ao consumismo em saúde e aumento do rendimento em todos os agentes económicos, incluindo o Estado.

Assim, a elevada incerteza quanto à evolução das despesas operacionais nos hospitais empresariais públicos Portugueses, são traduzidos nos custos com pessoal/profissionais de saúde, gastos com o fornecimento de materiais consumíveis, custos com medicamentos e outros custos de serviços externos.

Por um lado, neste contexto de custos operacionais consideramos a problemática dos tempos de espera, quer nas consultas quer nas cirurgias hospitalares, pelo que o estudo do nexus entre custos e os tempos de espera, constitui o principal objetivo para a realização deste trabalho de investigação. Por outro lado, consideramos a definição de quatro objetivos específicos a serem incluídos na relação entre custos operacionais e tempos de espera, que se enumeram: (i) Se existem impactes diferenciais dos tempos de espera na função custo hospitalar associados às variações sazonais e regionais e que afetam diretamente os processos internos de gestão de custos operacionais; (ii) Se o número de doentes saídos de internamento incluindo os internados pelas urgências hospitalares, alterando e modificando as consultas e as cirurgias programadas, induzem por tal efeito um ajuste e alteração nos tempos de espera; (iii) Se o comportamento dos custos operacionais aumentam versus diminuem com o tempo de espera, como consequência do maior versus menor excesso em

termos de capacidade; e (iv) Se os custos com os profissionais de saúde não devem serem analisados separadamente e isolados dos custos operacionais totais.

Em ambas proposições, pode haver um ponto em que tempos de espera mais altos aumentem os custos, o que pode ser devido aos custos mais altos da gestão dos tempos de espera. Por exemplo, quando os tempos de espera são muito longos, pode haver um aumento nos recursos necessários induzindo um aumento nos custos do tratamento e no tempo de permanência hospitalar e consequentemente um aumento nas taxas de incumprimento na realização de consultas e ou cirurgias programadas.

Existe, portanto, pelo menos teoricamente, um nível no tempo de espera que minimiza os custos totais de produção, pelo que acima desse nível, tempos de espera mais altos aumentam os custos operacionais hospitalares, tal como admitido no estudo de Siciliani et al. (2009), sendo este artigo a inspiração para o nosso trabalho de investigação.

No alinhamento destas considerações, propomos uma modelização económica para análise e avaliação da relação funcional em forma de U entre custos operacionais hospitalares e tempos de espera, considerando a formulação de duas equações: (i) Uma primeira equação em que estudamos a relação entre a elasticidade custos operacionais hospitalares e os seguintes determinantes: tempos de espera relativos às primeiras consultas e às cirurgias realizadas, respetivos resultados como sejam o número de primeiras consultas e o número de cirurgias realizadas, taxa de ocupação; (ii) Uma segunda equação custo, onde procuramos enfatizar em particular a relação entre a elasticidade custos com profissionais de saude relativamente aos tempos de espera relativos às primeiras consultas e às cirurgias realizadas, respetivos outcomes como sejam o número de primeiras consultas e o número de cirurgias realizadas, taxa de ocupação.

Em ambas as equações de custos incluimos na analise 38 Hospitais Publicos Empresariais considerados no SNS, numa análise temporal mensal durante o período de Janeiro 2015 até Dezembro 2019. Consideramos ainda na análise o painel dividido em 5 grupos de hospitais: Grupo B onde se incluem o Hospital Santa Maria Maior, CH Médio Ave, CH Póvoa de Varzim/Vila do Conde , Hospital Figueira da Foz, CH Médio Tejo, ULS de Castelo Branco, ULS Nordeste, ULS Guarda, ULS Litoral Alentejano; Grupo C onde se incluem: CH Tâmega e Sousa,CH Entre Douro e Vouga, CH Baixo Vouga, CH Cova da Beira, CH Leiria, CH Barreiro/Montijo, CH Setúbal, CH Santarém, Hospital Sra. da Oliveira, ULS Alto Minho, ULS Matosinhos, ULS Baixo Alentejo, ULS Norte Alentejano, Grupo D, onde se incluem CH Vila Nova Gaia/Espinho, CH Tras-os-Montes e Alto Douro, CH Tondela/Viseu, CH Garcia de

Horta, CH Fernando Fonseca, CH Espirito Santo, CH Universitário do Algarve, Grupo E, onde se inclue o CH Porto, CH. S.João, CH Coimbra, CH Lisboa Central, CH Lisboa Norte, CH Lisboa Ocidental e ainda o Grupo F formado pelo IPO Porto, IPO Coimbra e IPO Lisboa, clusters estes formados seguindo o critério definido pela Administração Central do Sistema de Saúde (ACSS).

Para dar respostas aos objetivos específicos pretendidos e descritos acima, socorremos de opções de avaliação quantitativa com várias abordagens econométricas, no qual o recurso às estimações das relações de cointegração se justifica, utilizando um Modelo painel Autoregressivo com Desfasamentos Distribuídos. Especificamente neste estudo de investigação, para validar as relações de curto e longo prazo propostas entre as variáveis consideradas na formulação das duas propostas teóricas nas equações custos, realizamos a sua estimação com recursos aos estimadores: PMG (Pooled Mean Group), proposto por Pesaran, Shin & Smith (1999, 2001), MG (Mean Group), proposto por Pesaran & Smith (1995) e DFE (Dynamic Fixed Effect), uma vez que estes métodos apresentam um melhor desempenho do que o estimador OLS (Ordinary Least Squares) por efetuarem uma correção à endogeneidade e à correlação amostral.

Contudo caso os testes de cointegração apontem para a não existência de cointegração nas relações custos propostas, seguindo as propostas de Wang & Na Wu (2012), que recorreram do comando Stata cointreg para a estimação de três tipos de modelos de regressão de cointegração com base na covariância de longo prazo e usando os estimadores de mínimos quadrados ordinários totalmente modificados (FMOLS), propostos por Phillips and Hansen (1990), estimadores de mínimos quadrados ordinários dinâmicos (DOLS) propostos por Saikkonen (1992), Stock & Watson (1993) e métodos de regressão de cointegração canônica (CCR), propostos por Park(1992).

Abstract

The Portuguese National Health System (SNS) is composed of all public entities offering health services. There has been a successive increase in expenditure in recent years due to a variety of factors which have contributed to a high degree of uncertainty about the evolution of operating costs in Public Business Hospitals (EPE). In this problem of operating costs, we take into account the problem of waiting times, in both consultations and hospital surgeries. The main objective of this research is, therefore, to study the nexus between costs and waiting times between hospitals. Further, we also empirically assess whether this relationship presents a U-shaped behaviour. In this study, we have included a total of 38 Hospitals considered in the SNS, whose monthly period of analysis comprises January 2015 through December 2019 and divides the panel into five groups. The Autoregressive Distributed Lag panel model (ARDL) was used. Thus, the results of this study highlight that longer waiting times have significant effects on hospital costs and suggest that longer waiting times do not merely increase absence rates. At the same time, patients wait for external consultation and/or surgery. Instead, there appear to be significant long-run effects that last beyond the short-run waiting period.

Keywords

SNS; Portugal; Waiting Times; Operational Costs; ARDL; Public Business Hospitals.

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List of Acronyms

SNS	Sistema Nacional de Saúde
ACSS	Administração Central do Sistema de Saúde
NHS	National Health Service
EPE	Hospitais Empresariais Públicos

1. Introduction

In historical terms, the Establishment of the Portuguese National Health System (SNS) refers to the year 1979, Law No. 56/79 of 15 September, the framework of which is provided by all public entities offering primary and secondary health non-profit services. Regarding the SNS, the reforms are associated with major and well-founded changes to the hospital management model. This includes corporatization, as indicated by Ferreira & Marques (2015), the vertical and horizontal integration of public health providers, as referred to by Azevedo & Mateus (2014), and the formation of public-private partnerships, as pointed out by Cruz & Marques (2013), must be noted.

Thus, we can maintain that the majority of public hospitals in Portugal are now distributed horizontally (hospital centres), and only a few remain as single entities or have been merged into a vertical merger that establishes local health units. All of these reforms were planned, as Ferreira et al. (2017) argued, to reduce costs by leveraging possible economies of scale and scope and mitigating the expenditure of public funds, while health care providers are required to increase their cost-effectiveness. However, these expenses have increased in recent years due to demographic changes, technological innovations and improvements in health, the implementation of information technology that contributes to consumerism in health and increased profits for all economic operators, including the State.

In the current context, the Portuguese economy has a high budget deficit, worsening its dependence on external financing. Therefore, issues such as the economic and financial sustainability of the National Health Service imply that all efforts aimed to contain expenditure and contribute to the efficiency and effectiveness of the health system must be taken into account.

High uncertainty regarding the evolution of expenses in public business hospitals is associated with several factors: (i) increasing current expenditures for health professionals; (ii) overtime costs; and (iii) expenditure on supplies of consumables and external services, with a strong emphasis on medication expenses. On the other hand, if we add to the problem, the general increase in waiting times, both in consultations and hospital surgeries, this results in the deterioration of the patients' health status and prolongs the suffering and consequently loses usefulness.

Health care systems in Portugal use waiting times as a measure to ration access to health care, often generating excess demand. In order to manage this situation, it is necessary to use regulatory and/or market mechanisms that allow managing the demand for this care, such as the introduction of a price or value, since the resources are limited and insufficient to provide immediate medical treatment to all users of health services. Such mechanisms, as referred to in the consulted literature, among others, are referred to a price or value, which may be monetary or not, as is the case of waiting times. The impacts of waiting times on public hospitals occur either seasonally or regionally and differently depending on internal management processes.

For Sharma et al. (2013), in both consultations and surgeries, there are many cases with different medical intervention priorities that are frequently resolved by hospital emergencies, altering and modifying consultations and surgery programs, resulting in a change in waiting times. As a result, hospital costs increase versus decrease with waiting time, as a consequence of higher versus lower excess in terms of capacity. Even so, as suggested by Siciliani, Stanciole & Jacobs (2009), there may be a point where higher waiting times increase costs, which may be due to higher waiting list management costs. For example, when waiting times are very long, there may be an increase in the necessary resources, inducing an increase in treatment costs and hospital stay and, consequently, an increase in the rate of non-compliance during consultations and or scheduled surgeries. There is, therefore, at least theoretically, a level of waiting time which minimizes total production costs. Above that level, higher waiting times increase hospital operating costs.

As a general objective, the study of the relationship between waiting times and operating costs will now be enumerated. Further, we also empirically assess whether this relationship presents a U-shaped behaviour. It is reasonable to assume, as postulated in the literature, that waiting times reduce costs for low levels of waiting time while waiting times increase operating costs for high levels of waiting time. However, if the demand for consultation and surgery services is stochastic, as signalled by Iversen (1993, 1997), Goddard et al. (1995); Olivella (2003), Siciliani et al. (2009), Sharma et al. (2013), among others, it can be admitted that the long waiting times reduce the probability of the hospital organization having idle capacity. Therefore, it reduces costs because the waiting times allow more efficient use of hospital equipment and the consequent impact on the occupancy rate. These assumptions lead us to add to the postulated U-list the inclusion of the occupancy rate and the respective outputs, which will have an impact on the proposed cost function.

For a better understanding of the problem defined in this study's overall objective, we consider it important to identify the four realistic targets to be included in the relationship between the operating costs and the waiting times, which are enumerated: (i) Whether there are differential impacts of waiting times on the hospital cost function associated with seasonal and regional variations and directly affecting internal operational cost management processes; (ii) If consultations and surgeries are often resolved by hospital emergencies, altering and modifying consultation and surgery programs, leading to such alteration in waiting times; (iii) If operating cost behaviour increases versus decreases with waiting time, as a result of higher versus lower excess capacity; and (iv) If the costs to health professionals are not to be analyzed separately from the total operational costs.

The purpose of this thesis is to estimate empirically in a 1st equation the elasticity of hospital operating costs (including costs with healthcare professionals) concerning the following determinants: waiting times, outputs (1st consultations and surgeries performed) and occupancy rate; in a 2nd cost equation, we try to estimate the elasticity of costs with health professionals with the waiting times, outputs (1st consultations and surgeries performed) and occupancy rate.

In both cost equations, we have included a total of 38 Hospitals considered in the SNS, whose monthly period of analysis comprises January 2015 through December 2019. Regarding the regional inequalities inherent in the study, we complement the analysis by disaggregating the panel into four groups of hospitals (Group B, Group C, Group D and Group E, according to the criteria[1] defined in the Administrative Central Agency of Portugal's National Health Service - ACSS).

Following economic theory present in the literature review and the two functions explained above, we propose the use of models of cointegration. Given that all variables included in the cost function modelling present a behaviour characterized by trends and seasonal variations there are some cyclical variations and irregular fluctuations that should not be neglected at either the cross-sectional level or at the time series level. This type of variation is present when the series exhibits continuous growth or decline in successive periods (months). In these situations, a set of specific procedures is necessary to assess the possibility of long-run movements between the variables (cointegration hypothesis). Those procedures include the assessment in the order of integration of the panel's variables and to confirm the stationarity of the panel residuals.

[1] Hospital entities are grouped into financing groups, given their heterogeneous type of services, in order to approximate the price charged to the different costs incurred by each institution.

The remaining dissertation is structured as follows: Section 2 provides a contextual setting, including a brief overview of changes of the rates of total health operational costs, cost of a health professional, both the waiting times and changes of the rate of occupancy of public hospitals; Section 3 covers the literature review; Section 4 presents the data collected and describes the equations of costs models and econometric method selected; Section 5 reveals the preliminary analysis of the data and contains the results. Section 6 reports the discussion; finally in Section 7 the conclusions and policy implications are presented.

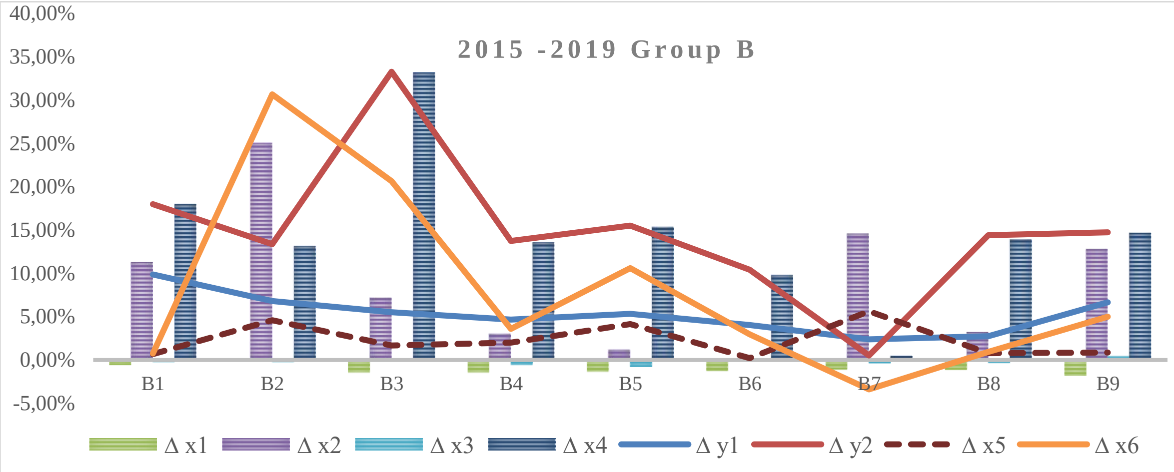
2. Contextual setting

The Portuguese SNS must provide people with universal, equitable and trend-free healthcare services, delivered within the time limits of the maximum guaranteed response time, (Decree-Law No. 11/93 of January 15 of the Ministry of Health, 1993: 130). However, certain co-payments have been implemented in the system to minimize and rationalize unnecessary demand for health care services. The capacity effect, the impact of the number of trained personnel and the influence of other hospital resources/facilities are reduced, and the health services offered are constrained. This result in an increase in waiting lists and waiting times, which also affects all external appointments and planned surgeries.

In the context of the objectives set out in the introduction section, we will then, based on figure 1 and Table A1 in the appendix, examine the actions of the rate of change considered in the study of the relationship between overall operating costs ($\Delta y1$) versus professional health staff costs ($\Delta y2$), and waiting times for external consultations ($\Delta x5$), and surgeries ($\Delta x6$), respectively in public hospitals (belong to the State Business Sector), by groups. Within the same 5-year time period, 2015-2019, we will analyze the behaviour of the other variables included in the same econometric relationship, i.e. rate of change of the consultations ($\Delta x1$), and surgeries ($\Delta x2$), the capability impact of the equipment ($\Delta x3$), and also the number of patients discharged from hospital ($\Delta x4$).

Thus, in Group B of our sample of public hospitals, the greatest increases in the rate of change in Total Operating Costs were seen in CH Médio Ave, CH Póvoa do Varzim and ULS Litoral Alentejano. In contrast, the greatest variations in Costs with Health Professionals were seen in Hospital Santa Maria Maior, CH Médio Ave and Hospital Figueira da Foz, so from the combination of these same results emerges CH Médio Ave with high rates of change in the two cost quantities.

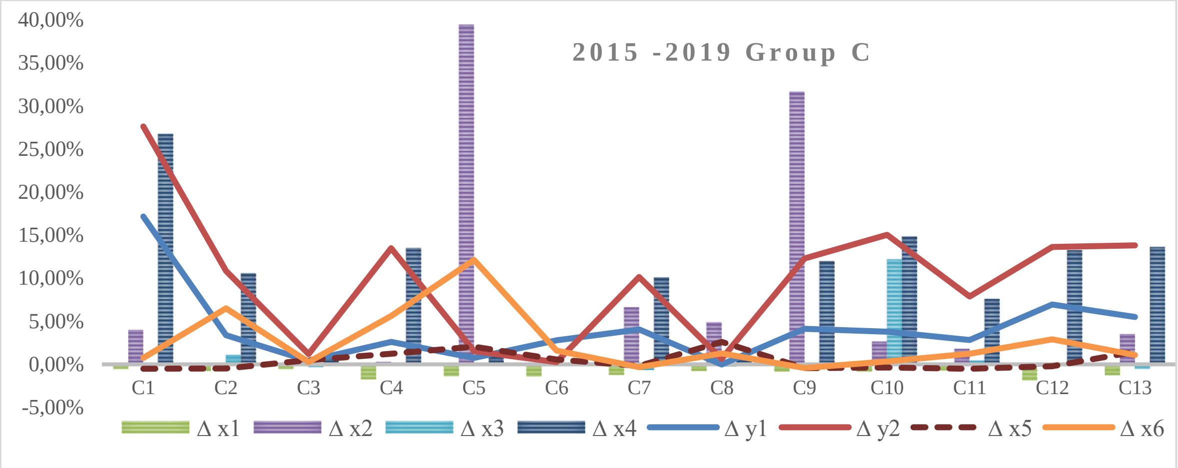
It should also be noted that the largest rise in the rate of change in waiting times was seen in ULS Castelo Branco, CH Póvoa do Varzim and Hospital Figueira da Foz, and related to waiting times in consultations, while CH Póvoa do Varzim, Hospital Santa Maria Maior and Hospital Figueira da Foz have the highest variations in waiting times for surgery. Therefore, we can verify that the increasing high operating costs and professional health costs in CH Póvoa do Varzim and Hospital Figueira da Foz are correlated with growing variations in waiting times. On the other hand, the largest reductions in waiting rates for surgeries and waiting times for consultations occur respectively in hospitals ULS Castelo Branco and CH Médio Tejo, which confirms, for these two hospitals, that low operating costs and costs with healthcare professionals are correlated with low waiting rates, evidence that now leads us to deal with the specific issues described, the behaviour of the U-shaped curve, between Total Operating Costs, Costs with Healthcare Professionals and Waiting Times, for this specific group of public hospitals.



Note: B1-CH Médio Ave; B2- CH Póvoa do Varzim; B3-Hospital Santa Maria Maior; B4-ULS Nordeste; B5-Hospital Figueira da Foz; B6-ULS Guarda; B7-ULS Castelo Branco; B8-CH Médio Tejo; B9-ULS Litoral Alentejano

Figure 1. Relationship between group B hospitals and the variables under study

Concerning the various outcomes that influence hospital costs, we found that the rate of change in surgeries varies inversely with the rate of change in consultations for all hospitals in the sample; in turn, the rate of change in installed capacity has positive magnitudes much higher than those seen in the rate of change in the number of patients discharged from hospital in all hospitals except hospital B7, in which there is an opposite behaviour.

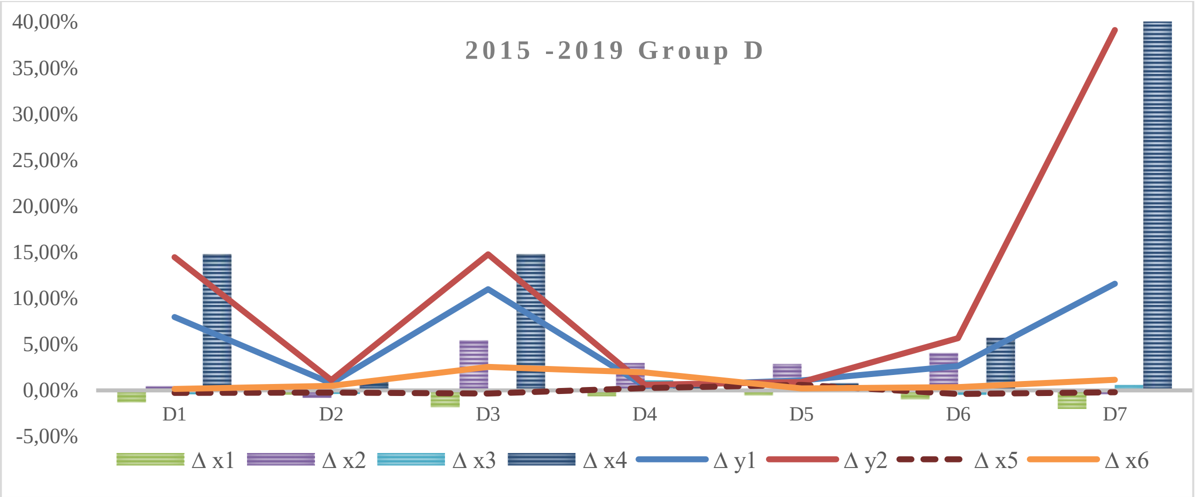


Note: C1-CH Douro e Vouga, C2-CH Tâmega e Sousa, C3-Hospital Senhora da Oliveira, C4-ULS Matosinhos, C5-ULS Alto Minho, C6-CH Leiria, C7-CH Baixo Vouga, C8-CH Cova da Beira, C9-CH Barreiro/Montijo, C10-CH Setúbal, C11-Hospital de Santarém, C12-ULS Baixo Alentejo, C13-ULS Norte Alentejano

Figure 2. Relationship between group C hospitals and the variables under study

We may verify that the rate of change in surgery in hospitals referring to Group C varies inversely with the rate of change in the consultations. For Group C in the sample currently under investigation, the sharpest increases in the rate of change in Total Operation Costs were verified in Hospitals C1, C12 and C13, but it was in hospital C1 that the highest rate was observed by far. While the most significant increases in the rate of change in Professional Health Staff Costs were seen in hospitals C1, C10, C13, C12 and C4, also in this type of costs we can see that it was hospital C1 that had the highest value by a large amount. So, when we join these two results from the dependents variables, we can conclude that it was in hospitals C1 and C13 that the highest rates of variation of the two types of costs were noted. The rate of change in the number of discharge from hospital is greater than the occupancy rate. When we analyse the variation rate of Waiting Times for External Consultations it was verified that hospitals C8 and C5 had the highest, but, on the other hand, it was the hospitals C1 and C11 that registered the lowest values (negative rates) which means a reduction of the waiting time for external consultations.

In comparison, the highest variation rate for Waiting Time for Surgeries was verified in hospitals C5, C2 and C4. Therefore, we can conclude that it was hospital C5 that observed the highest variations in waiting time. When analysing the graph, we can see that in hospitals C3, C6 and C8 the costs and waiting time are correlated (when the costs are low, the waiting time is too). We also find that professional health costs are directly impacted by the number of patients discharged from the hospital.

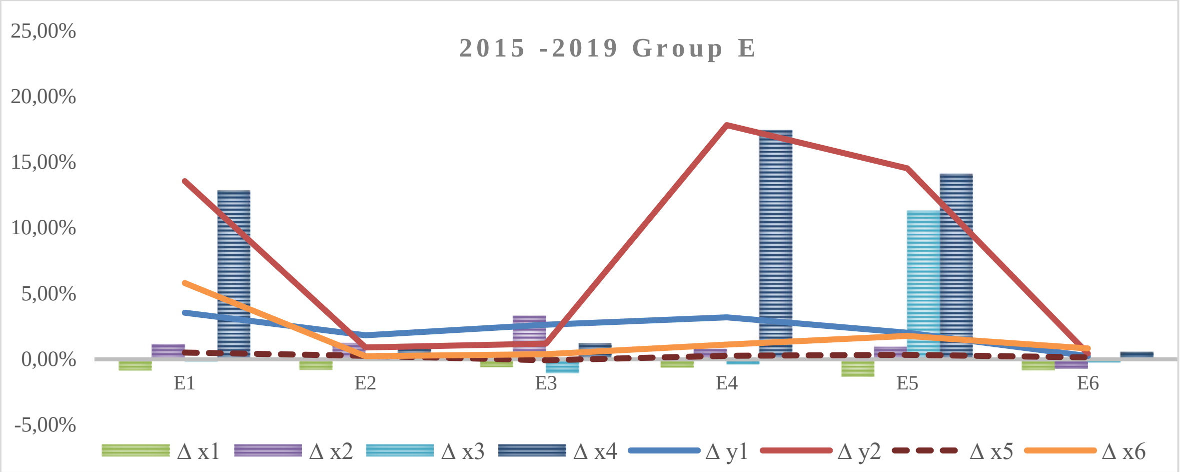


Note: D1-CH Trás-os-Montes e Alto Douro, D2- Vila Nova de Gaia/Espinho, D3-CH Tondela/Viseu, D4-Hospital Fernando Fonseca, D5- Hospital Garcia de Horta, D6-Hospital Espírito Santo de Èvora, D7-CH Universitário do Algarve

Figure 3. Relationship between group D hospitals and the variables under study

In Group D, we noticed that the rate of change in surgery and the rate of change in consultations are inversely related, as has already been observed in Groups B and C. The rate of change in the number of patients discharged from hospital has positive amplitudes higher than those recorded in the occupancy rate. It was in hospital D7 and D3 that the highest rate of change in Operating Costs was observed. Meanwhile, it was in hospitals D7, D3 and D1 that the sharpest rate of change related to Professional Health Staff Costs was verified, taking into consideration that hospital D7 had a substantial increase in the cost related to health staff. Therefore, it can be noted that hospital D7 and D3 observed the highest rates of any costs.

Meanwhile, the rate of change in the percentage of waiting times for surgery is always higher than the rate of change in the percentage of waiting times for external consultations, except for hospital D5. It was in hospital D5 that the largest rise in the rate of change in Waiting Time for External Consultation was observed, taking note that in this group one trend of diminution of the waiting time was verified. When the analyses focus on the Waiting Time for Surgeries, that trend disappears. It was in hospitals D3 and D4 that the highest rates in waiting times for surgeries were verified. So, in this group of hospitals, it is possible to conclude that only in hospital D3 waiting times for surgeries increase with the rise of the two types of costs, which means that in this hospital these three components are correlated. We also found that professional health costs are strongly affected by the number of patients discharged from the hospital.



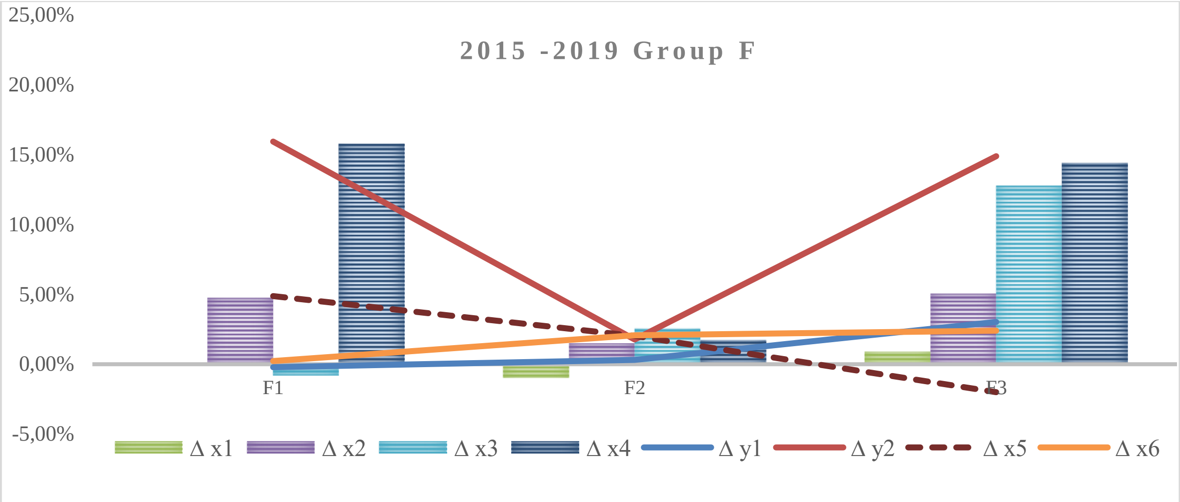
Note: E1-CH São João; E2-CH Porto; E3-CH Universitário de Coimbra; E4-CH Lisboa Ocidental; E5-CH Lisboa Central; E6-CH Lisboa Norte

Figure 4. Relationship between group E hospitals and the variables under study

Looking now at Group E, it is possible to see that hospital E1 and E4 present the highest rate of change in Operating Costs, while the greatest rate of change in Professional Health Staff Costs was seen in hospitals E4, E5 and E1. When joining these two results, it is obvious that it was in hospitals E1 and E4 that the highest costs were seen regardless of the type. We observe that the rate of change in surgery varies inversely with the rate of change in consultation. The rate of change in the number of people discharged from a hospital is greater than the rate of occupancy in all hospitals. The rate of change in the percentage of first consultations in Adequate Time is relatively stable, there is no major difference in values between hospitals, and the E3 hospital is the only one to display negative results.

We notice that personnel expenses are directly impacted by the number of patients discharged from the hospital.

Regarding the Time of Waiting for External Consultations, it was in hospital E1 that the sharpest increase in the rate of change was verified. The same conclusion can be taken when referring to the Waiting Time for Surgeries. Therefore, it is possible to assume that the U-shaped curve was verified to hospital E1 (the costs and the Waiting Times are correlated).



Note: Group F: F1-IPO Porto, F2-IPO Coimbra, F3-IPO Lisboa

Figure 5. Relationship between group F hospitals and the variables under study

Finally, in Group F of our sample, the biggest increase in the rate of change in Operating Costs was seen in hospital F3. Meanwhile, for hospital F1, a decrease was verified. We noted that the change rate of surgery varies inversely with the change rate of consultation. The rate of change in the number of patients discharged from the hospital is substantially higher than the rate of occupancy in hospital F1. Nevertheless, it remains higher, but with a smaller difference in hospital F3. On the other hand, for hospital F2, the occupancy rate is higher than the rate of change in the number of patients discharged from the hospital.

In accordance with the other groups, we believe that personnel expenses are directly impacted by the number of patients discharged from the hospital. Concerning the Professional Health Staff Costs it was in hospitals F1 and F3 that the greatest increase was seen. So, it was hospital F3 that registered the highest costs. Analysing the Waiting Time for External Consultations, it is possible to see that the highest rate of change of consultation occurred at hospital F1.

Regarding the Waiting Time for Surgeries, it was in hospitals F3 and F2 that the biggest rates of change occurred. We evaluated that the rate of change in the percentage of waiting times of surgery and the rate of change in the percentage of waiting times of external consultations spread in opposite directions. Concluding, it is possible to see that in this group, there is only a correlation to hospital F3 between the two types of costs and the waiting time for surgeries.

3. Literature Review

3.1. Hospital Occupancy Rate and Hospital Outcomes

The National Health System policymakers articulated with hospital managers and other health units are facing the problem of optimizing technical and technological efficiency in managing tangible and intangible resources, including waiting lists for medical appointments and surgery. According to the literature focused on this problem, we highlight the studies by Romley et al. (2011), Stukel et al. (2012), Romley & Sood (2013), Sheetz et al. (2014). These studies suggest, on the one hand, that treatments and surgeries conducted by hospitals with higher intensity of patient frequency are correlated with better results. On the other hand, the findings revealed the presence of lower mortality rates and lower readmission rates by the hospitals in which patients are handled under the maximum capacity condition. However, research carried out by Doyle et al. (2015), and Doyle et al. (2017), indicate that non-serious intensive care is especially advantageous at hospitalization level. Nonetheless, under the restricted condition of hospital capability, whereby facilities with high rates of non-acute care usage expose poorer outcomes and therefore lower quality of service provided.

The contributions of several studies are also reinforced by Stukel et al. (2005), Sirovich et al. (2006), Chandra & Staiger (2007), Wennberg (2010), and Doyle (2011). They evaluate the association effect between the intensity of health care in the regions and larger hospitals presenting areas with treatment intensity and surgeries performed. Results indicate that these outcomes are no better than those obtained by providers in restrictive facilities that treat patients with less intensity. There is also no consensus on the empirical evidence found in the literature review. Regardless of the effects of improving or not improving primary and/or secondary health care, including those conducted under high intensity, taking into account differences both at the regional level and at the hospital provider level.

If we include in the issue the short-run and long-run feed-back effects between installed capacity and these hospital outcomes, there are different interpretations of the results. As a result, Kleiner (2019) recently analyzed the long-run relationship between the intensity of the health care/services offered and the constraints on installed capacity, that is, the allocation of resources in hospitals. The findings of the same study show that hospital services with more intensive procedures for delivering health care decrease the rate of readmission of patients, ensuring high-quality health care.

In the short-run, however, unexpected shocks in demand can occur, namely in need of the patient's hospitalization. Freedman (2016), Evans & Kim (2006), Baker et al. (2004), among others, suggest the potential need to relocate patients according to available hospital facilities and/or guarantee reserve capacity. Such decisions depend on the availability of short-run hospitalization (number of beds available depending on the number of patients discharged from the hospital). In turn, authors such as Brennan et al. (2000), Yamane (2003), Crosse (2009), Handel & McConnell (2009), Hsia et al. (2012), Shen & Hsia (2015), among others, argued about the importance of referral to outpatient clinics (health centres) due to hospital capacity restrictions verified during periods when the maximum capacity or overcrowding of users or patients is undergoing treatment and/or hospitalization, i.e. subject to capacity restrictions.

3.2 Waiting Times and Hospital Costs

In the literature review, Cullis & Propper (2000), waiting is necessary when resources are insufficient to provide immediate medical treatment. "Optimum" waiting time occurs when the NHS provides a socially optimal resource allocation and when patients are ordered in the list in an optimum way. Even if an optimal waiting period is not reached, however, it remains possible to be cost-effective in handling those waiting.

Consumers of tax-financed systems do not pay the full price of their healthcare at the point of demand, so unless capacity exceeds demand when the price is about zero, demand must be restricted by means other than price. The most commonly used means of limiting demand in these systems are the explicit waiting lists.

The existence of waiting lists raises the issue of time as a health-care price from a consumer perspective. However, the fact that waiting lists are a feature of health-care systems where the state is the financial mediator means that waiting lists are essential for the political economy. Economists concluded that, in the case of excess demand, waiting times serve as non-monetary costs to keep demand and the availability of health care in balance. Lindsay & Feigenbaum (1984); and Martin & Smith (1999).

A longer wait on the demand side will cause some patients to go to private service at a premium or pursue a less costly pharmaceutical treatment, thereby lowering the demand for public surgery. On the supply side, waiting times may encourage hospitals to work harder to offer more care if doctors are altruistic or if there are sanctions in place for hospitals that surpass acceptable guarantees of waiting time (see Martin & Smith, 1999; and Propper, Burgess & Gossage, 2008; Riganti et al., 2017).

Iversen (1993) indicates that waiting times are at a stage at which higher waiting times raise costs. For high waiting times, the cost savings resulting from a marginal increase in waiting become negligible in terms of the lower likelihood of idle capacity. On the other hand, a small increase in waiting may increase the costs of maintaining the waiting list for high waiting times (Siciliani et al., 2009).

There are many facets of the potential costs associated with longer wait times, at a minimum, waiting imposes on patients seeking treatment, extending welfare costs and the period, while the patient remains debilitated. Patients are often unable to work while waiting and frequently use their conditions to obtain benefits. This materializes in short-run effects on productivity and government finances. Longer waiting times may also have implications that extend beyond the treatment and (usual) recovery period for a patient. If long waiting times reduces the effectiveness of treatment, this may result in the deterioration of the patient's health while awaiting. More prolonged waiting can have long-run health implications for the patients affected (Malmivaara et al., 1995), decrease their future efficiency and increase their potential use of sickness-related benefits and healthcare services, (Godøy et al., 2019). If demand is stochastic, waiting times can reduce idle power, leading to more efficient resource utilization (Iversen, 1993, 1997; Barros & Olivella, 2005).

Hospital costs are lowered by waiting times due to lower excess space. However, as Iversen (1993) indicated, there may be a point where longer waiting times increase costs, which may be due to the higher costs of handling the waiting list. (Joskow, 1980; Friedman & Pauly, 1981; Mulligan, 1985; Joskow, 1985; Gaynor & Anderson, 1995; Keeler & Ying, 1996; McGuire & Hughes, 2003) argue that unpredictable demand matters and raises prices. In other words, higher volatility, calculated by higher unanticipated demand, results in higher hospital costs. One can quantify unexpected demand as the difference between actual demand and expected demand, where demand is defined as an auto-regressive mechanism (Keeler & Ying, 1996; McGuire & Hughes, 2003).

If the effect of waiting time on costs is nonlinear in the specifications, then there is potentially a U-shaped relationship between hospital costs and waiting times (Siciliani, Stanciole, & Jacobs, 2009). If the relationship between waiting times and costs is U-shaped: waiting times minimize costs when waiting times are low, whereas waiting times increase costs when waiting times are high. Iversen (1993, 1997) claims that for short waiting times, as a result of lower overcapacity, longer waiting times minimize hospital costs. If the demand for healthcare is stochastic, higher waiting times increase the likelihood that the system will have unused resources and thereby reduce costs.

It seems essential to mention that the long-run effects between installed capacity and results (outcomes) are assured by the dynamics of constant short-run adjustments. So it will be important to analyze and differentiate the short-run and long-run influence of installed capacity on hospital outcomes, including costs, so in this research, we will pay attention to these differentiating effects in the short and long run

4. Data and Methodology

4.1. Data, specification of variables and proposition of hypotheses

The sample comprises 38 EPE (Public Business Entities) Hospitals of Portuguese SNS observed monthly from 2015 to 2019, generating a robust panel of 2280 observations. The use of annual data would mean a smaller number of observations. In contrast, the use of monthly data would include a much greater set of observations which would help to characterize the results of the sample more precisely.

To reduce the heterogeneity across hospitals, we have therefore excluded from our sample PPP Hospitals, psychiatric Hospitals and Hospitals run by Santa Casa da Misericórdia. We also excluded a few EPE Hospitals and Hospitals of the Public Administration Sector from missing data in the selected variables.

The data were obtained from benchmarking and transparency area of SNS (Portuguese National Health Service) in collaboration with ACSS (Central Administration of Health System). One of the variables is "Health Operational Costs" (OP Costs), measured in euros. Our measure of “waiting times” is the average wait for elective admissions. It measures the average number of days between the decision to be admitted to the waiting list and the actual admission for treatment. It includes in-patient admissions as well as daily-cases. We have waiting times for consultations (WTime1), and surgeries (WTime2).
We have as outputs, "first consultations" (OutC1) that represents the total number of first consultations provided and "surgical interventions" (OutC2) that portrays the total of outpatient surgical episodes. The variable "Health Human Resources Evaluation in Public Hospitals" corresponds to the number of employees with active employment contracts, such as doctors, nurses and other health professionals. The "occupancy rate" (Capac) variable shows the percentage relationship between the total number of days spent in the year and the capacity of the establishment. The “the number of patients discharged from hospital”

measures the production in hospital considering all patients who are discharged from hospital (Intern).

4.2. Cointegration in Panel Data

4.2.1 Panel Unit Root Tests

Unit root tests can be classified in the first and second generation (Matyas & Sevestre, 2008), where the main difference remains in the fact that the first generation considers independence between sections and the second generation allow some form of cross-sectional dependence. We begin the empirical analysis by applying panel unit root tests to check whether the variables are non-stationary or not. Root unit tests are frequently divided into two major categories: first-generation tests assuming cross-sectional independence (Levin et al., 2002; Im et al., 2003; Maddala & Wu, 1999; Choi, 2001); and second-generation tests which specifically allow for some form of cross-sectional dependence (Pesaran, 2007).

In order to verify, under the null hypothesis, whether all individual panel series contains a unit root, Levin et al. (2002) proposed the following panel-based ADF test, which restricts parameters by keeping them identical across sectional regions (see Eq (1)):

$$\Delta y_{it} = c_i + \rho_i \cdot y_{it-1} + \sum_{j=1}^{k} c_j + \rho_i \cdot y_{it-j} + \varepsilon_{it}, \quad (1)$$

where the periods are represented by $t = 1, 2, \ldots, T$, and the panel members are represented by $i = 1, 2, \ldots, N$. The groups are represented by $j = B, C, D, E, F$. The Levin-Lin-Chu test (LLC) establishes the null hypothesis of $\rho_i = \rho = 0$ for all i, against the alternative $\rho_1 = \rho_2 = \ldots = \rho < 0$ for all i, with $t_\rho = \hat{\rho} / s.e.(\hat{\rho})$ statistics based test. Nevertheless, one downside is that under both the null and alternative hypotheses, ρ is limited by being held identical across regions. Throughout this paper, five types of panel tests are calculated: LLC test (Levin et al., 2002), Breitung test (Breitung, 2000) and Hadri test (Hadri, 2000), assuming a common unit root, while the IPS test and the ADF-Fischer test assume a single unit root process throughout the cross-sections. The difference between Choi's test (2001) and Fisher's is the way that p-value is combined (Baltagi, 2005: 245).

4.2.2 Panel Cointegration Tests

Pedroni (2001; 2004), Kao & Chiang (2000), and Westerlund (2007) provided the reference, among others, for the panel approach to cointegration tests. Results relying on the homogeneous alternative hypothesis consist of pooled form estimates, which Pedroni (2001; 2004) calls statistics within-group. Test statistics are established, when considering the heterogeneous alternative hypothesis, through the estimated individual values for each panel unit *i,* which Pedroni (2001; 2004) calls between-groups estimators. Westerlund (2007) suggested four-panel tests of the non-cointegration null hypothesis that are based on structural rather than residual dynamics and therefore, do not enforce any common factor restrictions. They are intended to test the null hypothesis by inferring whether the term for error correction in a model for conditional error correction is equal to zero. If the null hypothesis of no error correction is rejected, then it also rejects the null hypothesis of no cointegration (Westerlund, 2007). Two tests are designed with an alternative hypothesis that the panel is cointegrated as a whole. While the other two test the alternative hypotheses that there is at least one individual series that is cointegrated. Each test can accommodate specific short-run dynamics of individual firms, including serially correlated error terms and non-strictly exogenous regressors, individual-specific intercept and trend terms, as well as individual-specific slope parameters. If a panel dataset follows an integrated order one, I(1), series, a panel cointegration model will be applied to decide whether or not there is a cointegration relationship. Persyn & Westerlund (2008) developed two group-mean tests G_r and G_α organised these group-mean tests into three steps. The first step is to estimate the equation by least squares for each unit i, which yields:

$$\Delta y_{it} = \delta_i' d_t + \alpha_i y_{i,t-1} + \lambda_i' x_{i,t-1} + \sum_{j=1}^{pi} \alpha_{ij} \Delta y_{i,t-j} + \sum_{j=-qi}^{pi} \gamma_{ij} \Delta x_{i,t-j} + \varepsilon_{it}, \quad (2)$$

where d_t contains the deterministic components; for simplicity, the K-dimensional vector x is a pure random walk such that Δx_{it} is independent of ε_{it}; and $\lambda_i' = -\alpha_i \beta_i'$. The parameters α_i determine the speed at which the system corrects back to the equilibrium relationship $y_{i,t-1}$- $\beta_i' x_{i,t-1}$ after a sudden shock. If $\alpha_i < 0$, then there is error correction, which implies that y_{it} and x_{it} are cointegrated; if $\alpha_i = 0$, then there is no error correction, and thus no cointegration (Persyn & Westerlund, 2008). The lag and lead orders, p_i and q_i are allowed to differ between individuals and ideally, can be determined by using a data-dependent rule. Having obtained $\hat{\varepsilon}_{it}$ and $\hat{\gamma}_{it}$, the next step is to compute: $\hat{u}_{it} = \sum_{j=-qi}^{pi} \hat{\gamma}_{ij} \Delta x_{i,t-j} + \hat{\varepsilon}_{it}$; and to calculate the group mean tests as follows: $G_r = \frac{1}{N} \sum_{i=1}^{N} \frac{\hat{\alpha}_i}{SE(\hat{\alpha}_i)}$; $G_\alpha = \frac{1}{N} \sum_{i=1}^{N} \frac{T\hat{\alpha}_i}{\hat{\alpha}_i(1)}$;

where $SE(\hat{\alpha}_i)$ is $\hat{\alpha}_i$'s the conventional standard error. Note that two of the statistics are based on surveying the error correction information along a cross-sectional dimension of the panel. The second step is to make use of $\Delta \tilde{y}_{it}$ and $\tilde{y}_{i,t-1}$ in estimating the common error-correction parameter and its standard error. In particular, Westerlund (2007) computed $\hat{\alpha} = \left(\sum_{i=1}^{N} \sum_{t=2}^{T} \tilde{\gamma}_{i,t-1}^{2} \right)^{-1} \sum_{i=1}^{N} \sum_{t=2}^{T} \frac{1}{\hat{\alpha}(1)} \tilde{\gamma}_{i,t-1}$; the standard error of $\hat{\alpha}$ is $SE(\hat{\alpha}) = \left((\hat{S}_N^2)^{-1} \sum_{i=1}^{N} \sum_{t=2}^{T} \tilde{\gamma}_{i,t-1}^{2} \right)^{-1/2}$.

Finally, the last step is to compute the panel statistics as $P_r, = \frac{\hat{\alpha}}{SE(\hat{\alpha})}$; $P_\alpha, = T\hat{\alpha}$.

4.2.3. Estimation of the cointegration vector

Upon both ensuring the non-stationarity of equation variables and the existence of cointegration between them, it is possible to conclude what deviations from the variables' long-run equilibrium affect the short-run dynamics. The answer to these deviations can be represented by the following reparametrization equation: $\Delta y_{it} = \phi_i (y_{i,t-1} - \theta_i' \cdot X_{it}) + \sum_{j=1}^{p-1} \lambda_{ij}^{*} \cdot \Delta y_{i,t-j} + \sum_{j=0}^{q-1} \delta_{ij}^{'*} \cdot \Delta X_{i,t-j} + \mu_i + \varepsilon_{it}$, in which $\phi_i = -(1 - \sum_{j=1}^{p} \lambda_{ij})$, $\theta_i = \sum_{j=0}^{q} \delta_{ij} / (1 - \sum_k \lambda_{ik})$, $\lambda_{ij}^{*} = -\sum_{m=j+1}^{p} \lambda_{im}$, with $j = 1, 2, ..., p-1$ and $\delta_{ij}^{'*} = -\sum_{m=j+1}^{q} \delta_{im}$, with $j = 1, 2, ..., q-1$. Particular attention will be paid in this analysis to the following two parameters: ϕ_i and θ_i, the adjustment speed from the error correction term and the long-run equilibrium relationship parameter vector. The term ϕ_i is expected to differ from zero, and this parameter is supposed to be substantially negative on the premise that the variables return to their long-run equilibrium. In this empirical study, the estimators listed will be presented and compared. However given the sample's nature, the PMG method (Pooled Mean Group), proposed by Pesaran, Shin & Smith (1999, 2001), seems to us a method that we can not discard for our modelling proposal, as there are grounds to believe that long-run relationships between included variables are similar among Total Group, or even between each individual group contrary to what is considered in MG method (Mean Group), suggested by Pesaran & Smith (1995).

In the case of Public Hospitals, this is due to the fact that all the observation units belong to the same Economy (Portugal), subjected to the same public and regulatory policies that are in effect at the SNS, influencing all Public Hospitals in the same way. At the same time, there are no reasons to suppose that the coefficient of the speed of adjustment or convergence to equilibrium is the same for all observation units, as is admitted in the DFE method (Dynamic Fixed Effect). Furthermore, in the context of a correction for the question of endogeneity and serial correlation of the regressors, the FMOLS (Full Modified Ordinary Least Squares) estimators, recommended by Pedroni (2000) will be used. The DOLS (Dynamic Ordinary Least Squares), suggested by Kao e Chiang (2000), which differs by the way the observations are combined is also used. However, following Pedroni (2000) guidelines, in which it is stated that on the one hand the Group-means estimators should have greater flexibility over the existence of heteroscedasticity in the cointegration vectors, and on the other hand, Group-means pose a better size distortion, whereby we will use this version for the FMOLS and DOLS estimators, respectively. The edges of FMOLS are valid endogeneity and serial correlation, as the PMG is asymptotic, eliminating the sample bias. However, two conditions are required, only one integrated vector, and the variables can not be co-integrated Narayan & Narayan (2005). According to Equation 3:

$$y_t = \sigma_0 + \sigma_1' X_t + \mu_t, \quad (3)$$

$with\ \ t = 1, 2, \ldots, n$. Where y_t is an I(1) variable and X_t is a $(kx1)$ vector of I(1) regressors, that are not co-integrated, Narayan & Narayan (2005).

Finally, the DOLS which corrects potential bias in the simultaneity between regressors. DOLS requires the regression of one of the I(1) variables on other I(1) variables, the I(0) variables, and lags and leads of the first difference of the I(1) variables. Dynamic OLS presumes a priori standardization in particular. DOLS can be estimated according to the equations: $\Delta X_t^1 = k_t^1$ and $X_t^2 = \phi_0 + \phi X_t^1 + k_t^1$, where $X_t' = [X_t^{1\prime} | X_t^{2\prime}]$, the dimension of X_t^1 and X_t^2 being $(p - r)x1$ and $(rx1)$, respectively. Error processes are considered to be stationary and by embedding both leads and lags of ΔX_t^1 in equation (8) and estimating the normalised co-integrating vectors, ϕ, by ordinary least squares (OLS), they can achieve an estimator asymptotically analogous to the maximum likelihood estimation (MLE), (see Narayan & Narayan, 2005). We also implemented the cointegration regression with the Qunyong Wang & Na Wu cointreg command (2012), which allows cointreg to estimate cointegration regression using completely adjusted ordinary least squares, dynamic ordinary least squares and canonical cointegration regression methods.

5. Results

In this section, the results of the tests of unit roots and cointegration in the panel will be presented. Estimates of long-run parameters for the proposed cointegration equations will also be presented.

To understand some characteristics of the series considered in our sample, and of the cross-sections, the presence of cross-sectional dependence, and the order of integration of all variables have to be analyzed. Thus, in the analysis of the existence of cross-sectional dependence for the set of variables, we used the so-called Pesaran CD Test, which the null hypothesis of this test predicts the cross-section independence and it was used to analyze if the memory of these variables shares common impacts. The Maddala & Wu test with lag length (1) without trend and with the trend was used.

Table 1. Cross-Sectional Depence Test (CD Test)

	Cross Dependence (CD Test) Panel 38 Hospitals		***Cross Dependence (CD Test) Group B***		***Cross Dependence (CD Test) Group C***	
	Equation 1	**Equation 2**	**Equation 1**	**Equation 2**	**Equation 1**	**Equation 2**
LOP Costs	92.46***	110.20***	30.65***	35.21***	29.04***	36.54***
LOutC1	127.95***	127.95***	23.65***	23.65***	41.16***	41.16***
LOutC2	75.87***	75.87***	13.30***	13.30***	30.22***	30.22***
LCapac	39.14***	39.14***	14.66***	14.66***	15.51***	15.51***
LIntern	94.62***	94.62***	34.03***	34.03***	31.57***	31.57***
LWTime 1	4.21***	4.21***	-1.72*	-1.72*	-2.83***	-2.83***
LWTime 2	28.89***	28.89***	2.11**	2.11**	11.21***	11.21***
LWTime 1	5.44***	5.44***	-1.42	-1.42	-2.08**	-2.08**
LWTime 2	32.00***	32.00***	2.29**	2.29**	10.97***	10.97***
	Cross Dependence (CD Test) Group D		***Cross Dependence (CD Test) Group E***		***Cross Dependence (CD Test) Group F***	
	Equation 1	**Equation 2**	**Equation 1**	**Equation 2**	**Equation 1**	**Equation 2**
LOP Costs	12.58***	11.72***	11.32***	12.42***	8.46***	9.63***
LOutC1	25.34***	25.34***	25.99***	25.99***	4.23***	4.23***
LOutC2	12.42***	12.42***	20.78	20.78	1.51	1.51
LCapac	8.30***	8.30***	6.11***	6.11***	-0.11	-0.11
LIntern	6.20***	6.20***	9.57***	9.57***	9.65***	9.65***
LWTime 1	-3.62***	-3.62***	16.83 ***	16.83 ***	-2.12**	-2.12**
LWTime 2	8.61***	8.61***	10.34***	10.34***	5.67***	5.67***
LWTime 1	-3.35***	-3.35***	16.62***	16.62***	-0.97	-0.97
LWTime 2	8.18***	8.18***	11.52	11.52	5.05***	5.05***

*Notes:Values in parenthesis report to standard errors. *, **, *** represent significance at 10%, 5% and 1% respectively. L is levels.*

The results presented in Table 1 support that all variables have cross-section dependence (H0 is rejected at the significance level of 1%), either for equation 1 (total operating costs) or for equation 2 (professional health costs), considering the global panel with the 38 hospitals. In turn, when considering the 5 Groups individually, the results of the Pesaran CD Test point to the rejection of the null hypothesis for all variables, considering equation 1 and equation 2 only for Group C and Group D, if we consider all variables.

It should be noted, however, that if we do not include in the analysis the logarithm of the variable number of surgeries performed and the variable in the quadratic form of Waiting times, all results confirm the presence of the cross-section dependency for all groups. On the other hand, we included in the analysis the first-generation unit root test that includes the ADF-Fisher Maddala & Wu (1999), to verify the presence of unit roots. The null hypothesis rejection is the presence of unit root of the individual unit root process.

Table 2. Second Generation Unit Root Test (CIPS Test)

	2nd Generation Unit Root (CIPS Equation 1) Panel 38		***2nd Generation Unit Root (CIPS Equation 2) 38***		***2nd Generation Unit Root (CIPS Equation 1) Group B***		***2nd Generation Unit Root (CIPS Equation 2) Group B***		***2nd Generation Unit Root (CIPS Equation 1) Group C***		***2nd Generation Unit Root (CIPS Equation 2) Group C***	
Level	**Without T**	**With Trend**	**Without T**	**With Trend**	**Without T**	**With Trend**	**Without T**	**With Trend**	**Without T**	**With Trend**	**Without T**	**With Trend**
LOP Costs	-27.909***	-28.700***	-21.741***	-28.093***	-14.380***	-14.198***	-12.870***	-13.657***	-15.902***	-16.737***	-13.243***	-16.668***
LOutC1	-15.216***	-17.539***	-15.216***	-17.539***	-6.850***	-9.097***	-6.850***	-9.097***	-7.232***	-8.382***	-7.232***	-8.382***
LOutC2	-22.535***	-22.893***	-22.535***	-22.893***	-11.368***	-11.528***	-11.368***	-11.528***	-13.543***	-13.740***	-13.543***	-13.740***
LCapac	-24.458***	-23.989***	-24.458***	-23.989***	-10.991***	-10.251***	-10.991***	-10.251***	-13.879***	-14.833***	-13.879***	-14.833***
LIntern	-25.210***	-28.630***	-25.210***	-28.630***	-13.036***	-13.517***	-13.036***	-13.517***	-14.953***	-17.105***	-14.953***	-17.105***
LWTime 1	1.416	4.047	1.416	4.047	0.891	1.406	0.891	1.406	-0.109	2.057	-0.109	2.057
LWTime 2	2.642	1.573	2.642	1.573	0.655	1.196	0.655	1.196	2.897	2.630	2.897	2.630
1st Difference	**Without T**	**With Trend**	**Without T**	**With Trend**	**Without T**	**With Trend**	**Without T**	**With Trend**	**Without T**	**With Trend**	**Without T**	**With Trend**
D.LOP Costs	-22.744***	-24.669***	-15.123***	-22.752***	-11.393***	-12.201***	-8.315***	-10.343	-12.790***	-13.591***	-8.825***	-13.025***
D.LOutC1	-6.707***	-7.748***	-6.707***	-7.748***	-2.202**	-3.317***	-2.202**	-3.317***	-3.459***	-4.070***	-3.459***	-4.070***
D.LOutC2	-13.208***	-12.976***	-13.208***	-12.976***	-5.999***	-6.134***	-5.999***	-6.134***	-8.119***	-8.161***	-8.119***	-8.161***
D.LCapac	-13.188***	-12.348***	-13.188***	-12.348***	-6.189***	-5.540***	-6.189***	-5.540***	-4.549***	-4.443***	-4.549***	-4.443***
D.LIntern	-18.715***	-23.220***	-18.715***	-23.220***	-10.027***	-10.438***	-10.027***	-10.438***	-10.820***	-13.536***	-10.820***	-13.536***
D.LWTime 1	1.707	4.044	1.707	4.044	0.505	0.758	0.505	0.758	1.766	2.883	1.766	2.883
D.LWTime 2	1.065	-0.219	1.065	-0.219	-0.505	0.152	-0.505	0.152	2.149	1.559	2.149	1.559
	2nd Generation Unit Root (CIPS Equation 1) Group D		***2nd Generation Unit Root (CIPS Equation 2) Group D***		***2nd Generation Unit Root (CIPS Equation 1) Group E***		***2nd Generation Unit Root (CIPS Equation 2) Group E***		***2nd Generation Unit Root (CIPS Equation 1) Group F***		***2nd Generation Unit Root (CIPS Equation 2) Group F***	
Level	**Without T**	**With Trend**	**Without T**	**With Trend**	**Without T**	**With Trend**	**Without T**	**With Trend**	**Without T**	**With Trend**	**Without T**	**With Trend**
LOP Costs	-12.049***	-11.942***	-9.526***	-11.415***	-11.678***	-11.529***	-7.216***	-11.592***	-8.026***	-8.197***	-7.163***	-8.197***
LOutC1	-5.734***	-6.39***3	-5.734***	-6.39***3	-7.372***	-8.446***	-7.372***	-8.446***	-7.507***	-7.435***	-7.507***	-7.435***
LOutC2	-9.491***	-9.680***	-9.491***	-9.680***	-8.232***	-8.553***	-8.232***	-8.553***	-5.307***	-6.742***	-5.307***	-6.742***
LCapac	-9.131***	-8.974***	-9.131***	-8.974***	-10.438***	-10.421	-10.438***	-10.421	-8.303***	-8.197***	-8.303***	-8.197***
LIntern	-10.921***	-12.331***	-10.921***	-12.331***	-7.680***	-11.480***	-7.680***	-11.480***	-8.004***	-8.197***	-8.004***	-8.197***
LWTime 1	1.408	2.506	1.408	2.506	0.801	2.628	0.801	2.628	2.286***	-1.912**	2.286***	-1.912**
LWTime 2	0.877	0.588	0.877	0.588	0.834	1.941	0.834	1.941	-3.585***	-2.481***	-3.585***	-2.481***
1st Difference	**Without T**	**With Trend**	**Without T**	**With Trend**	**Without T**	**With Trend**	**Without T**	**With Trend**	**Without T**	**With Trend**	**Without T**	**With Trend**
DLOP Costs	-10.994***	-10.370***	-8.585***	-9.282***	-9.853***	-11.048***	-4.461	-8.365***	-7.205***	-7.267***	-5.362***	-8.197***
D.LOutC1	-2.686***	-2.735***	-2.686***	-2.735***	-3.861***	-4.140***	-3.861***	-4.140***	-5.556***	-5.417***	-5.556***	-5.417***
D.LOutC2	-7.037***	-6.939 ***	-7.037***	-6.939 ***	-3.879***	-3.691***	-3.879***	-3.691***	-2.953***	-3.504***	-2.953***	-3.504***
D.LCapac	-6.718***	-6.458***	-6.718***	-6.458***	-4.260***	-4.507***	-4.260***	-4.507***	-7.528***	-7.241***	-7.528***	-7.241***
D.LIntern	-9.262***	-10.013***	-9.262***	-10.013***	-4.575***	-8.936***	-4.575***	-8.936***	-6.247***	-8.197***	-6.247***	-8.197***
D.LWTime 1	1.640	2.235	1.640	2.235	-0.202	1.576	-0.202	1.576	-1.608**	-1.106	-1.608**	-1.106
D.LWTime 2	0.199	0.472	0.199	0.472	-0.283	0.764	-0.283	0.764	-2.096**	-1.070	-2.096**	-1.070

*Notes:Values in parenthesis report to standard errors. *, **, *** represent significance at 10%, 5% and 1% respectively. L is levels and D is differences*

Due to the fact of the presence of cross-sectional dependence, we will comment only on the results for the second-generation unit root test of Pesaran CIPS test (2007). This is due to the fact that the first generation unit root tests of Maddala & Wu (1999) are not reliable when in the presence of cross-sectional dependence (see results in table A1 in appendix). We considered in the second generation unit root test (CIPS), the variables both in levels and in the first differences, whose evidence is reported in Table 2. The test results, both in levels and in the first differences, show for the aggregate panel with the 38 public hospitals that all variables (except waiting times for external consultations and for surgeries) considered in the analysis for equation 1 and equation 2, are stationary regardless of whether or not there is a trend.

As for the results of the variables in the first differences, most variables are stationary with and without trend, that is, most variables are integrated I(1), except the waiting times for external consultations and surgeries. Then, the realization of the unit root test is important because it is necessary to verify whether the same panel is considered heterogeneous or homogeneous. On the other hand, the robust CIPS test for the presence of dependence between cross-sections confirms the results, reinforcing the conclusions regarding the presence of unit root in the series of variables considered in the two specifications of total operational costs and costs with health professionals, respectively. In general, the assumption of non-stationarity of the series is legitimate, evidencing the possibility of admitting the existence of long-run relationships between variables.

According to table 3, the results of the cointegration tests will be presented for analysis.
Thus, the Westerlund cointegration test (2007) admits as null hypothesis (H0) the absence of cointegration, under the restriction of control of the presence of cross-sectional dependence. On the other hand, the test of the Gt and Ga parameters for cointegration considers the individual basis for each group of hospitals, and the test of the Pt and Pa parameters consider cointegration with the presence of effects on the aggregate panel (Westerlund & Edgerton, 2007).
In this study, the four tests were performed using the xtwest command in Stata (with the option constant trend lags (1) lrwindow (3) bootstrap (800)). Under these considerations, the presence of cointegration supports the necessary condition for the balance between variables in the long run to exist.

Table 3. Westerlund Test, Pedroni Test and Kao Cointegration Test

Westerlund Tests	***Cointegration Tests Panel 38***		***Cointegration Tests Group B***		***Cointegration Tests Group C***		***Cointegration Tests Group D***		***Cointegration Tests Group E***		***Cointegration Tests Group F***	
	Equation 1a[2]	**Equation 2a**	**Equation 1a**	**Equation 2a**	**Equation 1a**	**Equation 2a**	**Equation 1a**	**Equation 2a**	**Equation 1a**	**Equation 2a**	**Equation 1a**	**Equation 2a**
Gt	-16.253***	3.758	-7.716***	-1.157	-9.111***	-1.521*	-7.657***	0.462	-7.171***	-2.349***	-2.647***	-0.931
Ga	-17.257***	6.251	-9.503***	-1.582*	-9.857***	-1.388*	-7.698***	0.331	-7.222***	-2.792***	-4.303***	-0.508
Pt	-17.239***	3.769	-7.818***	-0.770	-10.248***	-1.140	-8.796***	-0.789	-6.973***	-2.461***	-2.912***	-1.448*
Pa	-21.711***	4.935	-11.654***	-1.716**	-12.654***	-1.270*	-10.010***	-1.085	-8.111***	-3.818***	-5.310***	-1.458*
Variance Ratio	2.831***	31.376***	1.6241*	13.046***	1.854**	15.994***	0.069	12.265***	-1.221	2.507***	5.094***	13.590***
	Equation 1b	**Equation 2b**	**Equation 1b**	**Equation 2b**	**Equation 1b**	**Equation 2b**	**Equation 1b**	**Equation 2b**	**Equation 1b**	**Equation 2b**	**Equation 1b**	**Equation 2b**
Gt	-17.924***	1.932***	-9.810***	-0.825	-9.915***	-1.157	-7.871***	-0.494	-7.158***	-3.976***	-3.614***	-0.409
Ga	-18.237***	5.376***	-9.659***	-0.673	-10.847***	-1.465*	-8.721***	-0.391	-7.306***	-3.927***	-4.349***	-0.438
Pt	-18.839***	2.339***	-10.000***	-2.137**	-10.360***	-1.025	-9.382***	-0.633	-6.908***	-4.116***	-4.478***	-0.882
Pa	-23.368***	4.495***	-11.788***	-2.017**	-13.673***	-1.420*	-11.704***	-0.479	-8.102***	-4.851***	-5.798***	-1.016
Variance Ratio	1.520*	27.742***	13.046***	16.954***	-0.799	11.941***	0.452	11.416***	-1.423*	2.861***	1.070	7.002***

Pedroni´s Test	***Cointegration Tests Panel 38***		***Cointegration Tests Group B***		***Cointegration Tests Group C***		***Cointegration Tests Group D***		***Cointegration Tests Group E***		***Cointegration Tests Group F***	
	Equation 1a	**Equation 2a**	**Equation 1a**	**Equation 2a**	**Equation 1a**	**Equation 2a**	**Equation 1a**	**Equation 2a**	**Equation 1a**	**Equation 2a**	**Equation 1a**	**Equation 2a**
Mod. Phillips Perron t	-20.137***	5.898***	-9.796***	-0.192	-11.910***	-0.0057	-8.510***	1.904**	-9.028***	-2.099**	-4.187***	1.422*
Phillips Perron tt	-35.971***	4.941***	-17.590***	-1.941**	-20.739***	-2.645***	-15.041***	1.824**	-20.827***	-4.489***	-6.846***	0.565
Aug Phillips Perron t	-36.590***	2.860***	-17.400***	-2.914***	-20.804***	-3.132***	-15.779***	1.348*	-18.236***	-5.425***	-6.831***	-0.364
	Equation 1b	**Equation 2b**	**Equation 1b**	**Equation 2b**	**Equation 1b**	**Equation 2b**	**Equation 1b**	**Equation 2b**	**Equation 1b**	**Equation 2b**	**Equation 1b**	**Equation 2b**
Mod. Phillips Perron t	-20.979***	4.639***	-9.538***	1.791**	-12.840***	-0.300	-8.135***	1.603*	-9.714***	-3.368***	-4.902***	-0.169
Phillips Perron tt	-40.593***	2.313***	-20.742***	0.214	-22.129***	-3.264***	-15.784***	0.848	-20.680***	-6.512***	-8.644***	-2.200**
Aug Phillips Perron t	-39.112***	0.639	-17.236***	-1.531*	-22.870***	-4.888***	-16.415***	0.408	-19.855***	-6.871***	-8.493***	-3.304***

Kao Test	***Cointegration Tests Panel 38***		***Cointegration Tests Group B***		***Cointegration Tests Group C***		***Cointegration Tests Group D***		***Cointegration Tests Group E***		***Cointegration Tests Group F***	
	Equation 1a	**Equation 2a**	**Equation 1a**	**Equation 2a**	**Equation 1a**	**Equation 2a**	**Equation 1a**	**Equation 2a**	**Equation 1a**	**Equation 2a**	**Equation 1a**	**Equation 2a**
Mod.Dickey Fuller t	2.832***	4.500***	1.777**	2.628***	1.741**	3.431***	0.7852	2.058**	0.512	0.650	1.431*	1.178
Dickey Fuller t	-0.616	4.768***	0.439	3.437***	-0.101	4.678***	-1.271*	2.333***	-1.811**	0.042	1.286*	1.047
Aug Dickey Fuller t	4.630***	6.499***	2.781***	4.561***	2.550***	5.720***	1.544*	3.303***	0.6385	1.661**	2.311***	1.841**
	Equation 1b	**Equation 2b**	**Equation 1b**	**Equation 2b**	**Equation 1b**	**Equation 2b**	**Equation 1b**	**Equation 2b**	**Equation 1b**	**Equation 2b**	**Equation 1b**	**Equation 2b**
Mod.Dickey Fuller t	1.298*	2.324***	0.657	2.499***	0.556	2.887***	0.159	0.818	0.441	0.699	1.433*	0.821
Dickey Fuller t	-3.349***	2.132**	-1.555*	3.212***	-2.201**	3.358***	-2.361***	0.687	-1.940**	0.126	1.190	0.437
Aug Dickey Fullert	2.816***	5.225***	1.533*	4.433***	1.181	4.827***	0.809	2.075**	0.670	1.380*	2.152**	1.206

*Notes:Values in parenthesis report to standard errors. *, **, *** represent significance at 10%, 5% and 1% respectively. L is levels and D is differences*

[2] In the cointegration tests it was necessary to divide eq1 and eq2 into two subequations each. Thus we defined eq1a the regression total costs as a dependent variable and the independent variable waiting times for consultations, number of outpatient consultations and in eq1b total costs and waiting times for surgeries and number of surgeries. In eq2a and b, the same, but as a dependent variable the costs with health professionals.

The results of the Westerlund test, considering the four statistics reported in Table 3, for the admissibility of cointegration in equation 1 (the relationship between total operational costs and their determinants) either for the aggregate panel (38 Hospitals) or for each panel of Hospitals (group B, group C, group D, group E and group F), of which there is sufficient statistical evidence for the rejection of the null hypothesis at the significance level of 1% and 5%, respectively. In turn, when we consider the results in equation 2 (the relationship between costs with health professionals and their determinants), only for hospital group E, is there sufficient statistical evidence for the rejection of the null hypothesis at the significance level of 1% and 5%, respectively.

Pedroni's test statistics, for the two total operational cost equations, reject the null hypothesis that there is no cointegration at either the level of 1% or at the level of 5% for the aggregate panel with the 38 Hospitals as well as for each of the five groups of hospitals selected. It is necessary to record the statistically significant evidence for the equation proposed for the costs of health professionals, the non-rejection of the null hypothesis in equation 2a in the case of group B, group C and group F and groups D and F in the case of equation 2b, either at the level of 1% or at the level of 5%, respectively.

In turn, Kao test statistics for the two Total Operating Costs equations do not reject the null hypothesis that there is no cointegration into group D, group E and group F selected either at the level of 1% or 5%. It is also necessary to record, statistically significant for the equation proposed for professional health costs, the non-rejection of the null hypothesis in equation 2a in the case of groups E and F, in the case of equation 2b, this same statistical evidence for groups D, E and F, at either 1% or the level of 5% is highlighted.

To evaluate the two long-run relationships proposed between the variables of hospital costs and their determinants and to perform tests to verify the presence of these relationships in the two equations the use of estimation methods selected according to the limitations described in the analysis of the cointegration tests is made, namely the use of the PMG, MG and DFE methods, which involve very restrictive hypotheses concerning the heterogeneity/homogeneity of the parameters. We also included the DOLS and FMOLS methods that differ from PMG, MG and DFE because they perform the correction for the endogeneity of the variables.

According to the results shown in table 4, for equation1 and the aggregated panel with 38 Portuguese public hospitals and five groups of Portuguese public hospitals considered; the regressions have been estimated to control the nonlinearities of total operational costs response to waiting times for external consultations and surgeries for all hospital groups. This also implies that the elasticity of total operational costs to waiting times for external consultations and surgeries is not constant.

Table 4. Results of panel ARDL estimators (PMG, MG and DFE) and others estimators (DOLS, CCR and FMOLS) Eq1

	Group B			Group C			Group D			Group E		
Equation 1 ***D.LTotal OP***	**PMG**	**MG**	**DFE**	**PMG**	**MG**	**DFE**	**PMG**	**MG**	**DFE**	**PMG**	**MG**	**DFE**
D.LOutC1	-0.0844	0.1831**	0.0736**	0.0079	0.0117	0.0861	0.0069	0.0973	0.1125*	0.2372***	0.1620*	0.2545***
D.LOutC2	0.0147	0.0562***	0.03165**	0.0021	0.0029	0.0572***	0.0275	0.0038	0.0090	0.0328	0.0659	0.0156
D.LCapac	0.1011**	0.1355	0.0149	0.05747	0.0278	0.0023	0.2122*	0.1380	0.2159**	0.0645	0.0811	0.0.125
D.LIntern	-0.4742***	-0.4752***	-0.4743***	-0.4731***	-0.4942***	-0.4987***	-0.5194***	-0.4887***	-0.4283***	-0.4317***	-0.5369***	-0.4094**
D.LWTime1	-0.0834	0.5419	1.0186**	-3.5292	1.0921	0.0967	-2.5389	6.1105*	-0.9171	-2.4686	-2.0001	-0.8340
D.LWTime2	-0.3684	-1.3557	0.8135	-2.3112*	-0.0299	0.2266	-0.7956	-1.7904	0.5086	1.8868	0.5948	-0.5052
D.LWTime1 Q	8.4936	6.8784	-2.1212**	6.5295	-2.9389	-0.0939	6.8047	-6.8153	1.9632	3.3889	2.1149	1.6056
D.LWTime2 Q	2389.31	16.8333	-1.7564	13.5426*	-1.2711	-0.2638	9.1935	11.811	-2.1028	-7.5642	-5.3676	1.5802
Intercept	7.6244***	13.1889***	10.009***	8.9087***	11.996***	10.932***	8.5210***	11.455***	11.487***	11.992***	12.458***	12.833***
ECM	-0.726***	-1.093***	-0.9098***	-0.7530***	-1.0613***	-0.9035	-0.8013***	-1.0065***	-0.924***	-1.005***	-1.202***	-1.066***
LOutC1 (-1)	0.0954**	0.1385	0.01133	0.0830	0.0545	0.1569***	0.2089***	0.0575	0.0221	0.1511**	0.1174*	0.1562*
LOutC2 (-1)	0.0364**	0.0856***	0.0558***	0.1383**	0.0655*	0.1453***	0.0449	0.0864***	0.0956***	0.1183***	0.1104**	0.0600*
LCapac (-1	-0.1922**	-0.0738	-0.2023**	-0.03212	-0.0335	-0.0272	0.0967	0.0404	0.0866	-0.0009	-0.0250	-0.0057
.LIntern (-1)	0.5227***	0.5052***	0.5191***	0.5076***	0.5358***	0.5456***	0.4504***	0.4696***	0.4056***	0.3706***	0.5662***	0.4122***
LWTime1 (-1)	0.3911**	1.3232	0.5699***	0.05829	0.3563	-0.0845	-1.5447***	7.4238**	-1.2793**	0.0435	0.9707	0.0392
LWTime2 (-1)	-0.2760	0.5572	-0.7229**	-0.0949	0.9749	0.3596	0.5409	-1.3583	-0.1087	-0.0494	0.3738	-0.5941
LWTime1 Q (-1)	-0.72732	-3.5779	1.1658***	-0.2019	0.3403	0.0009	2.7373***	-11.4049**	2.0820**	0.7110	-0.7378	0.8281*
LWTime2 Q (-1)	0.4063	-24.235	3.0658**	-0.1054	-10.307	-1.5747*	-0.0180	2.6745	1.0745	0.6805	0.1626	1.9035
Hausman Test	-22.21	0.000	0.000	-12.75	0.02	0.01	-0.46	0.02	-5.82	33.61***	0.01	-29.46
Observations	531						413			354		

	Group F			Panel 38 Hospitals Equation 1 *D.LTotal OP*			Panel 35 Hospitals Equation 1 *D.LTotal OP*		
	PMG	**MG**	**DFE**	**PMG**	**MG**	**DFE**	**PMG**	**MG**	**DFE**
D.LOutC1	0.0955	0.2189**	0.1413**	0.09320***	0.001934	0.021307	0.0797**	0.02497	-0.04409
D.LOutC2	0.0250	0.0638	0.0213	0.06124***	0.0686***	0.09157***	0.0651***	0.0826***	0.1037***
D.LCapac	0.2786	0.2045	0.0026	-0.002075	0.005317	0.00251	-0.01551	-0.02766	-0.02124
D.LIntern	-0.3360***	-0.3448***	-0.3211***	0.46853***	0.51042***	0.49093***	0.4710***	0.5199***	0.4993***
D.LWTime1	-16.0222	-21.731	-4.7112*	0.13374	1.61299	0.08689	0.14047	2.1237**	0.08573
D.LWTime2	2.5590	10.4847	1.5115	0.033953*	1.39061	-0.04149**	0.03480	0.29824	0.03170
D.LWTime1 Q	23.406	29.928	16.869	-0.11294	0.12948	-0.03664	-0.1215	-3.201**	-0.03562
D.LWTime2 Q	-4.265***	-17.975	-1.7350	0.62800*	0.97098	0.7849**	0.5450	-9.4975	0.41047
Intercept	8.5146**	8.1287***	10.807***	8.3765***	11.918***	10.584***	8.583***	12.274***	10.751***
ECM	-0.669***	-0.915***	-0.873***	-0.745***	-1.069***	-0.8966***	-0.757***	-1.082***	-0.904***
LOutC1 (-1)	0.0073	0.3064**	0.0876**	0.034505	-0.01133	-0.02385	0.01936	-0.03443	-0.0463**
LOutC2 (-1)	0.0037	0.0979	0.0459	-0.010435	0.01902	0.0355***	-0.00569	0.02745*	0.0435***
LCapac (-1	0.1331	0.2228	0.0113	0.1239***	0.09962*	0.00312*	0.11882	0.08674	0.0081
LIntern (-1)	0.334***	0.3778***	0.3691***	0.4653***	0.4843***	0.4615***	0.4764***	0.4955***	0.4709***
LWTime1 (-1)	6.7217*	-4.2372	-2.6126*	-3.0711**	-0.37680	0.05436	-2.235*	1.4242	0.1874**
LWTime2 (-1)	4.0482**	15.303	1.3739**	-0.85814	0.22638	0.25809**	-1.0174	-0.61586	0.3061
LWTime1 Q (-1)	-31.5779	16.741	15.245	0.14784	0.23639	-0.00506	0.6599**	-0.32339	-0.1616**
LWTime2 Q (-1)	-5.2575**	-24.956	-1.1054	0.01027**	0.04099	-0.30865**	10.863***	5.2985	-0.7874
Hausman Test	-2.54	0.01	0.00	-21.90	0.00	0.00	-27.02	0.00	0.00
Observations	177			2242			2065		
R square									

*Notes: Values in parenthesis report to standard errors. *, **, *** represent significance at 10%, 5% and 1% respectively. L is levels and D is differences*

Let us now focus on the signal of coefficients estimated by the regressions, considering both types of waiting times.Therefore, the results of the DFE model indicate for aggregated panel with 38 public hospitals, that in short-run and long-run regressions the coefficient of waiting times for the linear component is negative, validating the U-shaped. While the quadratic is positive in the case of waiting times associated to surgeries; while the results for panel with 35 public hospitals, excluding group F (oncology hospitals), showed that same effect is reversed and waiting times start to increase total operational costs and the quadratic coefficient of waiting times is negative, such as inverse U-shape is validated.

In the relationship between operating costs and hospital occupancy rate, the results show in the long-run, marginal increases in the hospital dimension effect lead to positive increases in costs, with different magnitudes for each group under analysis. In turn, in the short-run, inverse behaviour is predominant among these same quantities, except in group F (oncology hospitals) in which increases in capacity effect imply increases in total operating costs.

Regarding the expected signals for the coefficients associated with waiting times for external consultations, it is verified that in the long run in group D, E and F, the hypothesis of the relationship of the curve between these same quantities are validated in U-shape. Whereas in hospital groups B and C, the results point to an inverse behaviour, validating the inverse U-shape. In turn, in the relationship between the scheduled waiting times for surgeries and operational costs, the U-shaped curve is validated in the long-run for all hospital groups analyzed. In contrast, this relationship exists in the short-run but only for group C and group F; while in groups B, D and E, there is a behaviour of this same relationship in the inverse U-shaped. Although the effect of waiting times is consistent with the theory for some hospital groups, the estimated coefficients are not always statistically significant for the public hospital groups considered in our sample

According to table 5, the results of the DOLS and FMOLS estimation of our second proposed relationship between costs with health professionals and their determinants considered in equation 2 show a positive short- and long-run effect between hospital capacity used and staff costs, either for the global panel of 38 hospitals or for the panel with the 35 hospitals. For the other groups of hospitals, the positive effect of the capacity used and the costs of health professionals in most groups, except in group B, should be recorded in the long run; whereas in the short run this exception occurs in group C, with the existence of an inverse relationship between these two quantities. However, in group E (larger hospitals), this result is not verified. On the contrary, an inverse relationship between the effect of used capacity and staff costs is seen.

Table 5. Results of panel ARDL estimators (PMG, MG and DFE) and others estimators (DOLS, CCR and FMOLS) Eq2

	Group B			Group C			Group D			Group E		
Equation 2 *D.L CostsPHealth*	**DOLS**	**CCR**	**FMOLS**	**DOLS**	**CCR**	**FMOLS**	**DOLS**	**CCR**	**FMOLS**	**PMG**	**MG**	**DFE**
D.LOutC1	0.01204**	0.1354***	0.0132***	0.0145***	-0.01216	0.0148***	0.0096*	-0.3279***	0.01133***	0.1041	0.0205	0.04034
D.LOutC2	0.00333	-0.1911***	0.00316**	-0.0039***	0.0183**	0.0039***	0.0059**	-0.4694***	-0.0054**	0.0064	0.0063	0.0119*
D.LCapac	0.00107	-0.7336***	0.00105	0.0008	0.3421***	0.00096	0.0318***	-0.2190***	0.0297***	-0.0436***	-0.0145	-0.0032
D.LIntern	1.0080***	-0.3170***	1.0069***	1.0048***	0.8386***	1.0059***	0.9983***	0.5948***	0.9978***	0.9908***	1.0020***	1.0051***
D.LWTime1	0-.2355**	3.1402***	-0.2392***	-0.1065**	0.2804**	-0.1119***	-0.01619	0.11347***	0.00234	1.5440	1.1248	0.3619*
D.LWTime2	0.27109	-31.718***	0.2336**	0.03324	-0.3625**	0.02869	0.26232	-0.1384***	0.2553**	0.5161**	0.7396***	0.8233***
D.LWTime1 Q	0.5703***	3.9637***	0.5732***	0.2159***	-0.4823**	0.2115***	0.0975	-0.1267***	0.08345	-2.2201	-1.4766	-0.2364
D.LWTime2 Q	-0.6182	171.753***	-0.48784	0.05496	1.2901**	0.06695	-0.47543	0.26520	-0.4864**	-0.5312	-1.3484***	-1.4944*
Intercept	-0.0547	-0.0787***	-0.0506**	-0.0382*	-0.1045***	-0.0661	-0.01171	0.2131***	-0.03825	4.6937***	6.7294***	4.3684***
ECM										-0.5116***	-0.7689***	-0.5143***
.LOutC1 (-1)	-0.00187	0.00041	-0.00094	0.00347	0.0050***	0.0046***	-0.00251	-0.0084***	-0.0006	-0.3284	-0.0143	-0.0124
.LOutC2 (-1)	-0.00001	0.0009	0.00055	-0.00204	-0.00248**	-0.00208**	-0.00248	0.00487***	-0.00100	0.0165	0.0218	0.2202*
LCapac (-1	0.00835	0.0062	0.00761	-0.00139	-0.00176	-0.00144	0.01400	0.00706***	0.01033	0.0015	0.1202	-0.0109
.LIntern (-1)	0.00855**	0.0086***	0.0066***	0.00305	0.01013***	0.00533***	0.0064**	-0.0201***	0.0061***	1.0013***	0.9998***	1.0087***
LWTime1 (-1)	-0.02397	-0.00549	-0.01156	0.00261	0.00386	0.00265	-0.03297	-0.0922***	-0.02248	0.1547**	-1.4354	0.1512
LWTime2 (-1)	0.02736	0.0594**	0.0144	-0.01172	0.00337	-0.00458	-0.04809	-0.0770***	-0.0122	0.1925	0.1141	-0.1513**
LWTime1 Q (-1)	0.05353	0.0076	0.0272	0.00993	0.0064	0.0055	0.05776	0.1554***	0.04314	0.1157	2.6684	0.2179
LWTime2 Q (-1)	-0.13616	-0.3019**	-0.0750	0.04552	0.02139	0.04193	0.09403	0.1644***	0.02389	-0.0602	0.3245	0.7555**
Hausman Test										-14.21	0.00	0.00
Observations	531	530	530	767	766	766	413	412	412	354		
R square	0.998	0.058	0.985	0.998	0.410	0.990	0.998	0.731	0.993			

	Group F			Panel 38 Hospitals Equation 2 *D.L CostsPHealth*			Panel 35 Hospitals Equation 2 *D.L CostsPHealth*			Grupo E Equation 2 *D.L CostsPHealth*		
	DOLS	**CCR**	**FMOLS**	**DOLS**	**CCR**	**FMOLS**	**PMG**	**MG**	**DFE**	**DOLS**	**CCR**	**FMOLS**
D.LOutC1	0.00996	-1.9e11***	0.0117***	0.0110***	0.00252	0.0116***	0.00233	0.15477	0.1209**	0.00892	1.0e11***	0.00800
D.LOutC2	0.0075***	2.96e11***	0.0064**	-0.0010**	0.0084***	-0.0008*	-0.00918	-0.00220	0.0408**	0.00238	7.52e10***	0.00404
D.LCapac	0.00738	-1.3e11***	0.00765	0.00096	-0.01485	0.00094	0.00205	0.09617**	-0.00398	-0.00335	5.19e10***	-0.0051**
D.LIntern	0.9994***	-1.1e11***	0.9995***	1.0014***	0.8542***	1.0022***	1.0012***	1.0906***	1.0872***	1.0011***	-1.5e11***	1.0034***
D.LWTime1	-0.2504	-3.3e11***	-0.30445	-0.0517***	0.2278***	-0.03523**	0.1882***	-0.49123	-0.04317	0.32994	-2.8e11***	0.2965**
D.LWTime2	-0.2299*	5.34e11***	-0.2293***	0.04917**	0.02039	0.05308**	0.4005***	-0.67963	-0.07233	0.9637**	4.48e11***	0.7585***
D.LWTime1 Q	0.45465	8.74e11***	0.74857	0.1626***	-0.3024***	0.1308***	-0.04552	3.2034	0.28438	-0.21754	5.12e11***	-0.20193
D.LWTime2 Q	0.4534**	-1.2e12***	0.4547***	-0.0547**	0.16984*	-0.0582**	-0.43619**	0.2184	0.55816	-2.1930**	-8.7e11***	-1.617***
Intercept	0.03725	4.85e9***	0.02994	-0.0120**	-0.0619***	-0.0270***	1.3865***	3.0562***	0.7518***	0.05651	-8.5e08***	0.00919
ECM							-0.1737***	-0.4112***	-0.0970***			
LOutC1 (-1)	-0.0046	-2.93e8***	-0.00232	-0.00006	0.00023	-0.00009	0.0122***	0.01064**	0.00709**	0.00330	4.79e07***	0.00392
LOutC2 (-1)	0.0026	4.91e8***	0.00034	-0.00045	-0.00071	-0.000267	-0.00319**	0.000057	0.00179	-0.00657	8.83e06***	-0.00530
LCapac (-1	0.0301***	1.32e8***	0.0300***	0.00202**	0.0025**	0.00201**	0.00570	0.011489	-.0.0008	0.00136	-1.0e08***	0.00268
LIntern (-1)	-0.00307	-5.24e8***	-0.00246	0.0021***	0.0083***	0.0039***	0.9984***	1.0075***	1.0062***	-0.00540	5.61e07***	-0.00086
LWTime1 (-1)	0.10486	2.14e10***	0.05581	-0.0070**	-0.00551	-0.0064**	0.05574	0.01259	-0.0440**	-0.00472	-1.2e08***	-0.0122
LWTime2 (-1)	-0.1037	-1.1e10***	-0.1207**	-0.00817	-0.00663	-0.00656	0.08557	0.17767	0.15001	-0.00789	-3.5e07***	-0.02276
LWTime1 Q (-1)	-1.1921	-1.9e11***	-0.88175	0.0235***	0.0195**	.0.0208***	0.52256	0.64990	0.16519**	0.02829	2.14e08***	0.03142
LWTime2 Q (-1)	0.20753	2.05e10***	0.2292**	0.02211	0.01940	0.02117	-0.90057	-0.50927	-0.20571	0.0456	1.15e08***	0.05650
Hausman Test							-22.62	0.00	0.00			
Observations	177	176	176	2242	2241	2241	2065			354	353	353
R square	0.999	0.803	0.998	0.999	0.085	0.995				0.994	0.874	0.712

*Notes: Values in parenthesis report to standard errors. *, **, *** represent significance at 10%, 5% and 1% respectively. L is levels and D is differences*

Regarding the validation of the U-shaped curve in the relationship between waiting times and costs with health professionals, the results of the DOLS and FMOLS estimation point to both aggregated groups of 38 hospitals and 35 hospitals both in the short and long-run for the existence from the U-curve to the waiting times associated with external consultations, since the waiting times for surgeries are positively related to the costs of hospital staff in the initial stages so as to have an inverse (negative) behaviour in the long-run. This thus validates the inverse U-shaped curve.

Regarding the group of Hospitals E (part of the largest public hospital units in the country, providing highly differentiated health care, such as the Lisboa Norte Hospital Center, EPE and the Hospital Center of São João, EPE) and according to the results of the DOLS and FMOLS estimation, it should be noted that the waiting times associated with external consultations and those related to long-run surgeries, both exhibit an inverted U-shaped behaviour. However, in the short-run, there is an inverse in this relationship, validating the U-shaped curve.

The estimated results for the relationship between staff costs and short-run waiting times for hospital groups B and D show evidence to validate the U-shaped curve. In contrast, for group F, the same results point to validating the inverted U-shaped curve. In the estimated relationship between waiting times for scheduled surgeries and staff costs, the results point to Groups C, D and F the non-validity of the U-shape or inverted U, since the estimated coefficients reveal a negative sign for all three of these groups. In contrast, in group B, there is evidence to validate the U-shaped curve.

6. Discussion and Policy Implications

Our results emphasize the importance of the operational management of physical and human resources that directly affect the rate of hospital use, corroborating the evidence found by Brennan et al. (2000), Yamane (2003), Crosse (2009), Handel & McConnell (2009), Hsia et al. (2012), Shen & Hsia (2015), assuming that increases in the occupancy rate (reduction of hospital facilities and reserve capacity for potential minimus) imply increases in the redeployment and relocation of patients together with the increase in the availability of short-run hospitalization (number of beds available depending on the number of patients who have been discharged from the hospital).

Significant effects of longer waiting times on hospital costs, particularly in Hospitals that are part of Group E, may have different implications that go beyond treatment and the (normal) recovery period for a patient and affecting the number of days of hospitalization, maintenance and management of installed capacity, affecting the future economic and financial efficiency of public hospitals as evidenced in the results of the recent study by Godøy et al. (2019).

In the case of hospital groups where hospital costs are reduced due to lower rates of installed capacity utilization and shorter waiting times, it is expected that there will be inconsistent results such as those shown for group B and Group C hospitals, so according to Godøy et al. (2019), longer waiting times increase costs only in the long-run, which may be due to the lower costs in the management of waiting lists in the short-run This evidence is further corroborated in the arguments associated with the results of the studies by Gaynor & Anderson(1995); Keeler & Ying, (1996); McGuire & Hughes, 2003), among others. On the other hand, and in the alignment of the results found for the groups of hospitals in which the U-shaped relationship between hospital operating costs and waiting times were validated. These same results are corroborated by the arguments mentioned in the studies by Iversen (1997), and Siciliani et al. (2009).

For the set of hospitals in which the inverted U-shaped relationship was validated, as opposed to the study by Siciliani et al. (2009), waiting times maximize costs when waiting times are low while waiting times decrease costs when waiting times are high. It states that for low waiting times, as a result of lower overcapacity, longer waiting times minimize hospital costs. Although our study suggests a significant effect of waiting times on operating costs and costs for healthcare professionals, the results have important policy implications concerning the effectiveness of policy initiatives that encourage an expansion of health care providers to reduce waiting times through more funding for hospital health units, the extension of working hours and/or hiring of more health professionals, the review of contracts, hiring of suppliers of medicines and existing private equipment, among other measures to mitigate costs through waiting times.

According to Siciliani & Hurst, (2005), public health policymakers should be aware that adjustments in waiting times affect hospital costs, as increases in supply may be ineffective and insufficient to respond to increases in demand due to the non-compensatory effect of increases in labour supply.

Our results show that, in the Portuguese institutional context, the elasticity of hospital costs to waiting times is inelastic, particularly in hospital groups B and C (hospitals with lower geographical and/or population coverage). So, policies aimed at increasing supply and installed capacity would be effective in reducing waiting times. In contrast, the elasticity of hospital costs to waiting times is elastic, particularly in hospital group E (hospitals with greater geographical and/or population coverage). Therefore policies aimed at increasing supply and installed capacity would increase operating costs, but would not result in a reduction in waiting time that is so desirable from a social and economic point of view.

7. Conclusions

This research presents a proposal and its validation on the relationship between total operating costs and costs with health professionals and waiting times for external consultations and surgeries for a set of 38 public, corporate hospitals in Portugal, as well as a set of 5 groups of hospitals according to the clustering criterion, in compliance with the criterion laid down by the Central Administration of the Health System (ACSS). The main objective of this study was to validate the shape of the U curve for these same two relationships as they are formulated in theoretical terms. For example, when waiting times are very long, there may be an increase in the resources required, leading to an increase in treatment costs and length of hospital stay and consequently an increase in rates of non-compliance in consultations and or scheduled surgeries.

There is, therefore, at least theoretically, a level in waiting time that minimizes total production costs, so above that level, higher waiting times increase hospital operating costs and or high costs for health professionals. Thus, such a hypothesis that low waiting times are associated with total hospital operating costs (y1) and or costs with low health professionals (y2), or that high waiting times are associated with high operating costs and or high costs with health professionals. In these two proposed cost approaches, some control variables were selected according to the literature review to be included in these same relationships, more specifically, the number of external consultations (x1) and the number of surgeries (x2), the capability impact of the equipment (x3) and also the number of patients discharged from hospital (x4).

In terms of the empirical methodology adopted, the analysis of the stationarity of the variables in the panel, cross-sectional dependence tests, and 1st and 2nd generation tests of the unit root was incorporated, and the existence of cross-sectional dependence was verified, so the robustness of the 2nd generation CIPS tests confirmed that most variables at the level and in the first differences are integrated with order one, I (1), validating the presence of non-stationarity of the series. After verifying this last condition, to confirm the existence of cointegration, Westerlund, Pedroni and Kao co-integration tests were performed respectively. These tests individually rejected the hypothesis of cointegration for most hospital groups with significance levels of 1% and or 5% respectively. In this sequence of tests, it was possible to perform the estimates for the two long-run relationships suggested by the cointegration tests. Under these conditions of cointegration, different methods of estimating heterogeneous panels were used, such as Pooled Mean Group (PMG), Mean Group (MG), Dynamic Fixed Effect (DFE), Dynamic Ordinary Least Square (DOLS), Fully Modified Ordinary Least Square (FMOLS) and Canonical Regression Correlation (CCR).

The results for validation of model 1 show the relationship between operating costs and hospital occupancy rate, in the short- and long-run, that increases in the hospital dimension lead to positive increases in costs, with different magnitudes for each group under analysis for most of the groups analyzed. On the other hand, the coefficients associated with waiting times for external consultations, in the long-run, and groups D, E and F, show significant statistical evidence to validate the hypothesis of the U-shaped curve relationship. While in hospital groups B and C, the results point to the U-shaped inverse curve validity.

In turn, in the relationship between the scheduled waiting times for surgeries and operational costs, there is, in the long-run, the validation of the U-shaped curve for all hospital groups analyzed. In comparison, this relationship exists in the short run but only for group C and group F. In contrast, in groups B, D and E there is a behaviour of this same relationship in the inverted U-shaped.

In model 2, our findings indicate, for the aggregate sample of 38 and 35 hospitals respectively, as well as for the parcel groups considered, that in the long run there is a positive effect between capacity utilization and costs with health professionals, except group B. In contrast, in the short-run, this exception is for group C of hospitals. Regarding the validation of the U-shaped curve in the relation between waiting times and costs with healthcare professionals, the results, both in the short- and long-run, point to the existence of the U-shaped curve for waiting times associated with external consultations. Since waiting times for surgeries are positively related to the costs of hospital staff in the early stages so as to have an inverse (negative) behaviour in the long-run.This thus validates the inverse U-shaped curve.

In the short-run and for hospital groups B and D, there is statistical evidence to validate the U-shaped curve, while for group F, the same results point to validate the inverted U-shaped curve. In the estimated relationship between waiting times for scheduled surgeries and staff costs, the results suggest that Groups C, D and F do not validate the U-shaped or inverted U-shaped given the estimated coefficients reveal a negative sign for all of these three groups. At the same time, in Group B, there is evidence to validate the U-shaped curve. Thus, the results of this study highlight that longer waiting times have significant effects on hospital costs and suggest that longer waiting times do not merely increase absence rates. At the same time, patients wait for external consultation and/or surgery. Instead, there appear to be significant long-run effects that last beyond the short-run waiting period. However, this interpretation is potentially problematic, as the sample contains some very long waiting times, particularly in larger hospitals, and greater geographical coverage in terms of the population served, namely public hospitals belonging to hospital group E (larger hospitals and geographical coverage).

As far as recommendations are concerned, the results of our study point to the existence of asymmetries between operating costs, occupancy rates and waiting times in the various groups considered in the analysis, so it is justified to ascertain the causes of these asymmetries between groups and within each group. Following this statistical evidence, we believe that measures should be implemented that act directly on these causes and allow to reduce the current disparities between economic efficiency through costs between the various hospital units, in order to free up financial resources that allow to increase the supply of healthcare and reduce waiting times.

In summary, we will say that in general terms the objectives defined in this work were achieved since it was possible to estimate and statistically infer the veracity of the relationships formulated for the nexus of causality between the total operational costs and waiting times for external consultations and scheduled surgeries, and between the costs with health professionals and the same waiting times for some of the clusters of public hospitals in business (EPE). However, it is necessary to highlight some limitations found with regard to the validation of the same relationships but from a perspective of efficiency of the cost functions presented; as well as in a given frontier function, it has not been recognised either at the level of the aggregate panel or at the level of each identified cluster, which hospitals are most efficient and which hospitals are inefficient. Thus, in terms of future research, we consider that the application of a translog function in a stochastic frontier analysis would allow, on the one hand, to also validate the U-Shaped for the two proposed relationships between hospital costs and waiting times, as well as, on the other hand, to capture the interactive effects between the explanatory variables considered in the analysis. Last but not least, we will also say that the analysis of efficiency on the stochastic frontier would make it possible to know the positioning (ranking) of public business hospitals with better and worse cost efficiency.

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APPENDIX

Table A1 - Individual relationship between variables and hospitals

Hospital	Δ y1	Δ y2	Δ x1	Δ x2	Δ x3	Δ x4	Δ x5	Δ x6
B1	9.879%	17.981%	-0.575%	11.327%	-0.236%	17.983%	0.676%	0.76%
B2	6.817%	13.392%	-0.147%	25.082%	-0.255%	13.157%	4.601%	30.68%
B3	5.518%	33.288%	-1.427%	7.186%	0.105%	33.201%	1.687%	20.66%
B4	4.68%	13.75%	-1.44%	3.03%	-0.56%	13.62%	2.00%	3.58%
B5	5.33%	15.53%	-1.34%	1.18%	-0.81%	15.39%	4.13%	10.62%
B6	4.05%	10.43%	-1.28%	-0.17%	-0.04%	9.80%	0.22%	2.96%
B7	2.39%	0.52%	-1.08%	14.60%	-0.39%	0.46%	5.63%	-3.39%
B8	2.77%	14.43%	-1.13%	3.23%	-0.33%	13.93%	0.77%	0.95%
B9	6.66%	14.76%	-1.84%	12.80%	0.45%	14.68%	0.86%	4.98%
C1	17.175%	27.640%	-0.552%	3.983%	-0.126%	26.785%	-0.511%	0.74%
C2	3.394%	10.850%	-0.759%	-0.045%	1.076%	10.584%	-0.468%	6.51%
C3	0.418%	1.208%	-0.551%	0.366%	-0.345%	0.952%	0.483%	0.25%
C4	2.60%	13.50%	-1.75%	0.28%	0.11%	13.52%	1.25%	5.60%
C5	0.76%	1.55%	-1.38%	39.45%	-0.05%	1.45%	2.07%	12.14%
C6	2.81%	0.26%	-1.40%	0.01%	-0.03%	0.03%	0.56%	1.62%
C7	4.06%	10.14%	-1.23%	6.63%	-0.68%	10.13%	-0.17%	-0.31%
C8	-0.02%	0.64%	-0.78%	4.86%	-0.25%	0.73%	2.61%	1.29%
C9	4.13%	12.31%	-0.83%	31.65%	-0.06%	12.01%	-0.45%	-0.42%
C10	3.80%	15.06%	-0.86%	2.63%	12.19%	14.85%	-0.38%	0.32%
C11	2.83%	7.87%	-0.69%	1.78%	0.42%	7.61%	-0.50%	1.23%
C12	6.97%	13.65%	-1.83%	-0.25%	-0.04%	13.28%	-0.21%	2.90%
C13	5.52%	13.83%	-1.25%	3.51%	-0.52%	13.62%	1.44%	1.07%
D1	7.963%	14.470%	-1.312%	0.431%	-0.448%	14.775%	-0.259%	0.16%
D2	0.776%	1.104%	-0.474%	-0.825%	-0.392%	0.893%	-0.222%	0.49%
D3	10.979%	14.793%	-1.840%	5.417%	0.041%	14.792%	-0.335%	2.55%
D4	0.48%	0.61%	-0.61%	2.97%	1.09%	0.42%	0.25%	1.95%
D5	1.10%	0.92%	-0.51%	2.86%	-0.04%	0.75%	0.60%	0.21%
D6	2.66%	5.66%	-0.98%	4.05%	-0.53%	5.71%	-0.39%	0.35%
D7	11.59%	39.15%	-2.00%	-0.43%	0.57%	54.44%	-0.19%	1.16%
E1	3.546%	13.562%	-0.843%	1.138%	-0.157%	12.856%	0.512%	5.80%
E2	1.819%	0.896%	-0.808%	1.233%	-0.121%	1.145%	0.268%	0.23%
E3	2.636%	1.193%	-0.575%	3.316%	-1.046%	1.224%	-0.074%	0.40%
E4	3.18%	17.83%	-0.63%	0.78%	-0.38%	17.45%	0.28%	1.13%
E5	2.02%	14.54%	-1.35%	0.96%	11.32%	14.12%	0.35%	1.78%
E6	0.24%	0.44%	-0.82%	-0.74%	-0.22%	0.55%	0.15%	0.84%
F1	-0.212%	15.946%	-0.035%	4.749%	-0.819%	15.785%	4.879%	0.23%
F2	0.302%	1.772%	-1.002%	1.507%	2.558%	1.725%	2.034%	2.08%
F3	3.026%	14.903%	0.880%	5.040%	12.796%	14.422%	-2.003%	2.40%

Table A2 – First Generation Unit Root Test (Mandala Wu Test)

	1st Generation Unit Root (MW Equation 1) Panel 38 H		*1st Generation Unit Root (MW Equation 2) Panel 38 H*		*1st Generation Unit Root (MW Equation 1) Group B*		*1st Generation Unit Root (MW Equation 2) Group B*		*1st Generation Unit Root (MW Equation 1) Group C*		*1st Generation Unit Root (MW Equation 2) Group C*	
Level	**Without T**	**With Trend**	**Without T**	**With Trend**	**Without T**	**With Trend**	**Without T**	**With Trend**	**Without T**	**With Trend**	**Without T**	**With Trend**
LOP Costs	1402.735***	1903.317***	1353.856***	1705.674***	357.632***	442.537***	376.597***	403.111***	435.664***	584.474***	421.936***	574.627***
LOutC1	1934.519***	1919.515***	1934.519***	1919.515***	366.940***	411.150***	366.940***	411.150***	607.902***	615.964***	607.902***	615.964***
LOutC2	1202.031***	1269.016***	1202.031***	1269.016***	270.394***	260.369***	270.394***	260.369***	395.857***	456.138***	395.857***	456.138***
LCapac	1445.155***	1378.820***	1445.155***	1378.820***	280.022***	245.030***	280.022***	245.030***	381.794***	381.919***	381.794***	381.919***
LIntern	1610.334***	1751.285***	1610.334***	1751.285***	423.917***	399.191***	423.917***	399.191***	508.952***	589.750***	508.952***	589.750***
LWTime 1	98.140**	61.407	98.140**	61.407	18.500	10.252	18.500	10.252	38.469**	16.981	38.469**	16.981
LWTime 2	75.600	66.270	75.600	66.270	29.890**	23.780	29.890**	23.780	15.553	9.949	15.553	9.949
1st Difference	**Without T**	**With Trend**	**Without T**	**With Trend**	**Without T**	**With Trend**	**Without T**	**With Trend**	**Without T**	**With Trend**	**Without T**	**With Trend**
D.LOP Costs	576.638***	926.230***	630.826***	814.860***	135.72***	202.55***	174.938***	198.297***	198.705***	290.755***	197.256***	257.068***
D.LOutC1	788.808***	804.340***	788.808***	804.340***	146.23***	182.06***	146.239***	182.06***	247.733***	262.442***	247.733***	262.442***
D.LOutC2	1202.031***	661.941***	1202.031***	661.941***	155.39***	144.56***	155.39***	144.56***	213.413***	252.720***	213.413***	252.720***
D.LCapac	608.563***	535.565***	608.563***	535.565***	104.09***	78.335***	104.094***	78.335***	116.981***	102.031***	116.981***	102.031***
D.LIntern	791.539***	840.802***	791.539***	840.802***	211.19***	197.79***	211.196***	197.79***	242.898***	267.793***	242.898***	267.793***
D.LWTime 1	76.286	51.246	76.286	51.246	22.898	13.529	22.898	13.529	16.870	9.031	16.870	9.031
D.LWTime 2	124.282***	97.534**	124.282***	97.534**	70.569***	47.645***	70.569	47.645***	22.512	16.716	22.512	16.716
	1st Generation Unit Root (MW Equation 1) Group D		*1st Generation Unit Root (MW Equation 2) Group D*		*1st Generation Unit Root (MW Equation 1) Group E*		*1st Generation Unit Root (MW Equation 2) Group E*		*1st Generation Unit Root (MW Equation 1) Group F*		*1st Generation Unit Root (MW Equation 2) Group F*	
Level	**Without T**	**With Trend**	**Without T**	**With Trend**	**Without T**	**With Trend**	**Without T**	**With Trend**	**Without T**	**With Trend**	**Without**	**With Trend**
LOP Costs	256.260***	350.637***	215.502***	280.899***	259.445***	366.545***	212.541***	286.555***	93.735***	159.124***	133.839***	153.804***
LOutC1	396.555***	379.138***	396.555***	379.138***	407.249***	370.357***	407.249***	370.357***	155.873***	142.906***	155.873***	142.906***
LOutC2	196.037***	210.410***	196.037***	210.410***	227.763***	218.455***	227.763***	218.455***	111.980***	123.644***	111.980***	123.644***
LCapac	187.727***	198.989***	187.727***	198.989***	286.765***	314.142***	286.765***	314.142***	209.382***	185.652***	209.382***	185.652***
LIntern	282.111***	306.606***	282.111***	306.606***	247.831***	305.621***	247.831***	305.621***	147.523***	150.118***	147.523***	150.118***
LWTime 1	7.423	7.877	7.423	7.877	4.933	7.998	4.933	7.998	28.815***	18.299***	28.815***	18.299***
LWTime 2	12.978	11.582	12.978	11.582	1.950	3.902	1.950	3.902	15.228**	17.057***	15.228**	17.057***
1st Difference	**Without T**	**With Trend**	**Without T**	**With Trend**	**Without T**	**With Trend**	**Without T**	**With Trend**	**Without T**	**With Trend**	**Without T**	**With Trend**
D.LOP Costs	114.102***	178.735***	103.903***	136.410***	93.346***	173.878***	94.287***	130.818	34.765***	80.311***	61.467***	80.657***
D.LOutC1	150.671***	139.750***	150.671***	139.750***	185.835***	167.508***	185.835***	167.508***	58.329***	52.575***	58.329***	52.575***
D.LOutC2	110.619***	122.131***	110.619***	122.131***	105.301***	96.432***	105.301***	96.432***	38.800***	46.093***	38.800***	46.093***
D.LCapac	104.941***	98.482***	104.941***	98.482***	81.593***	85.538***	81.593***	85.538***	102.775***	90.543***	102.775***	90.543***
D.LIntern	144.385***	151.688***	144.385***	151.688***	121.509***	144.649***	121.509***	144.649***	71.552***	78.875***	71.552***	78.875***
D.LWTime 1	9.132	8.135	9.132	8.135	5.410	7.581	5.410	7.581	21.974***	12.970**	21.974***	12.970**
D.LWTime 2	16.910	13.755	16.910	13.755	3.317	7.610	3.317	7.610	10.972*	11.809*	10.972*	11.809*

*Notes:Values in parenthesis report to standard errors. *, **, *** represent significance at 10%, 5% and 1% respectively. L is levels and D is differences*