Baumol's Cost Disease in the Health Care Sector

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Abstract

The concern for the impact of the Health Care costs in private and public spending has been increasing because of its effect on the country's financial stability.

Therefore, several drivers of Health Care Expenditure have been studied. However, one of its most relevant drivers is Baumol's cost disease. Baumol (1967) defines the cost disease as the difference between the wage growth in the overall economy and productivity growth in the services sector, such as the health care sector. This excess in wages causes the unit costs in the health care sector to increase over time.

In order to understand if there is enough margin for policymakers to establish effective policies to control for the rise in health care costs, this thesis studies the impact of Baumol's cost disease in this sector in OECD countries. To do so, I define an instrument, the adjusted Baumol variable, to measure Baumol's cost disease and apply it to a panel data set containing 18 OECD member countries from 1970 to 2016.

The results found show that the adjusted Baumol variable is explaining from 20% to 80% of the increase in Health Care expenditure, depending on the definition of the Baumol sector. These results may imply that policymakers still have some margin to implement policies since the rise in Health Care expenditure is partially explained by Baumol's cost disease.

Keywords: Health Care Expenditure, Unbalanced growth, Services Sector, Baumol's Cost Disease, Adjusted Baumol variable, Panel Data, Fixed Effects, Macroeconomics of Health Care, Fixed Effects Model

JEL codes: I10, C23, C26, H510, O110.

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Resumo

O impacto do aumento dos custos na despesa pública e privada relativos ao Sector da Saúde tem sido motivo de preocupação, uma vez que estes afetam a estabilidade financeira do país.

Assim, foram estudados vários fatores influenciadores dos gastos associados ao sector da Saúde. De acordo com os resultados obtidos, a doença de custos de Baumol foi um dos fatores com maior impacto no crescimento dos referidos custos. Baumol (1967) define a doença dos custos como sendo a diferença entre o crescimento dos salários na Economia e o crescimento da produtividade no sector dos serviços, como é o caso do sector da saúde. Portanto, esta diferença faz com que os custos unitários no sector de saúde aumentem ao longo do tempo.

Esta tese estuda o impacto da doença dos custos de Baumol no sector da Saúde com o intuito de compreender se existe espaço suficiente para a introdução de políticas eficazes na contenção do aumento dos custos associados a este sector. Portanto, foi definido um instrumento – variável de Baumol ajustada – para medir a doença de custos de Baumol e, posteriormente, foi aplicada com um conjunto de dados em painel, contendo 18 países membros da OCDE de 1970 a 2016.

Os resultados encontrados mostram que a referida variável explica entre 20% a 80% do aumento dos gastos com a saúde dependendo da definição do sector de Baumol. Conclui-se que existe margem para implementar políticas pois o aumento das de saúde não é totalmente explicado pela doença dos custos de Baumol.

Palavras-chave: Gastos no setor da Saúde, Crescimento Económico, sector dos Serviços, Doença de custos de Baumol, variável de Baumol Ajustada, Dados em Painel, Modelo de Efeitos Fixos.

Códigos JEL: C23, C26, H510, I10, O110.

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1 Introduction

Health care expenditure is an important topic to keep studying given the rising concern for the sustainability of public finances and the insights these studies can provide policy debate with.

In OECD member countries, from 1970 to 1980 the growth of per capita real health care expenditure increased substantially, this might have been caused by further access to insurance coverage in most OECD countries as well as the demand for improvements in health care. This great expansion of costs created the need for policy implementation by the governments to constrain public spending which, consequently, caused the growth rate of health care expenditure to decelerate from 1980 to 1985 and in some countries, for example, Denmark, France, Ireland, and the UK, it even became negative. However, from 1985 onwards the growth rate of health care expenditure picked up and kept on increasing until 1995. From 1995 to 2000, there is again a decrease in spending for this sector, although less significant than the decline observed before (see Table 1)[1].

Table 1. Total health care expenditure per capita, constant 2010 prices in US dollars

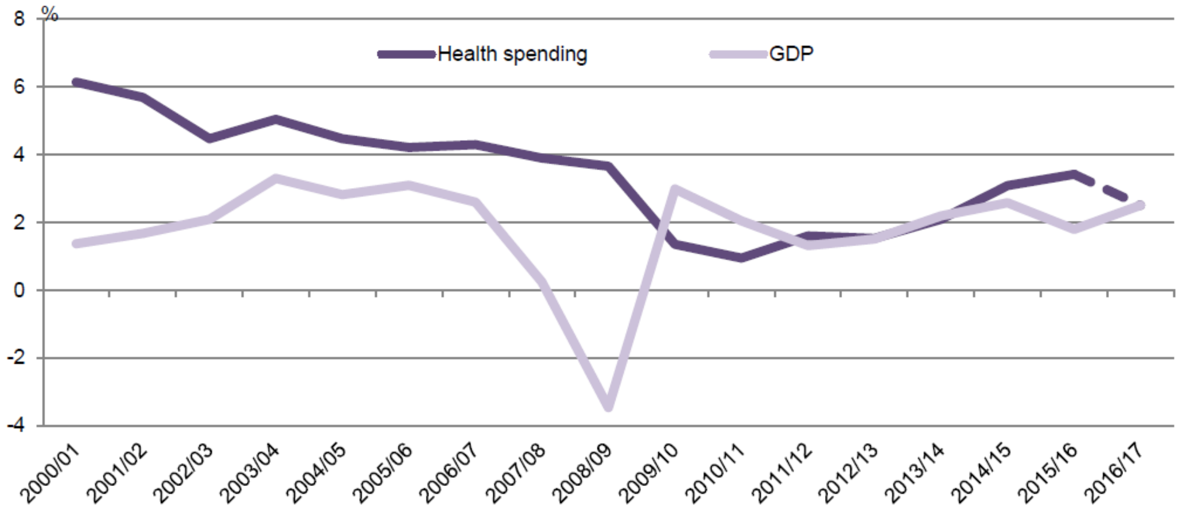
	1970	1975	1980	1985	1990	1995	2000
Australia	-	2569.3	2476.1	1704.6	2181.7	2463.0	2422.1
Austria	378.5	907.8	1556.2	893.7	2390.1	3360.1	2689.1
Belgium	469.8	1078.5	1756.5	1009.7	2145.0	2722.0	2219.3
Canada	1512.7	1863.1	1850.0	1973.6	2714.0	2417.8	2511.9
Denmark	-	2698.7	3055.3	1759.8	3255.6	3831.9	3149.3
Finland	979.1	1535.7	1825.7	1387.5	2852.3	2419.2	1923.7
France	933.4	1660.4	2133.1	1202.2	2373.4	3337.4	2563.1
Ireland	870.6	1270.6	1567.3	804.0	1307.9	1684.2	1764.2
Italy	-	-	-	-	2639.9	2024.5	1907.9
Japan	198.3	348.4	623.8	729.2	1328.0	2364.2	2454.7
Korea	174.1	146.6	243.5	238.2	508.8	621.7	617.4
Netherlands	-	1110.2	1660.8	1031.1	2296.4	2933.3	2264.5
Norway	1067.7	2261.6	3168.3	2122.0	3624.8	4070.0	4096.3
Portugal	1044.0	2907.2	1793.5	601.5	977.3	1303.9	1253.3
Spain	764.5	1522.0	1517.9	678.8	1689.2	1682.0	1343.5
Sweden	2030.1	3353.8	4151.8	2103.4	3314.8	2776.7	2606.1
United Kingdom	1106.0	1385.4	1665.0	1045.0	1678.1	1754.4	2080.4
United States	1452.5	1809.9	2363.7	3068.4	4093.4	4835.5	5632.9

Source: OECD Health Statistics 2018 (OECD 2018a)

1 Table 1 demonstrates the evolution of health care expenditure from 1970 to 2000. The lack of data available for this time frame (1970 – 2000) made it impossible to construct a graph for the entire time frame (1970 – 2017).

Afterwards, between 2000 and 2008, the growth rate of health care expenditure increased again reaching the fastest rate of health care expenditure for this time frame (2000 – 2017) that was around 4% to 6% per year, while, after the crisis in 2008/2009, when GDP declined substantially, the growth rate declined until reaching 1%, in 2011. Subsequently, the fastest rate registered was around 3%, from 2015 to 2016, and it was sparked by the increasing demand for long-term and outpatient care (OECD 2018b) (see Figure 1).

Figure 1. Annual growth of real GDP and real health care expenditure, 2000-2017 (in %)



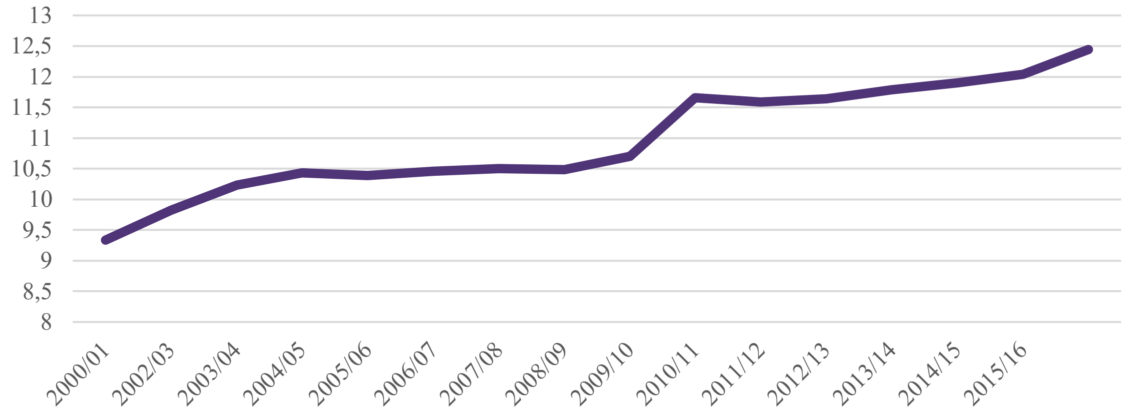
Source: Health Spending: Latest trends, 2018
Primary source: OECD Health Statistics 2018

The 2018 Ageing Report (European Commission 2018) suggests health care expenditure will increase in the future, according to its projections that are based on the assumption that spending per capita should evolve according to a country's income, but empirical research concluded that this may not be the case since the population tends to demand and expect improvements in health care services over time. Hence, the increase in income of a country might not always be aligned with the increase in demand for health care. As seen in Figure 1, health spending has only started following GDP growth more closely after the crisis of 2009.

Furthermore, health care expenditure as a percentage of GDP (Figure 2) increased around three percentage points from 2000 until 2016.

According to OECD projections (Oliveira Martins, de la Maisonneuve, and Bjørnerud 2013), and considering a "cost-pressure" scenario[2], by 2050 public spending in health care and long-term care will reach around 13% of GDP whereas, in 2005 reached only 6.8% of GDP. Although these projections are only referring to public and long-term health care expenditure as per cent of GDP, it is reasonable to assume that total health care expenditure as a per cent of GDP will increase.

Figure 2. Health care expenditure as % of GDP, in OECD countries



Source: World Health Organization Global Health Expenditure database
http://apps.who.int/nha/database

Newhouse's (1977) foremost research found that health care expenditure, although resulting from population ageing and national income, results also from the development of new medical technologies. These findings show the relevance of studying the drivers of health care expenditure.

Another factor motivating this research is that, in most OECD member countries, health care is subsidised or even provided by the government, this way the government is setting the prices, probably lower than the real costs of health care (Hartwig 2011). The latter is seriously affecting a country's public finance and policy.

[2] To understand the assumptions of "cost-pressure" scenario check Oliveira Martins, de la Maisonneuve, and Bjørnerud, *"Projections of OECD Health and Long-Term Care Public Expenditures"* (Oliveira Martins, de la Maisonneuve, and Bjørnerud 2013).

For that reason and considering this increased preoccupation with public spending, it is important to keep developing the investigation of this topic, especially including Baumol's cost disease as a major driver of the rise in HCE[3]. The research done so far considering this perspective, for example Hartwig (2008) and Colombier (2017) studied this topic for OECD countries, Medeiros e Schwierz (2013) studied it for the European Union, while Bates and Santerre (2013) investigated the impact of the cost disease on the health care sector in the United States.

Previous research by Hartwig (2008) concludes that Baumol's cost disease has a full impact on the evolution of HCE, however, as other authors believe (Bates and Santerre 2013; Colombier 2017) the impact of the cost disease is of major importance but does not explain the evolution of HCE entirely since other drivers may be affecting it, and maybe at even higher proportion, for example, female employment and GDP per capita, as found in this research. So, following the latest reasoning, this study intends to investigate the magnitude of the impact of Baumol's cost disease in per capita health care expenditure, with a sample of 18 OECD member countries from 1970 to 2016. Furthermore, it also analyses the effect of several other drivers such as GDP per capita, population ageing and its health status (life expectancy at birth and at 65 years of age), the evolution of cancer – growth of the number of neoplasms – and unemployment rate.

Therefore, this dissertation intends to provide some consistency to the previously found results by Colombier (2017) and Bates and Santerre (2013). Thus, by adopting the same methodology as the mentioned authors, it will be possible to compare and maybe provide some proof of robustness for the previously used methodologies.

This study is also contributing to the literature by providing evidence on never studied before drivers that are also affecting HCE. A surprising finding is the fact that female employment is explaining a major part of the behaviour of HCE.

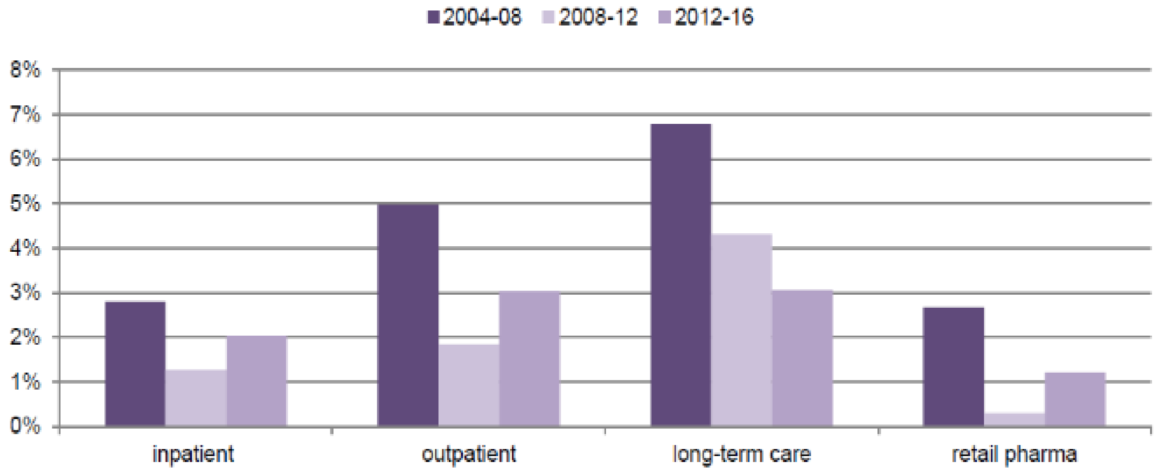
Ultimately, this study wants to offer the literature some insight on the need and possible relevance of introducing policies in this sector and even other nonprogressive sectors, to help increase efficiency in the health care sector and consequently reduce or control the costs associated, in the long run.

For that reason, Figure 3 was chosen to demonstrate the different proportions of spending for four types of health care service. It is evident that a higher portion of capital is usually being

[3] Throughout this dissertation, per capita current health care expenditure will be referred to as HCE.

allocated to long-term care while the least proportion is being allocated to retail pharma. As a result, future research should focus on distinguishing how Baumol's cost disease is affecting every different service of health care, in order to provide a more detailed explanation for the rise of HCE. This way, policymakers could design more specific and effective policies to control the rise in HCE and consequent damages of public finances.

Figure 3. Average yearly growth of selected health care services, OECD average, 2004-2016



Source: Spending on Health: Latest Trends (OECD 2018)

1.1. Baumol's model of unbalanced growth

According to Baumol (1967), the economy is separated into two types of sectors: the technologically progressive sector and the nonprogressive sector. These sectors are distinguished as the latter is more labour intensive while the former is not.

Technologically progressive sectors are characterised by the intense use of technological innovation. The introduction of technological innovation is continuously contributing to the increase of labour productivity in this type of sector. The best example is the manufacturing sector.

Indeed, the nonprogressive sector is usually said to comprise the services sector, where the amount of labour employed in the provision of the service itself is proportionally related to its quality. In fact, Baumol (1967) states that in this sector "labour is in itself the end product" and introduces personal services as one of the sectors affected by the disease, as well as, "live performing arts, automotive repair, health care, education, postal services, automotive, accident insurance and care of the indigent" (Baumol 1993). These are also characterised as stagnant sectors since they have been almost non-responsive to productivity growth for as long as the data is available, which means that productivity in these sectors is indeed growing, only more slowly than the others.

Baumol (1993) states that the personal services are part of the nonprogressive sector and that these are not untouched by technological innovation, since innovation is everywhere, even if it is not as big as an increase in productivity growth, furthermore the effect is not direct, it is more indirect. An example in the health care sector is the introduction of technology in administrative systems, which allows for more efficient storage and transmission of patient data.

According to Baumol's Model of Unbalanced Growth (Baumol 1967), the wages of the two different sectors move together. Therefore, when the wage in the progressive industry increases as a result of productivity growth, the wage in the nonprogressive industry must increase equally to keep the balance of the shares of labour employed in both sectors. As a matter of fact, if the wages did not move together, the workers employed in the nonprogressive sector would prefer to work in the progressive sector – with the higher wage, which would lead to the lack of essential input in the nonprogressive sector.

Baumol assumes labour as the only input (for simplification).

1.2 Discussion of the assumptions

Essentially, nominal wages in the overall economy move together, according to productivity growth in the progressive sector, leading to a decrease of nominal costs in that sector while unit costs remain constant. Hence, its price level remains constant while unit costs and relative prices in the nonprogressive sector are higher, i.e., the cost of labour is higher because wages are higher, while the output is constant.

The nonprogressive sector is more affected by the cost disease when the difference between its productivity growth and the productivity growth of the progressive sector is higher (Colombier 2017) because the higher the productivity growth in the progressive sector, the higher the overall wages in the economy. Meaning that the relative cost of labour is increasing in the nonprogressive sector when wages increase, given that the productivity remains constant in this sector. Therefore, the cost disease is affecting these stagnant sectors the most, when the difference between wage growth and productivity growth is higher.

In the nonprogressive sector, the output is demand driven by the rise of productivity since workers are the consumers and their wages increase with productivity in the progressive sector. As a result, its supply must increase proportionally to the productivity growth of the economy. Therefore, the nonprogressive sector will require that a higher share of labour is allocated to it, which means that its relative cost of labour will increase. To support the extra labour needed there must be a larger share of GDP allocated to the nonprogressive sector in order to cover the increasing relative costs in this sector.

The latter suggests that there will be a lower share of labour and GDP employed in the progressive sector, which will lead to a decreasing output that, consequently, slows down productivity growth of the overall economy. This allocation of labour and GDP is the actual "Baumol's cost disease". The cost of labour is higher in the nonprogressive sector because even though there is more input (labour), productivity is not growing as fast as in the manufacturing sector. In fact, the cost disease may be affecting the economy even more because the share of nonprogressive industries is increasing (Nordhaus 2008).

In most developed countries, there has been an increase in the share of labour allocated to services sector – nonprogressive sector – leaving a smaller share allocated to the more progressive sectors (Colombier 2017). This shift is promoting a decrease of aggregate productivity since more input is being allocated to the less productive industry (Nordhaus 2008). However, this may be happening due to automation and technological development that are replacing employees in sectors like manufacturing, which, as time goes by requiring less and less labour to produce the same amount of output, but this shift may actually be maintaining aggregate productivity since it does not allow productivity in progressive sectors to go down.

However, in order for this to happen, productivity needs to be a “normal good”, otherwise demand for it will disappear. An important question is whether or not health care is a “luxury good”. According to Baumol (1993), some of the services are still demanded when its price increases, which means they are price inelastic. This may be the case of the health sector. Otherwise, if price elasticity is not low enough the sector may be in danger of disappearing. The latter assumption is quite extreme as real-life households will always demand health care, regardless of the price.

Previous literature (Oliveira Martins and de la Maisonneuve 2006) concludes that the fastest rise of nominal health care prices comparing to the growth of national income is causing real health care expenditure to increase.

In Baumol’s perspective “productivity growth in the economy means we can afford more of everything” (1993, 23), “it is only an illusion that we cannot do so” (1993, 21). As support for this argument, Bradford, Malt and Oates (1969) defend that consumers have access to additional services and goods in a productivity growing economy if a controlled portion of input of the progressive sector, i.e., sector with growing productivity, is allocated to the nonprogressive sector to ensure its output growth, attempting to balance productivity in both sectors. Conversely, Colombier (2017) defends that this allocation of input to the nonprogressive sector promotes its expansion and, consequently, a decreasing productivity growth economic-wide. This happens because a larger proportion of the economy is now the Baumol sector – a sector with little or no productivity growth - whereas before it was the progressive sector.

Hartwig (2008) alludes to the directly proportional relation between increasing wages as a consequence of excess productivity growth, and the increasing health care expenditure.

1.3 What is the nature of productivity increases in the Health Care Sector?

Regarding productivity growth in the health sector, one may argue that productivity is growing in this sector given all the technological innovation the medical procedures have been subject to, that have increased efficiency, recovery time of the patient and even increased the chances of recovery or survival of the patient. However, this kind of improvement cannot be considered or measured as a rise in productivity because, although these medical advances guarantee an improvement in the quality of the service, they are not able to guarantee an increase in the quantity of output. As a result, the improvement in medical technologies does not replace labour.

Therefore, it is not possible to compare with the productivity growth in progressive industries, like manufacturing, since this improvement and introduction of new technology will, most likely, replace labour.

A good example (Hartwig 2011) is the use of an innovative medical exam that will improve the quality of the diagnosis but will probably take longer than a traditional physical examination. This means that the quality of the output can be said to be increasing, but the quantity is not. On the other hand, when it comes to surgical procedures, the advances made in this field tend to reduce the recovery time of the patient which means less time hospitalised so fewer costs. Nevertheless, one cannot state there is an increase in output in the same way there is in the manufacturing sector, for instance.

Another argument that is usually brought forward against Baumol's theory is that productivity in the health care sector is growing at the same pace, or even faster than the progressive sectors' productivity, because of the reasons stated above. It is only the failure in measuring this productivity that shows the opposite. To deal with this argument and considering the advice provided by previous research (Boskin et al. 1996; J.E Triplett 1999; Berndt et al. 2001) it was decided not to use medical price indices given the evidence on the upward bias associated with it. The fact that these indices do not include or update the quality of the treatments and services provided is causing this upward bias that, consequently, will affect real value added of the industry. This event happens because value added for the is computed by deflating nominal expenditure of the industry using this medical price index, i.e., a lower denominator produces an increased result.

2 Literature review

Several authors tested Baumol's theory of unbalanced growth empirically, more specifically the argument of the existence of a Cost Disease affecting the health care sector. Moreover, interestingly, most of these authors found evidence in favour of Baumol's argument and developed further theoretical framework for the model.

Research on the rise of HCE and the Baumol's cost disease still lacks consensus and robustness of the conclusions because most authors rely on different methodologies and data. Therefore, there is not enough consistency to allow for the comparison of the different results discovered.

In 1977, Newhouse paved the way for the research on the evolution of HCE and its effect on the population's well-being. The association found between GDP per capita and HCE was likely his main contribution to the literature. Both time-series and cross-country data proved HCE to be a luxury good considering that income elasticity of HCE is substantially higher than one.

Disentangling Baumol's diseases into six "syndromes" [4], Nordhaus (2008) found evidence in the data in favour of the "price and cost disease", "stagnating real output" syndrome and "impact on aggregate productivity growth" meaning that the output of nonprogressive industries increases at a slower pace than the overall economy, triggering the decrease of aggregate productivity growth, considering the fact that the increase in the demand for output of nonprogressive industry is increasing (therefore, the portion of aggregate output representing nonprogressive industries is increasing). On the other hand, the "unbalanced growth" syndrome and "impact on factor rewards" are not in alignment with the empirical results found. Nordhaus (2008) did not find the increase in productivity to have a beneficial impact on wages – factor rewards. Additionally, he found that the higher share of the nominal output of the economy originates from the nonprogressive sector, while productivity growth is only occurring in the progressive sector, meaning that a larger share of labour is being allocated to the services sector.

To test whether the increase in wages caused by excess of labour productivity growth in the progressive sector is driving the rise in HCE in 19 OECD countries Hartwig (2008) developed the first *Baumol variable* and proved its statistical significance by regressing per-capita wage

[4] (1) cost and price disease; (2) stagnating real output; (3) unbalanced growth; (4) impact on employment and hours; (5) impact on factor rewards; (6) impact on aggregate productivity growth (see Nordhaus (2008)).

growth, real GDP growth and employment growth on the growth of per-capita current health care expenditure, individually and combined (*Baumol variable*). The author defined the *Baumol variable* as the difference between wage growth and the growth of productivity - ratio of GDP per employee. Hartwig (2008) argues that the coefficient of the Baumol variable should be a good measure of the reliability of the Baumol theory: being different from zero does give credit to the theory. Moreover, the author tested the introduction of another explanatory variable, the growth of GDP per capita, which, as the *Baumol variable*, turned out to be statistically significant. Furthermore, the author found that the model was explaining 75% of the variation in HCE which was a major milestone for the research on this topic given the *Baumol variable* coefficient being different than the one indicated Baumol's theory to be right.

Focusing on 50 US states from 1980 to 2009, Bates and Santerre (2013) applied the same definition of the *Baumol variable* – difference between per capita wage growth and productivity growth – and tested its impact on per capita current HCE adjusted by the share of employment in the healthcare sector. Moreover, a vector of control variables (per capita GSP, share of the population with 65 years old or above, poverty rate, union coverage, unemployment rate) was introduced to check the robustness of the estimation. However, since the *Baumol variable* was suspected of being endogenous, i.e. it may cause the rise in HCE or may be caused by it, the authors performed a Two Stage Least Squares estimation, using nominal housing price index of the previous year as an instrumental variable, in order to solve the problem of endogeneity. The results of this estimation confirmed that per capita HCE is rising in parallel to the increase of excess wage growth relative to productivity growth, proving the existence of the disease in the health care sector in the US.

Soon after, Medeiros and Schwierz (2013) revisited Baumol's cost disease, using Hartwig's (2008) approach. They studied its importance on a sample of OECD countries with macroeconomic panel data and provided the literature with "long-term projection scenarios for the ratio of HCE-to-GDP". The results showed that the non-demographic drivers (income, the rise of relative prices of health services and technological progress in the medical sector) are the main contributors to explaining the recent rise in HCE, providing the literature with more evidence of the impact of Baumol's cost disease.

Nevertheless, Colombier (2017) filled in the gap in research by finding if and how affected the health care sector was by the cost disease in 20 OECD countries, from 1970 to 2010. So he developed a mathematical formulation for the model (Colombier 2012), described in the next chapter using a different definition of *Baumol variable*. Colombier (2017) defined it as the *adjusted Baumol variable,* and it is the difference between per capita wage growth and growth rate of labour productivity in the overall economy adjusted by the share of the *Baumol sector* in total employment; this way it is possible to measure to what extent the health care sector is affected by the cost disease keeping in mind that the wider the difference between wages and productivity the more affected by the disease. However the author decided to use two distinct definitions of *Baumol sector*, total services in the overall economy and, as Baumol stated, *community, social, and personal services without business-sector services* (Colombier 2017, 1616). Using a similar methodology as other authors (Bates and Santerre 2013) the author also suspected of an endogeneity bias, so using productivity growth of the manufacturing industry as instrumental variable and a matrix of drivers of HCE for the Two Stage Least Squares estimation, he found the coefficient of the *Baumol variable* to be statistically significant and to be around 0.3 meaning that there is only a proportion of HCE being affected by the cost disease, contributing between 0.15 and 0.40pp to per capita HCE annual growth.

The fact that the share of labour input in the *Baumol sector* is increasing while the share of labour input in the nonprogressive sector is not, maybe causing this endogeneity issue since this growth of the *Baumol sector* is causing a decline of the output in the overall economy.

The analysis of the results led Colombier (2017) to believe that the cost disease does not fully affect the health care sector, hence policymakers still have some margin to define policies against the rise of HCE. It may be the case that some of the parts of the health care sector as nursing care or doctors' consultations are causing the cost disease

Later, Hartwig (2011) provided the literature with an alternative test for the Baumol's cost disease, using the changes in relative prices of health care and checking whether these are causing the rise in HCE by testing the appropriateness of medical price indices for the study of Baumol's theory in an international setting. Using a sample of 19 OECD countries and panel data as in previous research, the author found the growth of GDP per capita and growth rate of relative medical care prices to be robust and to have strong explanatory power, proving to be the cause of increasing HCE and corroborating the Baumol hypothesis of cost disease.

In contrast to the previously mentioned research, Triplett and Bosworth (2003) defend that the Baumol's cost disease "has been cured" since the growth rate of labour productivity in the services sector after 1995 reached the productivity in the overall US economy. The factors found to be contributing to this convergence of productivity rates were the acceleration – from around 0 to 1.4 per cent a year - of multifactor productivity in the services sector, increase of the investment in Information and Technology and use of purchased intermediate inputs that improved services efficiency.

Previous literature concluded that the cost disease is affecting long-term care expenditure rather than the entire health care sector (Oliveira Martins and de la Maisonneuve 2006). This would be an important topic for future research since it could provide a completely different insight on the Baumol's cost disease.

A review of the existent literature on the drivers of HCE (Martín, del Amo Gonzalez, and Dolores Cano Garcia 2011) displayed conflicting results and conclusions, perhaps due to the absence of consistent methodologies when studying this topic and the fact that different authors attribute the fluctuations in HCE to different factors such as population ageing (Di Matteo 2005), evolution of income (Barros 1998), both (Roberts 2000), and also to proximity to dead (Zweifel, Felder, and Meiers 1999; Werblow, Felder, and Zweifel 2007). Yet there is agreement on the fact that GDP per capita is a robust driver of HCE and that several variants of the Baumol variable appear to give a significative contribute to explaining the trending rise of HCE. In fact, literature (European Commission 2018) defends that although demographic factors may have some impact on HCE rise, the impact of non-demographic factors is way more significative.

Nevertheless, the authors started introducing extra explanatory variables to isolate the impact of the Baumol variable and control for other drivers of HCE.

Authors such as Bates and Santerre (2013) and Colombier (2017), using the same methodology, including a *Baumol variable*, per capita GDP and a vector or matrix of control variables, tested how affected by the cost disease is HCE both in US and OECD countries. The control variables and the related findings found by these authors are summarised in Table 2.

Table 2. Summary: variables in previous literature

Suggested by	Variable	Findings
Colombier (2017) Sample: 20 OECD countries from 1970 to 2010	Death rate	it is an indicator of the health status of the population but, it does not affect HCE since it is not significant
	Density of physicians	not significant, meaning that "neither excess supply nor supply-induced demand" affect HCE (Colombier 2017, 1614)
	Infant mortality	it has a statistically significant negative coefficient representing the health status of the population
	Life expectancy	proxy for medical progress, since it should increase with progress, but it does not affect HCE because it is not significant
	No. Of acute bed days per capita	proxy for the efficiency of the health sector that was statistically significant
	Share of population aged 65 and above	proxy for the morbidity of the population found to be statistically significant and robust to most types of estimations
	Trade union density	it is not significant; consequently, labour market conditions do not affect HCE
Bates and Santerre (2013) Sample: 50 US states from 1980 to 2009	Percentage of the population with incomes below the federal poverty level	it does not cause a rise in HCE because it is not statistically significant
	Share of population aged 65 and above	The statistically significant variable that is causing an increase of HCE in the US
	Unemployment rate	it is probably explaining "the increased spending on Medicare that takes place during a recession" since it is found to be a significant variable (Bates and Santerre 2013, 389)
	Union membership rate	it is not correlated to per capita HCE as its coefficient is not statistically significant

As stated above, many other authors are focusing their research on the link between age indicators and HCE. For example, Dormont (2006) examines the effect of indicators of morbidity of the population and evolution of medical practices on over the year evolution of the age profile. To examine the effect of morbidity, the author uses a vector of explanatory variables representing illnesses and disabilities of the French population, between 1992 and 2000. To measure improvement in medical practices the author selected variables such as "home and office physician visits", "pharmaceutical and hospital expenditures". The results show that HCE is more affected by the evolution of medical practices, possibly investment in innovation, than by ageing.

Contrasting to the usual assumptions of the previously mentioned research, some authors refer to a "red herring" hypothesis and defend that the observed correlation between the rise of HCE and the increase of the elderly share of the population actually results from proximity to death (Werblow, Felder, and Zweifel 2007) i.e., when people are older they are likely closer to their time of death and keeping in mind that there is a "high cost of dying" (Zweifel, Felder, and Meiers 1999, 485), that is what is causing higher HCE to be correlated with elderly population.

OECD projections (Oliveira Martins, de la Maisonneuve, and Bjørnerud 2013) again show an increase in expenditure on health care and long-term care on average by OECD member countries from 2005 to 2050. Using both demographic (age) and non-demographic (income) drivers and assuming the last can be split into a "cost containment" scenario that should "mitigate" the effect of a "cost pressure" one.

3 Theoretical framework

This chapter will present the first framework developed by Colombier (2012)[5] and all the equations are of his authorship. Therefore, the notation used will be the same as Colombier (2017).

According to Baumol's model of unbalanced growth (Baumol 1967), there are two types of sectors: (A) progressive sector, (B) nonprogressive sector. From now on, the nonprogressive sector will be referred to as the *Baumol sector*.

Considering the previously mentioned assumption that labour is the only input, Colombier (2017) defined the following real output functions for both sectors:

$$Y(t)_A = aL(t)_A e^{rt} \ \ with \ \ r > 0 \tag{1}$$

$$Y(t)_B = bL(t)_B e^{st} \ with \ s \geq 0 \ and \ r >> s \tag{2}$$

At time *t* total input in the overall economy is $L(t)$: $L(t)_A$ for the progressive sector and $L(t)_B$ for the Baumol sector; correspondingly, *r* and *s* are the growth of labour productivity for each industry. In light of Baumol's model, productivity growth of the progressive sector *r* is greater than productivity growth of the Baumol sector s, which in the long term is thought to have a minor but positive productivity growth. The constants, a and b could, for example, represent the different "states of technological knowledge" (Colombier 2017, 1605) for each sector. Bates and Santerre (2013) mentioned that marginal productivity of labour would increase in the progressive sector while remaining constant in the nonprogressive sector, i.e., when increasing one unit of input in the progressive sector, *ceteris paribus*, the output will increase while nothing significant would happen to the output of the nonprogressive sector. Equations (1) and (2) provide evidence for the latter argument.

[5] *Colombier, C. 2012. "Drivers of Healthcare Expenditure: Does Baumol's Cost Disease Loom Large?" FiFo Discussion Papers No. 12-5. FiFo, Institute for Public Economics, University of Cologne* is the working paper version of Colombier (2017). So there will only be references to his last paper throughout this research.

Assuming market equilibrium, the ratio of both outputs is identical to the ratio of real demand:

$$Y_{(t)_B a}/Y\,(t)_{A^b} = L\,(t)_B/L\,(t)_A e^{(r-s)t} = \gamma \quad \text{with } \gamma := \ constant. \tag{3}$$

The behaviour of real demand depends on the type of goods supplied by each sector. If:

- Demand for both goods is price elastic, then the real demand ratio should decrease over time
- Demand for the product supplied by the Baumol sector – health care – is price inelastic, which keeps the real demand ratio constant. It also occurs when the government is subsidizing this sector, which is the case for several OECD member countries

As stated earlier, Baumol (1967) reckons that wages are equal for both sectors, at every point in time, and change in accordance with productivity growth in the progressive sector. As Bates and Santerre (2013, 387) denoted:

$$W(t) = W_0 e^{\mathrm{rt}} \tag{4}$$

Therefore, Colombier (2017) defines unit labor costs for each sector in the following expressions:

$$C_A = \omega(t)L\,(t)_A/Y\,(t)_A = we^{rt}L\,(t)_A/a\,L(t)_A e^{rt} = \omega/a \tag{5}$$

$$C_B = \omega(t)L\,(t)_B/Y\,(t)_B = we^{rt}L\,(t)_B/b\,L(t)_B e^{st} = w\,e^{(r-s)t}/b \tag{6}$$

After using the output functions to define the unit cost, it is possible to conclude that in the progressive sector the unit costs C_A do not depend on time, i.e. are constant over time since the wages in the overall economy are moving according to the growth of its productivity. However, in the Baumol sector, the unit costs C_B are changing over time and with the difference between the productivity growth rates in the progressive and Baumol sectors, *r* – *s*, illustrating the Baumol's cost disease. The cost disease impact on Baumol sector is as greater as the gap between productivity growth in the progressive sector *r* and, *s* the productivity growth of the Baumol sector; since *r* is equivalent to the growth rate of wages, the cost disease is the difference in the increase in wages and productivity growth in progressive sector.

Following this reasoning, Colombier (2017, 1607) defined productivity growth of the overall economy as:

$$\hat{y} = \frac{r + s\gamma e^{(r-s)t}}{1 + \gamma e^{(r-s)t}} \tag{7}$$

Therefore, assuming that growth rate of wages is $\widehat{\omega}$ and consequently, $\widehat{\omega} = r$:

$$\widehat{\omega} - \hat{y} = r - \frac{r + s\gamma e^{(r-s)t}}{1 + \gamma e^{(r-s)t}} = (r-s)\frac{\gamma e^{(r-s)t}}{1 + \gamma e^{(r-s)t}} = (r-s)l(t)_B \quad with\, l_B := L_B/L \tag{8}$$

The equation above demonstrates that the *Baumol variable* - difference between wage and productivity growth - is equal to the difference between productivity growth in the progressive sector and the Baumol sector ($r - s$), adjusted for the share of employment in the Baumol sector, $l(t)_B$. Contrarily to the Baumol variable defined by Hartwig (2008), which implies that total labour force is employed in the Baumol sector: they assume that $(\widehat{\omega} - \hat{y}) = (\mathrm{r} - \mathrm{s})$ so that $l(t)_B$ is approximately one. The Baumol variable approaches the growth of unit costs of the Baumol sector $(\mathrm{r} - \mathrm{s})$ only asymptotically. Even though the share of labour force, allocated to the Baumol sector, is increasing in most OECD countries, one cannot assume that almost all the labour is allocated to this sector[6].

$$\lim_{t\to\infty}(\widehat{\omega} - \hat{y}) = \lim_{t\to\infty}(r-s)\frac{\gamma e^{(r-s)t}}{1 + \gamma e^{(r-s)t}} = r - s \tag{9}$$

Considering the latter argument, the Baumol variable should be "adjusted by the inverse of the share of the Baumol sector in the total labour force" (Colombier 2017, 1607) as in the following expression:

$$r - s = (\widehat{\omega} - \hat{y})\frac{1}{l(t)_B} \tag{10}$$

$$\Delta \log\big(C_B(t)\big) = r - s = \frac{1}{l(t)_B}(\widehat{\omega} - \hat{y}) \tag{11}$$

[6] In 2009, in a sample of OECD countries, Colombier (2017) found that average employment share of the Baumol sector is around 75%.

After deriving the expression above, it is possible to estimate the Baumol variable for the Baumol sector - health care expenditure – using the right side of the equation. Moreover, it is possible to state that the left side represents the growth rate of the unit costs in the Baumol sector.

4 Data Sampling and Variables

Using data from 18 OECD member countries[7] from 1970 to 2016, it was possible to construct an unbalanced panel since there was no available data for every year and country of the sample. The criteria used in the selection of countries present in the sample was based on data availability. The countries with missing data (either for per capita Current Health Expenditure or the necessary variables used to compute the adjusted Baumol variable – GDP; total employment; labour costs; employment in the services sector; employment in community, social and personal services) for twenty years in a row were not included in the sample.

4.1 Dependent variable: Current health expenditure per capita

Current health expenditure per capita was collected from the OECD Health Database both in current and constant 2010 price in local currency and it represents the expenditure on health for all functions[8], providers[9] and financing schemes[10]. However, this dataset did not provide observations for every country and year.

[7] The sample includes Australia, Austria, Belgium, Canada, Denmark, Finland, France, Ireland, Italy, Japan, Korea, Netherlands, Norway, Portugal, Spain, Sweden, United Kingdom, United States.

[8] According to OECD System of Health Accounts, all the functions included in total expenditure in health care are: *curative care, rehabilitative care, long-term care, ancillary services, medical goods, preventive care, governance and health system and financing administration, other health care services not elsewhere classified (n.e.c.).*

[9] According to OECD System of Health Accounts, there are primary providers, such as *hospitals, residential long-term care facilities, ambulatory care services providers, ancillary services providers, retailers and other providers of medical goods, preventive care providers and secondary providers such as, health system administration and financing.*

[10] Financing schemes considered by OECD System of Health Accounts are *Government schemes, Social Health insurance, compulsory private insurance, Compulsory Medical Saving Accounts, Voluntary health insurance schemes, Non-profit institutions financing schemes, Enterprise financing schemes (other than employer-based insurance), Household out-of-pocket expenditure and RoW financing schemes.*

4.2 Explanatory variables

Adjusted Baumol variable

This variable was created according to the theoretical framework presented above using the difference between *growth of wage per worker* and the *growth of productivity in the overall economy*, adjusted for the *labour share of the Baumol sector*. Therefore, there was a need to collect and compute these variables.

Labour-related data – labour costs; total employment; total employment in the services sector; total employment in community, social and personal services - was collected from OECD STAN Database for Structural Analysis, in current and constant 2010 prices in local currency and national income data from OECD Annual National Accounts.

In order to estimate the *growth of wage per worker,* the labour costs (compensation of employees) were divided by total employment and, lastly, its growth rate was determined.

Additionally, the *growth of aggregate productivity* was computed by dividing GDP by total employment and assessing its growth rate.

To adjust the Baumol variable, the labour share of the Baumol sector was estimated; however, the research will be performed with two different Baumol sectors: total services; *community, social and personal services* as argued by Baumol (1993).

GDP per capita

National income is, according to most authors (Barros 1998; Roberts 2000; Hartwig 2008; Bates and Santerre 2013; Colombier 2017) one of the main drivers of HCE, for this reason, this study will assess that hypothesis.

Constant 2010 prices in local currency data were extracted from World Bank National Accounts.

Share of population with 65 years old and above

Population ageing as also been recognised by some authors (Bates and Santerre 2013; Colombier 2017) as a driver of HCE because it represents the changing morbidity of population. So, the increase in this share should be linked to the rise in HCE since this portion of the population usually has a higher demand for these services.

This share was computed using data from OECD Historical Population Data and Projections.

Life expectancy at birth

Data on this variable was collected from OECD Health Status Database, and it should be a proxy for medical development, as the increase in life expectancy arises from medical advances of technologies and pharmaceuticals

Life expectancy at 65 years old

This variable was suggested by Christiansen et al. (2006) and is included as a demographic variable and because the age composition is a relevant driver of HCE. Data for Life expectancy at age 65 for male and female were downloaded from the OECD Health Status Database, and the average of both variables was used in the regression.

Neoplasms (tumours)

The choice of these variables was based on the fact that, in OECD member countries, the number of people affected by the disease is rising and so are the health care costs associated. Costs are significantly higher for this disease than for other chronical illnesses. Data for the number of neoplasms was collected from OECD Health Status Database.

Female employment as a percentage of total employment

Data on female employment was collected from OECD Annual Labour Force Statistics.

This variable was included in the study considering the argument presented in Kaiser Women's Health Survey (Kaiser 2018) that women with less resources and no health insurance delay or go without health care, therefore the increase in the share of women employed means more resources and, most likely health insurance coverage which means more women are seeking health care.

4.3 Instrumental variable: previous-year housing price index

As mentioned in the literature, the Baumol variable is likely to be endogenous, hence the use of an instrumental variable to perform a Two Stage Least Squares estimation should be the best solution (Bates and Santerre 2013; Colombier 2017). This variable was chosen because it should be a reasonable indicator of wage growth in a country. This way it is likely correlated with the Baumol variable since this variable is computed using data for wage growth.
Housing price data were collected from OECD House Prices Database, in current and constant 2010 prices in local currency.

4.4 Summary statistics

Table 3 shows the summary statistics for all the variables included in the regressions, in constant 2010 prices and local currency.

Taking into consideration the ongoing debate on the order of integration of the variables used for the research on this topic and the recommendations present in the literature (Gerdtham and Jönsson 2000), both the dependent variable and all the explanatory variables, except for the adjusted Baumol variables, were transformed into first differences of logarithms to avoid spurious results. Both adjusted Baumol variables consist of the difference between growth rates, so there is no need to use its growth rate.

The discrepancy in the number of observations is due to data availability.

The mean for both adjusted Baumol variables turns out negative, which is not in line with Baumol's theory since the growth of wages should be higher than productivity growth. Instead, the results show that on average productivity growth is higher than wage growth for the overall economy. Possible reasons that explain the lack of growth of the wages are trade shocks and monopsony in the labour market which may depress the growth in wages below productivity growth rates. It is also possible that austerity applied recession in public spending may have hurt wage growth specifically for that period.

Table 3. Descriptive statistics for real data

	Obs.	Mean	Std. Dev.	Min	Max
Growth of current health expenditure per capita	786	0.038	0.046	-0.157	0.475
Growth of per capita GDP	828	0.021	0.026	-0.091	0.218
Adjusted Baumol variable – total services	802	-0.001	0.040	-0.353	0.206
Adjusted Baumol variable – community, social and personal	802	-0.001	0.105	-0.924	0.590
Growth of share of 65 years old and above	828	0.013	0.012	-0.031	0.066
Growth of female employment	802	0.006	0.010	-0.034	0.064
Growth of life expectancy rate at birth	788	0.003	0.003	-0.013	0.030
Growth of number of neoplasms	784	0.013	0.017	-0.050	0.112
Growth of life expectancy rate at 65 years old	783	0.008	0.012	-0.034	0.068
Growth of unemployment rate	460	0.014	0.142	-0.397	0.977
Growth of housing prices in the previous year	745	0.018	0.070	-0.196	0.336

Labour outsourcing in developing countries is one of the most significant trade shocks affecting developed economies. This happens because these countries supply cheaper labour. In order to compete, the wages in the developed countries will inevitably adapt and decrease (Di Tella and Rodrik 2019).

Monopsony in the labour market happens when the employers, through collusion, have autonomy to set the wages in the labour market unilaterally (Steinbaum and Stucke 2019). This way the wage growth is not dependent on productivity growth of any sector of the economy. This may cause a slower growth of wages.

Another factor that may be causing this result could be the fact that the average of the difference between wages and productivity growth is dependent on data and observations for each country and, there may be outliers.

Nevertheless, it would be important to investigate this detail in future research.

All the statistics estimated for the other variables are in line with the expected results. The high and positive mean of 3.8% growth of per capita current health care expenditure is proof of the importance of the research on this topic and the creation of policies to control this cost disease.

5 Empirical Analysis

5.1 Methodology

In order to estimate the effect of Baumol's cost disease on the rise of HCE, the following expression represents the stochastic equation of the growth rate of per capita current health care expenditure:

$$\Delta log(HCE(t))_i = \underbrace{\alpha \frac{1}{l(t)_{B,i}} \left(\widehat{\omega}_i(t) - \hat{y}_i(t)\right)}_{\textbf{Adjusted Baumol variable}} + \beta_j Z_{i,j}(t) + u_i(t) \tag{12}$$

with: $u_i(t) = \mu_i + \lambda(t) + e_i(t)$

Where:

i = country i and i =1, … , 18

t = time t and t = 1970, … , 2016

α = coefficient of the adjusted Baumol variable

$\beta_{j=0}$ = represents the intercept

$\beta_{j>0}$ = coefficient of matrix $Z_{i,j}(t)$ containing extra explanatory variables

$u_i(t)$ = composite error term

μ_i = unobserved country effects

$\lambda(t)$ = unobserved time effects

$e_i(t)$ = error term

Taking into account the expressions presented in the theoretical framework section, Colombier (2017) developed this expression to formally represent the effect of the adjusted Baumol on per capita HCE, letting the several variables vary over time and state.

The coefficient of the adjusted Baumol variable α represents the quantitative impact of the cost disease on per capita Current Health Care Expenditure. The closer to 1 the major is the impact of Baumol's cost disease in HCE. This might answer the question imposed by this and Colombier's (2017) research and provide insight into the possible application of policies to treat or deal with this disease.

In previous literature, authors estimate regressions both with deflated variables and non-deflated ones to verify the relevance and explanatory power of monetary fluctuations on National Income (GDP). Hartwig (2008) finds estimations with deflated variables to have a lower *adjusted* R^2, meaning monetary fluctuations have high explanatory power. The same happens when Colombier (2017) does estimations in real and nominal terms; the *adjusted* R^2 doubles with the use of current prices. As a result of the previous findings, both nominal and real variables will be used for all the next estimations.

There were several common denominators in the previously mentioned literature such as the use of panel data; Hartwig (2008, 2011) tested the robustness of the estimation techniques by adding further explanatory variables, tested parameter stability over time by splitting the estimation period into sub-periods and by excluding countries from the sample, one by one; Bates and Saterre (2013) and Colombier (2017) use a falsification test to assure that the estimation methods used were capturing Baumol's theory of cost disease instead of trends in the data. Moreover, given the lack of consensus about the order of integration of the variables, authors tend to use growth rates to avoid spurious results. However, in 2014, Hartwig used Extreme Bounds Analysis, given the models' uncertainty associated with this topic, to test the sensitivity of the components and findings of the models relative to alternative methodologies.

As reported by Hsiao (2003) and N. Anders Klevmarken (1989) the use of panel data is quite beneficial since it controls for individual heterogeneity associated with samples containing different countries, while time-series or cross-section do not. Additionally, as stated by Baltagi (2005), panel data has the advantage of providing "more informative data, more variability, less collinearity among the variables, more degrees of freedom and more efficiency" which consequently allow for the identification and measure of otherwise undetected effects.

However, data collection for panel can be a difficult task, and there may be measurement errors in the data. For example, countries frequently provide their own computed data to the different databases. As a result, the methodologies used to compute the same variable vary according to the country. Another downside is the cross-section dependence found in most macro panels, nevertheless, if accounted for should not affect inference.

The use of a Two-way fixed effects estimator (using time fixed effects as well as country fixed effects) seems reasonable because time fixed effects are controlling for factors like medical advances and public policy evolution that are common to all OECD member countries present in the sample and are influencing the growth of HCE. On the other hand, country fixed effects are controlling for the unobserved factors influencing the growth of HCE specific to each country.

As in previous literature (Bates and Santerre 2013; Colombier 2017), it is likely that the resulting estimates of the Two Way Fixed Effects estimator suffer from both heteroskedasticity and serial correlation; hence in order to determine the need for the use of clustered standard errors both the Wooldridge test on autocorrelation and the Modified Wald test for groupwise heteroskedasticity were performed. The results were in line with the previously mentioned suspicions, so the standard errors were clustered in order to guarantee that those and the tests statistics are correct and allow for these features.

5.2 Results for Baseline regressions

The results found for the models represented in Table 4, in constant 2010 prices and current prices, are in line with the results found by most of the previously mentioned authors (Hartwig, 2008; Bates and Santerre 2013; Colombier 2017). For the models using only the Baumol variable adjusted by the labour share in the services sector, it was found that this variable is statistically significant and its positive coefficient ranges from 0.24, for nominal data, to 0.32 for real data. Similar results were found for the coefficients of HCE in both real and nominal models including GDP per capita as another explanatory variable, though the magnitude of GDP's coefficients is somewhat different (0.34 – 0.38). Although the magnitude of the coefficients is not precisely the same for both models with real and nominal variables, they are quite similar and all positive and statistically significant, thus the conclusion is the same.

Table 4. Two Way Fixed effects using current and constant 2010 prices
(Baumol sector = total services sector)

	Log Difference of Current Health Care Expenditure, per capita			
	Constant 2010 prices		Current prices	
	Without per capita GDP	**With per capita GDP**	**Without per capita GDP**	**With per capita GDP**
Adjusted Baumol variable (total services sector)	0.322*** (5.29)	0.348*** (6.17)	0,241*** (2,78)	0,381*** (8,12)
GDP per capita	–	0.336*** (5.32)	–	0,732*** (7,33)
Constant	0.05* (2.02)	0.042 (1.66)	0,125*** (4,67)	0,048 (1,72)
Adjusted R²	0.25	0.31	0.48	0.694
Observations	760	760	759	759
F test (time vs. Pooling)	6,28***	4,96**	65,86***	32,47***
Hausman test (FE vs. RE)	1.63	775,54***	0	7,88**
Wooldridge test for autocorrelation in panel data	16.126***	9.611***	11,071***	5,511**
Pesaran's test of cross-sectional independence	-3.872***	-3.784***	-3,629***	-3,629***
Modified Wald test for groupwise heteroskedasticity	565.86***	617.93***	512,55***	547,74***

notes:
The estimations were performed using the Two-Way Fixed Effects Within-Estimator.
Standard errors were Clustered by Country to deal with autocorrelation and heteroskedasticity.
All variables are in First Differenced Logarithms, except for the Adjusted Baumol Variable.
The Baumol variable was adjusted by the **Baumol sector**; **Baumol sector** = total services sector.
Adjusted Baumol Variable = (growth of wages per employee in overall economy – growth of productivity growth in overall economy) / (share of labour allocated to total services sector).
The table reports the coefficients of each variable and the standard errors, in parenthesis.
f-test on country effects and time effects, respectively, H0: no significant effects.
Hausman test on fixed effects (FE) vs. random effects (RE) model, H1: RE model is inconsistent, chi-square test statistic.
Wooldridge test for autocorrelation in panel data, H0: no first order autocorrelation.
Pesaran's test of cross-sectional independence, H0: no cross-section independence
Modified Wald test for groupwise heteroskedasticity, H0: homoskedasticity.
*Statistically significant at the 10 per cent level.
**Statistically significant at the 5 per cent level.
***Statistically significant at the 1 per cent level.

5.3 Adding extra explanatory variables

The introduction of more explanatory variables in the model is a recurrent strategy used in literature to verify the robustness of the estimations. The use of proxies for several suspected drivers of HCE helps to control for the other factors affecting this variable, isolating the causal effect of the Baumol variable in HCE. According to Wooldridge (2015), not including relevant variables in the model may cause OLS estimators to be biased, this phenomenon is formally known as *omitted variable bias*. Yet, the addition of extra explanatory variables in the regression does not guarantee a solution for this problem because other important factors affecting HCE like the evolution of medical technology and its quality and policy implementation cannot be taken into account easily.

The extra explanatory variables are typically used to provide some robustness test for the first estimations (Model without GDP per capita and Model with GDP per capita) presented in Table 4. The criteria for the selection of these variables was based either on the literature (Hartwig and Sturm 2014; Martín, del Amo Gonzalez, and Dolores Cano Garcia 2011) or data availability. Several other variables were considered such as obesity, poverty rate and R&D but the number of missing observations did not allow for its inclusion in the estimations. Additionally, variables like infant mortality used in previous research were not selected due to possible endogeneity issues since the growth rate of infant mortality is not a good indicator of causality for HCE.

When adding further explanatory variables, the selection criteria were relaxed in order to allow the regressions estimations, given the fact that there is a high number of observations missing for these variables.

The variables were introduced in the model one by one according to the number of observations, i.e., the variables with the higher number of observations were introduced primarily.

Table 5 shows the results obtained from regressing all the independent variables, in constant 2010 prices and local currency, on per capita HCE using the Two-Way Fixed Effects estimator. The results are homogeneous given that the significance of the variables does not change with the introduction of new ones and regardless of the number of observations.

The growth rate of GDP per capita is always statistically significant: its positive coefficient becomes higher as more control variables are introduced ranging from 0.32 to 0.53[11]. This result was expected given that previous literature focused on Baumol's cost disease also found this correlation between GDP per capita and HCE (Colombier 2017; Bates and Santerre 2013; Hartwig 2008).

On the other hand, the results found for the proxy for population ageing – growth rate of the share of the population of 65 years old and above – were surprising since there is no correlation between this variable and the growth of per capita HCE. In all of the models presented in Table 5 the coefficients for these variables are not statistically significant.

The growth of female employment, however, has a significant coefficient for each specification that ranges from 0.39, for model 6, and 1.25 for model 1 (including all variables), when using real data. For nominal data the coefficient ranges from 0.38 to 1.18 while remaining statistically significant.

The results found for the growth rate of the number of neoplasms are the most puzzling since, using real or nominal data, these are not robust to the introduction of the growth rates of the unemployment rate and the share of the population aged 65 and above. The coefficient for the number of neoplasms is significant at a 10% level except only when these variables are excluded. It was expected this coefficient to be consistent.

Both life expectancy at birth and life expectancy at 65 years old are indicators of the health status of the population, but their correspondent coefficients are not statistically significant in the estimations presented in Table 5. However, in the literature (Colombier 2017) the results suggest a correlation between life expectancy at birth and per capita HCE. Nonetheless, it is recommended caution when using both of these proxies since there is a chance that they are endogenous. These are good measures of the population's health status since when life expectancy is higher one may argue that population is healthier, therefore does not require as much health care, so fewer costs. At the same time, there is the chance that the rise in HCE is impacting life expectancy of the population because HCE rises when investment in medical progress, medicine and technology increases so this would increase the life expectancy of the population.

[11] The coefficients mentioned are relative to the regressions reported in Table 5 using constant 2010 prices in local currency and a Baumol sector equal to the total services.

Table 5. Two Way Fixed Effects, using control variables (Baumol sector = total services sector)

	Constant 2010 prices					
	Log Difference of Current Health Care Expenditure					
	1	2	3	4	5	6
Adjusted Baumol variable (total services sector)	0,322*** (0,06)	0,27** (0,07)	0,281** (0,07)	0,303*** (0,07)	0,312*** (0,07)	0,358*** (0,06)
GDP per capita	0,534*** (0,12)	0,401*** (0,07)	0,4*** (0,07)	0,366*** (0,06)	0,365*** (0,05)	0,324*** (0,06)
Growth of share of 65 years old and above	0,106 (0,22)	0,128 (0,17)	0,130 (0,16)	0,139 (0,16)	0,138 (0,16)	0,492 (0,31)
Growth of female employment	1,245** (0,31)	0,456** (0,18)	0,43** (0,17)	0,442** (0,18)	0,391** (0,16)	_
Growth of life expectancy rate at birth	0,739 (1,04)	0,241 (0,73)	0,239 (0,59)	0,027 (0,49)	_	_
Growth of number of neoplasms	-0,095 (0,07)	0,133 (0,08)	0,145* (0,07)	_	_	_
Growth of life expectancy rate at 65 years old	-0,207 (0,30)	-0,382 (0,19)	_	_	_	_
Growth of unemployment rate	0,009 (0,01)	_	_	_	_	_
Constant	0,014 (0,01)	0,029* (0,01)	0,03** (0,01)	0,034** (0,01)	0,055** (0,02)	0,035 (0,03)
Adjusted R^2	0,252	0,23	0,238	0,251	0,259	0,242
Observations	417	676	681	709	740	760
*F*test (time vs. Pooling)	41,68***	4,13**	4,47**	5,96***	5,91***	7,92***
Hausman test (FE vs. RE)	37,09***	26,00***	26,97***	27,45***	31,32***	15,97**
Wooldridge test for autocorrelation in panel data	0.008	2.715	2.353	2.044	2.143	15.26***
Pesaran's test of cross-sectional independence	-2.665***	-4.162***	-4.128***	-4.195***	-4.436***	-3.819***
Modified Wald test for groupwise heteroskedasticity	911.9***	290.8***	277.7***	271.1***	346.2***	626.4***

notes:

Refer to notes of **Table 4.**

The Baumol variable was adjusted by the Baumol sector; Baumol sector = **total services sector**.

Adjusted Baumol Variable = (growth of wages per employee in overall economy – growth of productivity growth in overall economy) / (share of labour allocated to total services sector).

*Statistically significant at the 10 per cent level.

**Statistically significant at the 5 per cent level.

***Statistically significant at the 1 per cent level.

Moreover, the model appears robust when further explanatory variables are added. The coefficients for both Baumol variables remain statistically significant throughout the introduction of six control variables, and their value ranges from 0.11 to 0.36 (for real data). The results found when using current prices in local currency were similar, and the coefficients range from 0.12 to 0.39. So, the OLS results suggest that HCE per capita is correlated to the Baumol variable. However, it is not possible to infer causality given the possible presence of an endogenous bias in the estimates.

Tables reporting the results for nominal data and the Baumol variable adjusted by community, social and personal services can be found in the Appendix (b).

5.4 Instrumental Variable Regressions

Why is it possible that the Baumol variable is endogenous? As stated before, this variable was computed using GDP (expenditure approach) and since a portion of GDP is the expenditure in health care then, one can argue that the impact of HCE on GDP would exert influence on the Baumol variable. This means that it is impossible to distinguish if the rise in HCE is causing the cost disease or if instead, as Baumol states, the cost disease is causing the rise in HCE.

To control for this possibility, it is common to re-estimate the model using Two-Stage Least Squares technique that allows for the inference of causality. Therefore, there was a need to find an instrumental variable.

Applying the same reasoning as Bates and Santerre (2013) that an increase in the growth rate of housing price leads to a higher cost of living, which consecutively leads to higher wages. This happens because employers do not want to lose their human capital to other geographical regions, or even a different country, with a lower cost of living, i.e., smaller growth in housing prices. More relevant information on previous year housing price index can be found in the Data chapter.

The Instrumental variable regression is performed excluding both life expectancy at birth and life expectancy at 65 years old for the reasons mentioned above. The issue of possible endogeneity of these two variables could be addressed by the use of two more instrumental variables, as it was done for the Baumol variable. Given the time constraint, the fact that these were just used as control variables and that the research is focused only on the impact of the cost disease in HCE these variables will not be included in the Instrumental variable regression.

The results of the Two Stage Least Squares estimation are reported in Table 6 and are in line with the OLS ones. The adjusted Baumol variable, GDP per capita and growth of female employment have positive and statistically significant coefficients, which means that it is possible to assume the existence of a relation of causality between all those variables and the growth of HCE.

The coefficients for both adjusted Baumol are positive, robust and highly statistically significant - reported in Table 6. For a Baumol sector including only *community, social and personal services* the coefficient ranges from 0.23 to 0.32 (see Appendix c), while for a Baumol sector including all the services the coefficient ranges from 0.55 to 0.84, for data in constant 2010 prices. Indicating that the cost disease is causing a large portion of the rise in HCE. It is found that a one percentage point increase of the growth rate of the Baumol variable (adjusted by the total services sector) causes around 0.6 to 0.8 percentage points increase in the annual growth rate of HCE, considering a Baumol sector including the entire services sector.

Table 6. Two Stage Least Squares, constant 2010 prices (Baumol sector = total services sector)

	Constant 2010 prices				
	Log difference of Current Health Care Expenditure				
IV regression - Second Stage	1	2	3	4	5
Adjusted Baumol variable (total services sector)	0.835** (0.26)	0.586** (0.22)	0.593** (0.22)	0.576** (0.23)	0.554** (0.21)
Growth of GDP per capita	0.570** (0.19)	0.427*** (0.09)	0.468*** (0.13)	0.445** (0.13)	0.444** (0.13)
Growth of share of 65 years old and above	0.075 (0.23)	0.126 (0.18)	0.158* (0.20)	0.163 (0.19)	–
Growth of female employment	1.258*** (0.30)	0.505** (0.14)	0.506** (0.15)	–	–
Growth of number of neoplasms	-0.091 (0.12)	0.048 (0.06)	–	–	–
Growth of unemployment rate	0.037** (0.02)	–	–	–	–
Constant	0.009 (0.02)	0.032*** (0.01)	0.031** (0.01)	0.041*** (0.01)	0.044*** (0.01)
Observations	398	664	692	698	698
Stock and Watson's rule of thumb (*t* statistic)	17.98	43.16	35.04	36.00	50.84
Hausman-Wu test	2.193	0.805	0.605	0.370	0.040
*F*test (time vs. Pooling)	819.32***	81.38***	421.15***	472.14***	676.43***
*F*test (country vs. Pooling)	442.51***	5894.77***	3198.94***	542.53***	344.83***

notes:
The estimations were performed using Two-Stage Least Squares Estimation, **instrumental variable: previous year housing price index.**
Standard errors were Clustered by Country to deal with autocorrelation and heteroskedasticity and are reported in parentheses.
All variables are in First Differenced Logarithms, except for the Adjusted Baumol Variable.
The Baumol variable was adjusted by the Baumol sector; Baumol sector = **total services sector**
Adjusted Baumol Variable = (growth of wages per employee in overall economy – growth of productivity growth in overall economy) / (share of labour allocated to total services sector).
Stock and Watson's rule of thumb
Hausman-Wu test for the endogeneity of the instrumental variable, H0: exogenous variable, *t* test statistic
f-test on country effects and time effects, respectively, H0: no significant effects.
*Statistically significant at the 10 per cent level.
**Statistically significant at the 5 per cent level.
***Statistically significant at the 1 per cent level.

Additionally, it is possible to observe that growth of GDP per capita, the growth of female employment and the growth of the unemployment rate have positive and statistically significant coefficients. Interestingly, the latter did not correlate to HCE in the previous OLS estimations, so this result was unexpected.

On the other hand, for the growth of the number of neoplasms, there is evidence from the previous OLS estimations of a slight correlation with HCE. However, it was not robust to change in control variables. But no causal relationship between these two variables was found when performing the Two-Stage Least Squares estimations.

Oliveira Martins, de la Maisonneuve and Bjørnerud (2013), although not using the same explanatory variables and not focusing in Baumol's cost disease, found that income explained around 1.8 per cent of the evolution in HCE. Newhouse's (1977) found that GDP per capita was explaining 90% of the variation in real per capita HCE in OECD countries. Hartwig (2011) found a coefficient of around 1 for a sample of 19 OECD countries. Clemente et al. (2004), also for a sample of OECD countries, and Okunade and Murthy (2002) studying a sample of US states, also found correlation between income and HCE.

Several tests were performed in order to study the validity and relevance of the instrumental variable. Since the model is just identified it is not possible to test the validity of the instrument using Sargan's overidentification test. However, it was possible to use Stock and Watson's rule of thumb to verify the relevance of the instrument. According to Wooldridge (2015) the usual rule for the 2SLS estimation is that $F > 10$ for the first stage but, in this case, since there is only one instrumental variable Stock and Yogo state that the first-stage t statistic of the instrumental variable should be, in absolute value, higher than $\sqrt{10} \approx 3.2$, meaning that $t^2 = F$. So, the results reported in Table 5 provide evidence in favour of the relevance of the instruments since all are, in absolute value, higher than $\sqrt{10} \approx 3.2$.

Moreover, it was necessary to perform the Hausman-Wu test for endogeneity that showed that for all the specifications used (1 – 4) there is no endogeneity.

6 Conclusions

The purpose of this study was to find whether a large portion of the increase in HCE is a result of low or non-existent productivity growth in the non-progressive sector, such as the health care sector, or if it is entirely caused by the cost disease by finding a positive and causal relationship between Baumol's cost disease and the rise in HCE for 18 OECD member countries from 1970 to 2016. This way it may become possible for policymakers to conclude about the implementation of policies for this sector to control for the continuous increase in costs. According to Baumol (1967), the unavoidable nature of both the progressive and nonprogressive sectors and the real costs necessary to support both types of activities do not allow any policy to solve or attenuate the effects of the cost disease, in the long term.

In order to define Baumol's cost disease empirically, I follow Colombier's (2017) development of the adjusted Baumol variable (see section 3). The choice for this framework resulted from the fact that this author's variable is adjusted for the actual share of labour force allocated to the entire services sector and for the community, social and personal services as cited by Baumol himself. Other authors considered that the total labour force was allocated to the Baumol sector (Hartwig 2008), i.e., the entire labour force is allocated to the services sector, or considered that only the health care services share of labour composes the Baumol sector. The latter is not correct according to Baumol's model of unbalanced growth where the Baumol sector includes all sectors affected by the cost disease and not only health care. Therefore, not adjusting for the correct share of labour in the nonprogressive sector may cause the conclusions drawn from results to be inaccurate.

Moreover, the use of a Baumol variable avoids the use of medical price indices which usually suffer from measurement errors.

The results obtained show that the health care sector is affected by the cost disease since this disease is contributing between 0.23 to 0.84 percentage points to the annual growth rate of per capita HCE, considering real data, for the OECD member countries included in the sample. These results also attest that not the entire health care sector is affected by the cost disease as many authors claim. Hartwig (2008), Medeiros and Schwierz (2013) and Hartwig and Sturm (2014) claim the full effect of the cost disease on the health care sector. However, they assume the entire labour force is allocated to the nonprogressive sector, i.e., the share of Baumol sector is 100%.

On the other hand, the conclusions of this research are in line with the ones by Colombier (2017) since he finds the cost disease to be contributing around 0.15 to 0.4 percentual points to the rise in HCE in OECD countries. The same happens when comparing results with Bates and Santerre (2013) for the US states where he finds that the cost disease is contributing between 0.03 and 0.04 to the growth of HCE even though he defines the Baumol sector as the labour share allocated only to the health care sector.

The main conclusion is that Baumol's hypothesis of the cost disease has a large impact on the annual growth rate of HCE, but other important drivers are explaining the evolution of HCE. Which is the case for GDP per capita, that explains around 0.57 per cent. Although the consensus on the matter of drivers of HCE does not exist, it was found that the growth of female share in the labour force has an amazingly high impact on HCE. This driver was never investigated before in the literature. There are not many studies related to the relation between these two topics but, one of the reasons for this causal relation may be the fact that when women have jobs, they have access to health insurance, so the demand for this service increases.

All the other drivers such as population ageing and health status indicators were found to be unrelated to the growth of HCE for the time frame and sample used for this research.

The findings in this paper indicate that there is still enough margin for policy creation to increase efficiency and decrease costs in the health care sector, since the there is not a full effect of the Baumol's cost disease in the rise of HCE.

A. Appendix

a. Summary statistics

Table 7. Descriptive statistics for nominal data

	Obs.	Mean	Std Dev.	Min	Max
Growth of current health expenditure per capita	786	0.084	0.070	-0.092	0.687
Growth of per capita GDP	828	0.069	0.057	-0.109	0.340
Adjusted Baumol variable – total services sector	801	-0.001	0.044	-0.378	0.219
Adjusted Baumol variable – community, social and personal	801	-0.001	0.116	-0.989	0.671
Growth of share of 65 years old and above	828	0.013	0.012	-0.031	0.066
Growth of female employment	802	0.006	0.010	-0.034	0.064
Growth of life expectancy rate at birth	788	0.003	0.003	-0.013	0.030
Growth of number of neoplasms	784	0.013	0.017	-0.050	0.112
Growth of life expectancy rate at 65 years old	783	0.008	0.012	-0.034	0.068
Growth of unemployment rate	460	0.014	0.142	-0.397	0.977
Growth of housing prices in the previous year	745	0.062	0.078	-0.213	0.534

b. Two-Way Fixed Effects Tables

Table 8. Two-Way Fixed Effects using current and constant 2010 price levels (Baumol sector = community, social and personal services)

Dependent variable	**Log Difference of Current Health Care Expenditure, per capita**			
	Constant 2010 price levels		Current price levels	
	Without per capita GDP	**With per capita GDP**	**Without per capita GDP**	**With per capita GDP**
Adjusted Baumol variable (community, social and personal services)	0,124*** (0,02)	0,132*** (0,02)	0,096** (0,03)	0,139*** (0,02)
GDP per capita	–	0,327*** (0,07)	–	0,711*** (0,11)
Constant	0,051* (0,03)	0,041 (0,03)	0,124*** (0,03)	0,049* (0,03)
Adjusted R^2	0.258	0.314	0.484	0.692
Observations	760	760	759	759
F test (time vs. Pooling)	6,72***	6,54***	69,11***	46,97***
Hausman test (FE vs. RE)	2.08	40,10***	0.02	8,82**
Wooldridge test for autocorrelation in panel data	15,738**	9,254**	11,237**	5,891**
Pesaran's test of cross-sectional independence	-3,944***	-3,854***	-3,421***	-3,688***
Modified Wald test for groupwise heteroskedasticity	557,20***	591,17***	519,58***	507,62***

notes:
Refer to notes on **Table 4.**
The Baumol variable was adjusted by the Baumol sector; Baumol sector = **community, social and personal services.**
Adjusted Baumol Variable = (growth of wages per employee in overall economy – growth of productivity growth in overall economy) / (share of labour allocated to community, social and personal services).
*Statistically significant at the 10 per cent level.
**Statistically significant at the 5 per cent level.
***Statistically significant at the 1 per cent level.

Table 9. Two-Way Fixed Effects, using control variables, constant 2010 prices (Baumol sector = community, social and personal services)

	Constant 2010 prices					
	Log Difference of Current Health Care Expenditure					
	1	2	3	4	5	6
Adjusted Baumol variable (community, social and personal services)	0,115*** (0,02)	0,106*** (0,02)	0,110*** (0,02)	0,118*** (0,02)	0,121*** (0,02)	0,137*** (0,02)
GDP per capita	0,530*** (0,11)	0,394*** (0,07)	0,393*** (0,07)	0,360*** (0,06)	0,359*** (0,05)	0,314*** (0,07)
Growth of share of 65 years old and above	0,111 (0,22)	0,147 (0,16)	0,151 (0,15)	0,161 (0,16)	0,159 (0,15)	0,519 (0,31)
Growth of female employment	1,283** (0,31)	0,484** (0,19)	0,458** (0,17)	0,472** (0,18)	0,419** (0,16)	–
Growth of life expectancy rate at birth	0,727 (1,03)	0,182 (0,73)	0,161 (0,60)	-0,047 (0,50)	–	–
Growth of number of neoplasms	-0,090 (0,06)	0,135* (0,08)	0,145* (0,07)	–	–	–
Growth of life expectancy rate at 65 years old	-0,229 (0,30)	-0,039 (0,20)	–	–	–	–
Growth of unemployment rate	0,010 (0,01)	–	–	–	–	–
Constant	0,008 (0,01)	0,024 (0,01)	0,027** (0,01)	0,031** (0,01)	0,055** (0,02)	0,033 (0,03)
Adjusted R^2	0.35	0.319	0.324	0.322	0.326	0.326
Observations	417	676	681	709	740	760
*F*test (time vs. Pooling)	14,00***	5,70***	6,26***	5,83***	5,91***	13,08***
Hausman test (fe vs. Re)	44,28***	27,95***	28,15***	24,61***	31,47***	14,41**
Wooldridge test for autocorrelation in panel data	0.001	2.221	1.908	1.634	1.809	14,710**
Pesaran's test of cross-sectional independence	-2,667**	-4,176***	-4,145***	-4,219***	-4,462***	-3,888***
Modified Wald test for groupwise heteroskedasticity	856,59***	285,15***	271,29***	264,78***	348,98***	601,11***

notes:
Refer to notes on **Table 4**.
The Baumol variable was adjusted by the Baumol sector; Baumol sector = **community, social and personal services**.
Adjusted Baumol Variable = (growth of wages per employee in overall economy – growth of productivity growth in overall economy) / (share of labour allocated to community, social and personal services).
*Statistically significant at the 10 per cent level.
**Statistically significant at the 5 per cent level.
***Statistically significant at the 1 per cent level.

Table 10. Two-Way Fixed Effects, using control variables, current prices (Baumol sector = total services sector)

	Current prices					
	Log Difference of Current Health Care Expenditure					
	1	2	3	4	5	6
Adjusted Baumol variable (total services sector)	0,377*** (0,08)	0,324*** (0,07)	0,333*** (0,07)	0,362*** (0,07)	0,359*** (0,06)	0,391*** (0,05)
GDP per capita	0,594*** (0,11)	0,735*** (0,13)	0,730*** (0,13)	0,720*** (0,12)	0,717*** (0,11)	0,739*** (0,10)
Growth of share of 65 years old and above	0,066 (0,24)	0,159 (0,16)	0,155 (0,16)	0,160 (0,18)	0,143 (0,19)	0,444 (0,31)
Growth of female employment	1,184** (0,30)	0,447** (0,17)	0,410** (0,15)	0,444** (0,15)	0,375** (0,13)	–
Growth of life expectancy rate at birth	0,976 (0,97)	0,591 (0,62)	0,385 (0,64)	0,126 (0,50)	–	–
Growth of number of neoplasms	-0,059 (0,10)	0,148 (0,09)	0,154* (0,09)	–	–	–
Growth of life expectancy rate at 65 years old	-0,232 (0,30)	-0,09 (0,16)	–	–	–	–
Growth of unemployment rate	0,008 (0,02)	–	–	–	–	–
Constant	0,030 (0,02)	0,034* (0,02)	0,038** (0,01)	0,042** (0,01)	0,068** (0,02)	0,041 (0,03)
Adjusted R^2	0.62	0.678	0.68	0.679	0.7	0.697
Observations	417	676	681	708	739	759
*F*test (time vs. Pooling)	24.33	9,61***	5,93***	10,62***	23,70***	12,34***
Hausman test (FE vs. RE)	15,16*	12,32*	12,59*	15,04**	14,09**	10,32**
Wooldridge test for autocorrelation in panel data	0.033	2.715	2.353	2.044	2.143	15,259***
Pesaran's test of cross-sectional independence	-2,665***	-4,162***	-4,128***	-4,195***	-4,436***	-3,819***
Modified Wald test for groupwise heteroskedasticity	911,93***	290,76***	277,71***	271,12***	346,17***	626,39***

notes:
Refer to notes on **Table 4**.
The Baumol variable was adjusted by the Baumol sector; Baumol sector = **total services sector**.
Adjusted Baumol Variable = (growth of wages per employee in overall economy – growth of productivity growth in overall economy) / (share of labour allocated to total services sector).
*Statistically significant at the 10 per cent level.
**Statistically significant at the 5 per cent level.
***Statistically significant at the 1 per cent level.

Table 11. Two-Way Fixed Effects, using control variables, current prices (Baumol sector = community, social and personal services)

	Current prices					
	Log Difference of Current Health Care Expenditure					
	1	2	3	4	5	6
Adjusted Baumol variable (community, social and personal services)	0,128*** (0,03)	0,119** (0,03)	0,123** (0,03)	0,134*** (0,03)	0,133*** (0,02)	0,143*** (0,02)
GDP per capita	0,566*** (0,11)	0,718*** (0,14)	0,713*** (0,14)	0,702*** (0,13)	0,700*** (0,12)	0,717*** (0,10)
Growth of share of 65 years old and above	0,062 (0,24)	0,178 (0,16)	0,175 (0,15)	0,182 (0,17)	0,162 (0,19)	0,464 (0,30)
Growth of female employment	1,215** (0,29)	0,481* (0,17)	0,441** (0,16)	0,477** (0,16)	0,405** (0,14)	–
Growth of life expectancy rate at birth	0,968 (0,98)	0,494 (0,63)	0,274 (0,67)	0,015 (0,52)	–	–
Growth of number of neoplasms	-0,053 (0,09)	0,150 (0,09)	0,156* (0,09)	–	–	–
Growth of life expectancy rate at 65 years old	-0,265 (0,31)	-0,091 (0,16)	–	–	–	–
Growth of unemployment rate	0,006 (0,02)	–	–	–	–	–
Constant	0,028 (0,02)	0,031 (0,02)	0,036* (0,02)	0,040** (0,02)	0,067** (0,03)	0,041 (0,03)
Adjusted R^2	0.612	0.674	0.676	0.675	0.697	0.694
Observations	417	676	681	708	739	759
*F*test (time vs. Pooling)	93,88***	10,29***	8,03***	31,31***	26,24***	27,70***
Hausman test (fe vs. Re)	20,51**	16,97**	16,46**	17,45***	16,01***	12,08***
Wooldridge test for autocorrelation in panel data	0.021	2.148	1.748	1.453	1.985	8,166**
Pesaran's test of cross-sectional independence	-2,493**	-4,123***	-4,067***	-4,071***	-4,288***	-3,695***
Modified Wald test for groupwise heteroskedasticity	1229,6***	308,48***	291,98***	289,27***	352,93***	507,61***

notes:
Refer to notes on **Table 4**.
The estimations were performed using the Two-Way Fixed Effects Within-Estimator.
The Baumol variable was adjusted by the Baumol sector; Baumol sector = **community, social and personal services.**
Adjusted Baumol Variable = (growth of wages per employee in overall economy – growth of productivity growth in overall economy) / (share of labour allocated to community, social and personal services).
*Statistically significant at the 10 per cent level.
**Statistically significant at the 5 per cent level.
***Statistically significant at the 1 per cent level.

c. Instrumental Variable Regressions

Table 12. Two Stage Least Squares, constant 2010 prices (Baumol sector = community, social and personal services)

	Constant 2010 prices				
	Log difference of Current Health Care Expenditure				
IV regression - Second Stage	**1**	**2**	**3**	**4**	**5**
Adjusted Baumol variable (community, social and personal services)	0.321** (0.10)	0.241** (0.09)	0.243** (0.09)	0.236** (0.10)	0.225** (0.09)
Growth of GDP per capita	0.568** (0.19)	0.416*** (0.09)	0.470** (0.15)	0.445** (0.15)	0.443** (0.14)
Growth of share of 65 years old and above	0.099 (0.24)	0.170 (0.19)	0.209 (0.21)	0.212 (0.21)	–
Growth of female employment	1.378*** (0.31)	0.551*** (0.15)	0.555*** (0.15)	–	–
Growth of number of neoplasms	-0.074 (0.12)	0.048 (0.06)	–	–	–
Growth of unemployment rate	0.042** (0.02)	–	–	–	–
Constant	0.006 (0.02)	0.030*** (0.01)	0.028*** (0.01)	0.040*** (0.01)	0.043*** (0.01)
Observations	398	664	692	698	698
Stock and Watson's rule of thumb (*t* statistic)	19.98	52.56	41.60	43.82	64
Hausman-Wu test	2.394	0.871	0.706	0.460	0.074
*F*test (time vs. Pooling)	723.57***	100.51***	215.05***	468.93***	506.98***
*F*test (country vs. Pooling)	399.52***	2266.04***	1868.76***	230.87***	438.76***

notes:
Refer to notes on **Table 6**.
The Baumol variable was adjusted by the Baumol sector; Baumol sector = **community, social and personal services.**
Adjusted Baumol Variable = (growth of wages per employee in overall economy – growth of productivity growth in overall economy) / (share of labour allocated to community, social and personal services).
*Statistically significant at the 10 per cent level.
**Statistically significant at the 5 per cent level.
***Statistically significant at the 1 per cent level.

Table 13. Two Stage Least Squares, current prices (Baumol sector = total services sector)

	Current prices				
IV regression - Second Stage	**1**	**2**	**3**	**4**	**5**
Adjusted Baumol variable (total services sector)	0.954*** (0.14)	0.751*** (0.16)	0.740*** (0.15)	0.738*** (0.15)	0.715*** (0.14)
Growth of GDP per capita	0.731*** (0.16)	0.693*** (0.10)	0.727*** (0.12)	0.703*** (0.12)	0.698*** (0.11)
Growth of share of 65 years old and above	0.087 (0.22)	0.184 (0.15)	0.238 (0.16)	0.248 (0.16)	–
Growth of female employment	1.234*** (0.33)	0.426** (0.14)	0.448** (0.14)	–	–
Growth of number of neoplasms	-0.066 (0.12)	0.013 (0.08)	–	–	–
Growth of unemployment rate	0.050*** (0.02)	–	–	–	–
Constant	0.021 (0.02)	0.048*** (0.01)	0.044*** (0.01)	0.055*** (0.01)	0.059*** (0.01)
Observations	398	634	691	697	697
Stock and Watson's rule of thumb (*t* statistic)	18.06	17.81	20.7	21.4	21.7
Hausman-Wu test	9.666**	4.448*	4.578**	3.704*	1.967
*F*test (time vs. Pooling)	811.09***	191.68***	488.1***	1349.41***	588.08***
*F*test (country vs. Pooling)	22957.2***	993.19***	1042.13***	6429.12***	8699.68***

notes:
Refer to notes on **Table 6**.
The Baumol variable was adjusted by the Baumol sector; Baumol sector = **total services sector.**
Adjusted Baumol Variable = (growth of wages per employee in overall economy – growth of productivity growth in overall economy) / (share of labour allocated to total services).
*Statistically significant at the 10 per cent level.
**Statistically significant at the 5 per cent level.
***Statistically significant at the 1 per cent level.

Table 14. Two Stage Least Squares, current prices (Baumol sector = community, social and personal services)

	Current prices				
	Log difference of Current Health Care Expenditure				
IV regression - Second Stage	1	2	3	4	5
Adjusted Baumol variable (community, social and personal services)	0.366*** (0.06)	0.310*** (0.06)	0.304*** (0.06)	0.303*** (0.06)	0.291*** (0.05)
Growth of GDP per capita	0.678*** (0.17)	0.673*** (0.11)	0.718*** (0.14)	0.690*** (0.14)	0.683*** (0.13)
Growth of share of 65 years old and above	0.097 (0.24)	0.244 (0.15)	0.311* (0.16)	0.321* (0.17)	–
Growth of female employment	1.357*** (0.35)	0.483** (0.16)	0.508** (0.15)	–	–
Growth of number of neoplasms	-0.046 (0.14)	0.013 (0.07)	–	–	–
Growth of unemployment rate	0.050*** (0.02)	–	–	–	–
Constant	0.022 (0.02)	0.048*** (0.01)	0.042** (0.01)	0.055*** (0.01)	0.060*** (0.01)
Observations	398	664	691	697	697
Stock and Watson's rule of thumb (*t* statistic)	18.32	23.14	23.23	24.3	23.4
Hausman-Wu test	13.589**	4.448*	6.601**	5.276**	2.833
*F*test (time vs. Pooling)	1678.76***	258.96***	233.64***	723.36***	527.24***
*F*test (country vs. Pooling)	29160.6***	1519.16***	2675.8***	4690.07***	8989.4***

notes:
Refer to notes on **Table 6**.
The Baumol variable was adjusted by the Baumol sector; Baumol sector = **community, social and personal services**
Adjusted Baumol Variable = (growth of wages per employee in overall economy – growth of productivity growth in overall economy) / (share of labour allocated to community, social and personal services).
*Statistically significant at the 10 per cent level.
**Statistically significant at the 5 per cent level.
***Statistically significant at the 1 per cent level.

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