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Effect of Private and Public Health Spending on Health Status: Market or Government Failure?

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Abstract

On the one hand, government intervention in the functioning of the market is inevitable due to market failure reasons such as uncertainty, asymmetric information and externalities; on the other hand, a high share of government in health services may result in government failure on the respective market. To effectively sustain increasing health spendings, it is vital to determine the optimal level for private and public health spending that have a positive effect on the health market. From this point of view, the objective of our study is to empirically evaluate the impact of public and private health spendings on health outcomes for 33 OECD countries over the period 2000–2021, utilizing the Hansen (1999) panel threshold model approach at different spending levels defined depending on the spending thresholds. In addition, the dynamic panel threshold analysis of Kremer *et al*. (2013) is also performed to check the robustness of the findings. Our empirical findings reveal that the effect of private health spendings on health status is stronger than that of public spendings. Moreover, when the public health spending exceeds the estimated threshold, it negatively affects health outcomes and increases public spending inefficiency on the health market, which could be evaluated as an indicator of government failure.

Keywords: Health spending, government failure, panel threshold
JEL Classification: I18, H11, C23

1. Introduction

Health and health services are among the most globally discussed issues through different economic, financial and social dimensions. Health services include goods/services provided to improve health, which is defined by the World Health Organization as a state of complete physical, mental and social well-being. Different from other goods/services on the market, it has a health-derived demand depending on health status. More clearly, as discussed by Hurley (2000), while goods and services in general have a direct impact on the individual's utility when consumed, the demand for health services is a derived demand since health services provide an improvement in health status.

As suggested by Getzen (2007), since improvement in health status depends on the demand for many goods and services, spending on health also exhibits a continuous upward trend over time. Due to changes in the ratio of health spending to GDP and changes in the growth rate across countries in general, resources allocated by countries to health services vary. Although health spending, which generally increased in the 1990s and 2000s, remained relatively stable after the 2008 global crisis, it started to rise again in 2020 due to the COVID-19 pandemic. The health spending-to-GDP ratio, which was 8.8% on average for OECD countries before the pandemic, increased to 9.7% in 2021. However, this ratio is expected to decrease due to both decreasing health needs and inflation, reducing the value of health spendings (OECD, 2023).

Besides the sharp rise in health spendings, another important aspect is the impact of health spendings in terms of public and private sectors. Different from other services, the unique structure of the health market leads to a relatively high share of public spending which is based on uncertainty, asymmetric information and externalities. On these grounds, the market mechanism inevitably fails, leading to a government intervention. This framework essentially entails a discussion about the limits of the government intervention in the health market, or more precisely, the increase in public and private health spendings based on the quality of and access to the health system. In this context, we intend to analyse the impact of spending expansion on the health status of individuals in a non-linear structure encapsulating different levels of public and private health spendings. Within this scope, our study is based on two main research questions, which are (i) "*Should health spendings really be considered a market failure and subject to government intervention, and if so, should there be a certain limit to government intervention?*" and (ii) "*To what extent does government intervention in the health market create a failure?*" These research questions embody the unique value and methodological superiority of our study. Thus, the Hansen (1999) panel threshold model, which is selected in accordance with the purpose of the study, enables examination of the impact of health spending policies on the health system in different regimes specified on the basis of public and private health spending levels. Moreover, the dynamic panel threshold analysis of Kremer *et al*. (2013) is also employed both to check the robustness of the threshold findings and to eliminate the problem of en-

dogeneity in a dynamic panel. The contribution of our study to the existing literature arises here since it specifically focuses on the effects of health spendings on health status by dividing health spendings into private and public components under the market and government failure debates, from a public finance perspective. From a methodological point of view, it applies a non-linear panel analysis methodology, which enables evaluation under different regimes specified in terms of estimated private and public health spending threshold values.

The remainder of the paper is structured as follows: In the following Sections 1 and 2, theoretical background and the literature analysing the impact of public and private health spendings on health outcomes are discussed, respectively. Section 3 presents the data, methodology and empirical findings. The concluding section provides policy recommendations within the framework of the empirical findings.

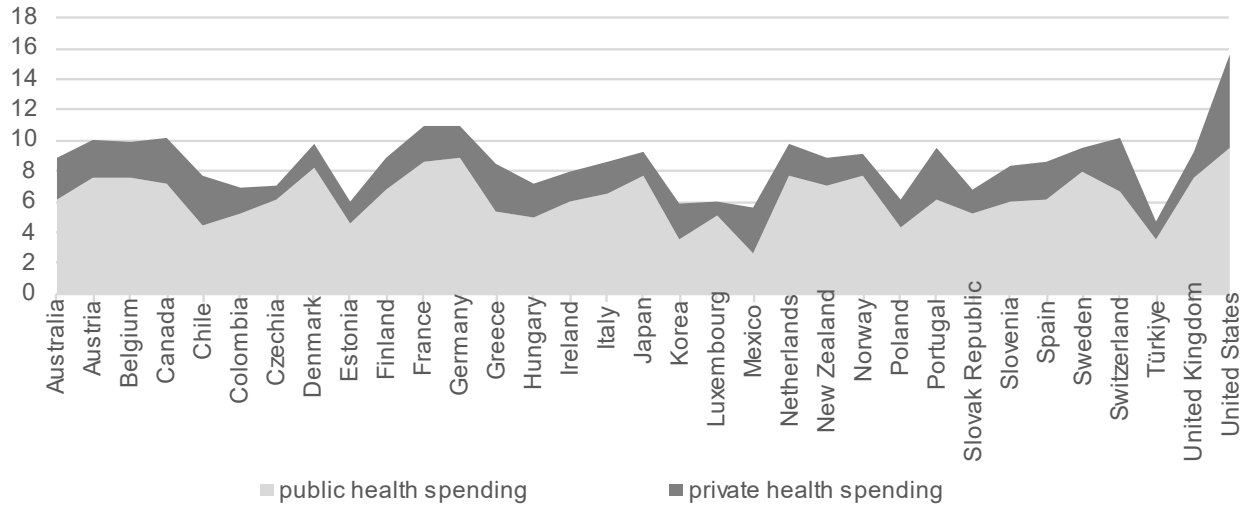
2. Theoretical Discussion

Analysing the underlying factors of increasing health spendings, it is revealed that both supply- and demand-side factors are dominantly effective. Jack (1999) attributed demand-side factors to demographic change due to increasing elderly population and epidemiological transformation in relation to changes in the prevalence and incidence of diseases. In addition, Getzen (2007), Caliskan (2008) and Williams (1973) have attributed the acceleration in the supply of health services to the increase in production techniques, production costs and payment methods, which also point to technological development.

In addition to the reasons for the upward trend in health spendings, an important part of the debate concerns the distribution of health spendings between the public and private sectors. In order to eliminate the uncertainty arising from the structure of health services, individuals often prefer to have insurance; thus, the existing risk is distributed among millions of people by pooling with general health insurance offered by public and private health insurance companies (Getzen, 2007). In this case, the sources particularly encountered for financing health services appear to be direct and indirect taxes levied by the government, social insurance contributions and private health insurance premiums and out-of-pocket health payments made by the patient[1] for health services (Culyer, 2005). The OECD data in Graph 1, exhibiting the two components of total health spending, indicate that the share of public health spending is quite high relative to the private component (OECD, 2024).

1 Apart from insurance activities, it is possible to say that when an unexpected expenditure is required, there are few resources that individuals can resort to. In such situations that require out-of-pocket health expenditures, individuals tend to turn to their own savings or borrowing (family or non-family). Especially the situation of borrowing, which makes the individual dependent, exacerbates the catastrophic effect of health expenditures (Getzen, 2007).

Graph 1: Share of public and private health spending (2000–2021 averages)



Source: OECD (2024)

More briefly, total health spending is the sum of public and private health spendings. Here, public health spending includes current and capital spending from government budgets and social or compulsory insurance funds, while the private component comprises private health insurance premiums, direct payments and out-of-pocket health spendings. Concerning the divergent impact of public and private health spendings, increased out-of-pocket health spendings may reduce the ability of individuals to spend on other goods and services (including other health goods and services). This may increase poverty and perpetuate poor health as individuals are unable to afford additional health goods and services. Such a situation, which can be characterized as a market failure, is pointed out as one of the reasons for government intervention in the health sector (Rahman *et al*., 2018).

From a more theoretical point of view, the primary reason for the relatively high share of public spending is based on the structure of the health market, which can be characterized as *sui generis* and distinguishes health services from others (Arrow, 1963). It is possible to list these characteristics, which form the basis of normative discussions, as uncertainty, asymmetric information between the parties and the creation of externalities (Phelps, 2013; Hurley, 2000). On these grounds, it is stated that the market would fail, which leads to the government intervention (Cullis and West, 1979; Hurley, 2000).

Uncertainty: The risks arising from uncertainties faced by individuals in the field of health are evaluated from two different perspectives. The first one is the uncertainty of being a patient, while the second one is associated with the success of the treatment (Arrow, 1963). Here, especially with regard to uncertainties in treatment, the government can aim to reduce the uncertainty

that may be created for patients to a certain extent through audits and licensing practices (Phelps, 2013).

Asymmetric information: Although the asymmetric information issue is based on Akerlof's (1970) research into the second-hand car market, since then the concept has also been used for insurance, financial credit and employment (Pindyck and Rubinfeld, 2013). In terms of health, asymmetric information arises when doctors have much more information about the diagnosis and treatment of a disease relative to patients (Phelps, 2013). This asymmetric information in health leads to market failure in terms of both the amount of health services provided and health insurance. In this case, health service providers have the opportunity to manipulate at least one of the quantity, quality and price of the service (Hurley, 2000).

Externality: In addition to the uncertainty and asymmetric information problems, another unique feature of the health market arises due to the indirect exogenous effect of economic units' production or consumption activities on others that cannot be reflected in market prices (Pindyck and Rubinfeld, 2013). For instance, immunization through vaccination as a preventive and protective practice against infectious diseases benefits not only the individual but also society as a whole. In addition to the improvement in the health status of the society, satisfaction with the ability of those who cannot benefit from health services to receive health services could also be indicated as a component of the external benefit (Folland *et al*., 2001). When the provision of such a health service where social and private benefits are differentiated is left only to the market, the problem of underproduction arises and the optimal social production level cannot be achieved. In this case, in addition to the provision of this service by the government for free or at a price lower than the market price, in an ideal pricing system to be realized through government intervention, it may also be considered to make a payment to everyone whose health is endangered. As an alternative market solution, a payment to the individual whose health is in danger by other members of society for immunization could also be considered. Both government and market solution alternatives for externalities ensure the achievement of the optimal situation, but the effect differs by all odds (Arrow, 1963).

The reason for the increasing role of the public sector on the health market is that governments implicitly or explicitly undertake the task of substituting market failures in their economic activities (Arrow, 1963). On the other hand, public spendings to correct market imperfections and ensure efficient allocation of resources may also create inefficiency. It is argued that many externalities are independent of individuals' actions and the achievement of the optimal outcome. Furthermore, it is asserted that many government interventions, even if perfect, may create more costs than benefits and imperfections in public decision making could lead to more imperfect consequences than the market case (Culyer, 1989).

More precisely, politicians responsible for determining health policies prioritize programmes that will ensure their political sustainability rather than the public interest (Bailey, 1995). Unlike the problem of underproduction on the market, inefficiencies in collective decision making and public provision could end up with excessive production of goods and services; this situation may lead to moral hazard problems such as health corruption, excessive use of drugs and overuse of health services, which put an upward pressure on public health spendings (Cullis and Jones, 1987). On these grounds, analysing the role of inevitable government intervention in enforcing the health status appears to be crucial as a matter of our study.

3. Relevant Empirical Literature

Due to the difficulty of measuring health status, it is challenging to establish a causal relationship between many measurable and unmeasurable factors affecting health status and health outcomes (Nixon and Ulmann, 2006). As a relatively more measurable factor, analysing the impact of health spendings, including the components of public and private spendings, seems significant since a substantial part of health services is still covered by the government. As shown in Graph 1, since private insurance coverage is limited in economies, there is an increase in tax financing or social security contributions instead of out-of-pocket spendings (Musgrove, 1996).

In this context, the related literature particularly focuses on analysing the impact of public health spendings as well as total health spendings. Gupta *et al*. (2002) examined the effect of increasing weight of more productive public spendings such as education and health. In the analysis, OLS (correction for changing variance) and two-stage least squares (2SLS) methods were performed to estimate the effect of increasing weight of those public spendings. The study revealed that education spendings lead to a decrease in infant and child mortality rates; however, the relationship between health spendings and mortality rates is weaker. In a study conducted by Musgrove (1996), while a relationship between health spendings and life expectancy at birth was found for low-income countries, no such relationship was established for other countries, indicating that higher health spendings lead to an improvement in quality but do not lead to a longer life expectancy. In addition, the study concluded that health spendings have no effect on child mortality rates and that the distinction between high- and low-income countries is not valid.

Filmer and Pritchett (1999) estimated the regression derived from an aggregate "health production function", which assumes that health status depends on a country's income, knowledge and social capacity. In addition to the ordinary least squares method, an instrumental variable (IV) estimation procedure using two-stage least squares (2SLS) was also applied in the respective study. The effect of public health spendings as well as other factors related to economy, education and culture on child and infant mortality rates was analysed and the study found that the impact

of public health spendings is very low. As a conclusion, per capita income, inequality in income distribution, female education, level of ethnic fragmentation and dominant religion were found to have a much greater impact on mortality rates.

Nixon and Ulmann (2006) examined the relationship between health spendings, life expectancy and infant mortality rates over the period 1980–1995 by means of a fixed-effect model utilizing a panel dataset of 15 European Union member countries. As a result, it was observed that increases in health spendings lead to a decrease in infant mortality rates. Furthermore, the effect on female and male life expectancy is much more limited. Accordingly, Crémieux *et al*. (1999) investigated the nexus between healthcare spending and health outcomes by means of generalized least squares methodology with a special focus on similar variables over the period 1978–1992 for Canada. They concluded that health spendings decrease infant mortality rates and increase life expectancy at birth.

In another study, Issa and Quattara (2005) analysed the effect of health spendings on infant mortality rates for 160 sample countries, which were divided into two groups according to their development levels. To demonstrate the robustness of the empirical findings, four different estimation methods were used, namely pooled ordinary least squares, fixed-effects and random-effects models as well as system GMM approach. The study, in which spendings were categorised into public and private spendings, found that there is a strong and negative relationship between public spendings and infant mortality rates in low-income countries and in terms of private health spendings in high-income countries.

Using a sample of 161 countries over the period 1995–2014, the relationship between infant, child and maternal mortality and life expectancy at birth and health spending was analysed by Rana *et al*. (2018) by using the panel autoregressive distributed lag method. The findings of the study show that the relationship between health spendings and health outcomes is stronger in low-income countries than in high-income countries. The study also revealed that an increase in health spending is associated with lower child mortality, while there is no relationship with maternal mortality. Furthermore, Ray and Linden (2020), who utilized data from 195 countries over the period 1994–2014, found that public health spending has a greater impact than private health spending on infant mortality and life expectancy. The study also concluded that the impact of public and private health spending on health outcomes is stronger in low-income countries.

Fayissa and Gutema (2005) conducted one-way and two-way fixed and random-effects estimations for 31 sub-Saharan countries over the period 1990–2000. The study, in which socio-economic and environmental factors were also included in the evaluation, concluded that health spendings have a negative impact on health status with regard to inefficiency in the provision of health services. Bidani and Ravallion (1997), who questioned the differences in total health

indicators among population subgroups for 35 developing countries with a random coefficient model by taking into account the margin of error, revealed that the health status of low-income people is worse than that of the rest of society on average. In addition, it was determined that public health spending plays a more effective role in improving the situation of this income group.

In a similar research, Novignon *et al*. (2012) investigated the impact of public and private health spendings on the health status of the society by means of linear panel models for 44 sub-Saharan countries covering the period 1995–2010. They found that health spending increases life expectancy at birth and decreases infant mortality rates. In addition to these positive effects of health spendings in general, another important finding of the study was that public health spendings are more effective than private health spendings. Chireshe and Ocran (2020), employing the generalised methods of moments (GMM) estimation method for 45 sub-Saharan countries over the period 1995–2018, revealed that infant mortality rates decrease as health spending per capita and the public health spending expand, and that life expectancy improves with a rise in health spending per capita. Another study for sub-Saharan countries over the period 2000–2015 by Kiross *et al*. (2020) asserted that public health spendings and transfers from abroad to the domestic health system reduce both infant and newborn mortality rates. However, no such result was found in terms of private health spendings.

Using data for 20 OECD countries over the period 1960–1992, Berger and Messer (2002) analysed the effects of public health spendings, insurance coverage and other factors such as tobacco and alcohol use, female employment, educational attainment and income inequality on health status by means of simple regression analysis applied to estimate health outcomes following Grossman's (1972) methodology. It was concluded that mortality rates are affected by both public health spendings and insurance coverage; an expansion in public health spendings raises mortality rates, while insurance coverage of inpatient and outpatient treatment decreases mortality rates. Therefore, within the framework of the findings of the study, it took a critical look at the increase in the weight of public health spendings.

Using data from 1999–2004 for 47 African countries, Anyanwu and Erhijakpor (2009) questioned whether there is a relationship between public health spendings and infant/under-five mortality rates. The study employed a robust ordinary least squares (ROLS) model and robust OLS with lagged explanatory variables as the baseline specification, robust two-stage least squares (R2SLS) to control for endogeneity and reverse causality and a fixed-effects estimator to control for measurement error and autocorrelation. It concluded that increasing public health spendings leads to a decrease in infant and child mortality rates. The impact of health spending on infant and child mortality was also analysed by Houeninvo (2022) by means of the system generalised method of moments and a least squares dummy variable-corrected bias estimators. The study concluded that health spending

reduces mortality rates. However, the effect of public health spending was found to be higher and the effect of private health spending increases with public health spending.

By means of a similar sample for 40 sub-Saharan African countries and based on Grossman's (2000) human capital model of health demand analysed by the fixed-effects model, Arthur and Oaikhenan (2017) revealed that an increase in health spendings has a positive effect on health status. One of the crucial findings of the study was that public and private sector spendings have different effects on health status. The study concluded that public health spending leads to a decrease in mortality rates, while out-of-pocket spendings by households increase life expectancy at birth. Although public spendings are superior to out-of-pocket spendings, it was also among the results obtained that there is a strong complementarity relationship between these two spending types.

Rahman *et al*. (2018) investigated the effects of health spendings on health status for 15 member countries of the South Asian Cooperation Organization (SAARC) and the Association of Southeast Asian Nations (ASEAN) with a panel data analysis in which fixed and random-effects models were estimated. In the study, where health spendings were evaluated separately as total, public and private, health status was indicated by improvements in health services, life expectancy at birth, infant mortality rate and crude mortality rate. The study concluded that an increase in health spendings reduces infant mortality rates and private health spendings are more effective than public health spendings.

Behera and Dash (2020) divided health spending into four groups: public health spending, exogenous transfers to the public sector, private sector out-of-pocket spending, and finally, private sector insurance payments. The study, employing GMM model for ten selected South-East Asia economies over the period 2000–2014, concluded that public health spending has a positive, albeit small, effect on life expectancy and infant mortality.

Likewise, in a study conducted for Nigeria, using data for the period 2000–2017, Owumi and Eboh (2021) examined the impact of public health spending, out-of-pocket spending and external health spending on life expectancy. They concluded that all groups of health spendings have a positive effect on life expectancy, while out-of-pocket health spending has the highest impact among the sources of health spending. Furthermore, Edeme *et al*. (2017), using data for the period 1981–2014 for Nigeria, also asserted that a rise in public health spending reduces infant mortality and improves life expectancy.

To summarize, the literature on the impact of health spendings on health outcomes generally focuses on the effect of public health spendings and addresses the issue by means of a linear approach. However, on the one hand, the failures that the health market is exposed to due to its unique structure legitimize government intervention; on the other hand, the consequences of the presence of the government on the health market require the issue to be analysed in terms

of public and private health spendings. This distinction, which is based on the theoretical framework, also necessitates the investigation of the effect of the size of public and private sector spending on the health market on health outcomes. Within this framework, unlike the traditional approach in the respective literature, the research addresses the question "*Does the effect differ when public or private sector spendings exceed certain levels?*" and makes it possible to discuss the issue along the axis of market and government failure. The empirical evaluation requires application of a non-linear methodology different from the existing practices; this is where the contribution of our study to the literature emerges.

4. Empirical Analysis

4.1 Data, methodology and model

The main objective of our study is to examine the effectiveness of health spending, which is one of the primary development policy instruments and considered a semi-public good in the public finance literature, in terms of its impact on the health status of the society. In this framework, based on our main research questions, we investigate whether public health spendings or private spendings of households are more effective on life expectancy at birth, which is specified as an indicator of health status. Within the scope of the study, we utilize the fixed-effects panel threshold approach of Hansen (1999), together with the approach of Kremer *et al*. (2013) for 33 OECD[2] countries over the period 2000–2021. A detailed description of the data is given in Table 1.

The OECD (2024) pointed out a number of variables such as mortality, life expectancy, causes of mortality, maternal and infant mortality, morbidity and cancer rate as indicators of health status. Among these, we use life expectancy at birth, namely "*hea_sta*" presented annually for the total population, as an indicator of health status. In other words, *hea_sta* shows how long a newborn baby can expect to live on average if mortality rates remain unchanged. On the other hand, the health spending indicators used as explanatory variables in the study are twofold. The first one is "*gov_spen*", which consists of public spendings and compulsory health insurance. In the study, private health spendings "*hou_spen*" are used to represent private health spendings other than public spendings. To investigate the non-linear effects of these regime-dependent variables, thresholds are also set for these variables. More briefly, "*gov_spen*" and "*hou_spen*" variables are also considered threshold variables in the regressions. On the other hand, "*trade*", "*inf*", "*growth*" *and* "*urban*" are taken into account as control variables in the models. As Fotourehchi and

2 Australia, Austria, Belgium, Canada, Chile, Colombia, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States.

Çalışkan (2018) mentioned, the expected impact of the control variables on health status is considered uncertain since they may have many positive effects on health status, such as the development of health technologies, access to better health services and improvements in nutrition and living standards, as well as many negative effects, such as changing lifestyles and intense stress due to factors such as increasing business volume, inflationary pressure, increasing urbanization or increasing environmental pollution and destruction of the natural ecological structure. Table 2 below provides descriptive statistics of the data.

Table 1: Description of data

Variables and abbreviations	Description	Source
Dependent variable		
Health status (*hea_sta*)	Life expectancy at birth (total, years)	OECD (2024)
Regime-dependent variables & threshold variables		
Public health spending (*gov_spen*)	Health spending (public/compulsory, % of GDP)	OECD (2024)
Private health spending / Private health spending (*hou_spen*)	Health spending (voluntary schemes/household out-of-pocket payments)	OECD (2024)
Control variables		
Trade openness (*trade*)	Foreign trade volume consisting of the sum of total exports and imports (% of GDP)	WB (2024)
Economic growth (*growth*)	Change in GDP calculated by spending method (%)	OECD (2024)
inflation (*inf*)	Change in consumer prices compared to the previous year (%)	OECD (2024)
urbanization (*urban*)	Urban population (% of total population)	OECD (2024)

Source: Authors' own elaboration

Table 2: Descriptives

Variable	Obs.	Mean	Std. dev.	Min.	Max.
hea_sta	726	79.04954	3.155875	70.2	84.6
gov_spen	726	6.195629	1.936884	2.012	15.861
hou_spen	726	2.246853	1.051569	0.575	8.37
trade	726	95.07361	56.90823	19.5596	393.1412
growth	726	2.384527	3.502036	−14.83861	24.47526
inf	726	2.658878	3.949535	−4.478103	54.91538
urban	726	59.1033	15.90057	25.37	100

Source: Authors' own calculations

One of the most critical problems encountered in terms of panel data analysis is heterogeneity, which points out structural relationships differing across units. Although linear models only reflect heterogeneity in the constant term, *i.e.*, in the intercepts, there exist various slope models that can solve this problem. Among these, Hansen's method is often preferred since it has a simple specification and clear policy implications. In Hansen's (1999) methodological procedure, the sample is internally subdivided into subgroups and thresholds are estimated; thus, the analysed relationship can be defined in different ways sensitive to the threshold value. In addition, it is aimed at constructing confidence intervals for the parameters with a derived asymptotic distribution. In order to evaluate the statistical significance of the threshold effect, the bootstrap method is defined. Thus, observations can be categorized into different regimes according to whether they are larger or smaller than the threshold value.

With threshold models, it is possible to detect structural breaks in the relationship between variables. In Hansen's method, whether the threshold effect is significant or not is evaluated by means of *F*-statistics. In this framework, according to the null hypothesis, indicating that the relationship is insignificant, there is no effect between the dependent variable and the explanatory variable that changes according to different regimes. Thus, the slope coefficients in front of the explanatory variable are equal to each other. The alternative hypothesis, which asserts that the relationships are non-linear and there is a significant single threshold effect, indicates that there is a regime-varying effect in the determinant of the explanatory variable on the dependent variable. In this case, the slope coefficients in front of the explanatory variable are different from each other.

Considering a single Hansen threshold model, the regression can be specified as follows:

$$y_{it} = \Omega + x_{it}\,(\rho_{it} \geq \gamma)\,\beta_1 + x_{it}\left(\rho_{it} \geq \gamma\right)\beta_2 + u_{it} + e_{it} \tag{1}$$

where ρ_{it} represents the threshold variable and γ is the threshold parameter that separates the model into two different regimes, each characterised by the coefficients β_1 and β_2. The term u_{it} represents the distinct impact that is exclusive to each object being analysed. It encompasses the unique attributes or impacts that are not accounted for by other variables in the model. Meanwhile, the term e_{it} represents the disturbance or error term, which signifies the amount of variation in the dependent variable that cannot be accounted for by the explanatory variables. This structure enables an analysis that may account for various behavioural patterns based on the value of the threshold variable.

In this framework, Equation (1) can be identified as follows:

$$y_{it} = \Omega + x_{it}\,(\rho_{it},\,\gamma)\,\beta_1 + u_{it} + e_{it} \tag{2}$$

where:

$$x_{it}\left(\rho_{it},\,\gamma\right) = \begin{Bmatrix} x_{it} I\left(\rho_{it} < \gamma\right) \\ x_{it} I\left(\rho_{it} \geq \gamma\right) \end{Bmatrix} \tag{3}$$

When the threshold parameter γ is determined, the estimation of the coefficient β can be performed using the ordinary least squares method as follows:

$$\hat{\beta} = \{X^*(\gamma)'X^*(\gamma)\}^{-1}\ \{X^*(\gamma)'X^*(\gamma)\} \tag{4}$$

Equation (4) shows the within-group deviations. This implies that γ is the deviation of the dependent variable from the group mean and γ corresponds to the deviation of the independent variables from their group means. To estimate the threshold parameter γ, a search can be performed on a specific subset of the threshold variable γ instead of the whole sample. Furthermore, the estimator for γ is defined as the value that minimises the residual sum of squares, which can be specified as follows:

$$\hat{\gamma} = arg\ \min_{\gamma} \mathrm{S}_1\left(\gamma\right) \tag{5}$$

When the threshold parameter γ is given, the model essentially transforms into a regular linear model. However, when the value of γ is unknown, a nuisance parameter problem arises. This leads to a non-standard distribution for the γ estimator. This complexity arises because the turning point of the regime change (γ) is uncertain, and its estimation significantly affects the behaviour of the model. Hansen (1999) showed that γ is a consistent estimator for the true threshold parameter γ.

He suggested that the most effective way to test the hypothesis $\gamma = \gamma_0$ is to construct a confidence interval using the "no rejection zone" method.

Accordingly, our study analyses whether the impact of public and private health spendings on health status can be evaluated under different regimes varying according to the levels of health spendings by performing Hansen's (1999) single threshold-based fixed-effects panel threshold approach. In this context, possible single-threshold models adapted to evaluate the effectiveness of public and private health spendings on life expectancy at birth as an indicator of health status are given below in Equations (6) and (7).

$$hea\_sta_{it} = \delta_{it} + a_1 X_{it} + \beta_1 regime_{it} + \varepsilon_{it},\ gov\_spen_{it} \leq \lambda_1 \tag{6}$$

$$hea\_sta_{it} = \delta_{it} + a_2 X_{it} + \beta_1 regime_{it} + \varepsilon_{it},\ gov\_spen_{it} \leq \lambda_1$$

$$hea\_sta_{it} = \theta_{it} + b_1 X_{it} + \phi_1 regime_{it} + \varepsilon_{it},\ hou\_spen_{it} \leq \lambda_2$$

$$hea\_sta_{it} = \theta_{it}\, b_2 X_{it} + \phi_1 regime_{it} + \varepsilon_{it},\ hou\_spen_{it} > \lambda_2 \tag{7}$$

In models with balanced panel data, the subscript i indicates unit effects and the subscript t indicates time effects. In the above specifications, hea_sta_{it} is the dependent variable indicating the health status, $\beta_1\ regime_{it}$ is the regime-dependent variable indicating the private health spendings of the public and households as *gov_spen* and *hou_spen*, ε_{it} is the error term and λ_1 and λ_2 are the threshold values estimated as a result of the analysis. Besides, gov_spen_{it} in Equation (6) and hou_spen_{it} in Equation (7) are the threshold variables that are considered to vary across units; β_1, β_2 and ϕ_1, ϕ_2 are the slope parameters that reveal the differential effect of the level of social capital under different regimes, *i.e.*, below and above the threshold value, X_{it}; variables defined as control variables in Table 1, δ_{it}; fixed effects indicating the heterogeneity of countries where public health spendings differ from each other, θ_{it}; fixed effects indicating the heterogeneity of countries where private health spendings differ from each other.

4.2 Empirical findings

As a next stage of the Hansen panel threshold procedure, we analyse the stationarity of the series by means of the second-generation panel unit root approach of Levin, Lin and Chu (LLC) and Im, Pesaran and Shin (IPS) since it is determined that the variables in question have horizontal cross-section dependence with regard to the Pesaran cross-section dependence[3] test. The unit root test results are presented in Table 3.

3 Can be shared upon request.

Table 3: Second-generation unit root test results

Variable names	LLC		IPS	
	With constant	With constant & trend	With constant	With constant & trend
hea_sta	2.4363 (0.9926)	4.7551 (1.0000)	3.7141 (0.9999)	0.4279 (0.6656)
gov_spen	0.2542 (0.6003)	–1.9285 (0.0269)	2.4052 (0.9919)	–2.1333 (0.0164)
hou_spen	–0.4366 (0.3312)	–3.7883 (0.0001)	1.6800 (0.9535)	–3.4515 (0.0003)
growth	–11.6256 (0.0000)	–9.7698 (0.0000)	–9.7864 (0.0000)	–10.4098 (0.0000)
trade	–3.0282 (0.0012)	–5.7875 (0.0000)	1.0857 (0.8612)	–4.1638 (0.0000)
urban	–0.3421 (0.3661)	–1.2989 (0.0970)	6.3662 (1.0000)	1.7109 (0.9565)
inf	–10.8246 (0.0000)	–9.1882 (0.0000)	–8.1751 (0.0000)	–7.0683 (0.0000)
d.hea_sta	–16.9656 (0.0000)	–14.8369 (0.0000)	–12.3220 (0.0000)	–12.9194 (0.0000)
d.gov_spen	–16.9535 (0.0000)	–14.5822 (0.0000)	–12.1722 (0.0000)	–12.7514 (0.0000)
d.hou_spen	–18.7795 (0.0000)	–16.5670 (0.0000)	–12.5640 (0.0000)	–12.9709 (0.0000)
d.urban	–6.5995 (0.0000)	–6.1568 (0.0000)	–6.2690 (0.0000)	–7.0335 (0.0000)
d.trade	–	–	–11.4475 (0.0000)	–11.8183 (0.0000)

Note: *d* indicates first difference; probability values are given in brackets.

Source: Authors' own calculations

As indicated in Table 3, the LLC and IPS panel unit root tests yielded consistent results for all variables with the exception of *trade*. While the variables *hea_sta*, *gov_spen*, *hou_spen* and *urban* are stationary at first differences, *inf* and *growth* are found to be stationary at level. The *trade* variable, for which different results were obtained, was also accepted as difference-stationary. In the following stages of the study, we proceed with the stationary data, yielding the results of the Hansen (1999) panel threshold model as shown in Table 4 below.

Table 4: Panel threshold regressions (public health spending threshold)

Dependent variable	Regime-dependent variable (rx)	
d.hea_sta	***d.hou_spen***	***d.gov_spen***
d.hou_spen	–	0.1705*** (0.0700)
growth	0.0176*** (0.0049)	0.0059* (0.0055)
d.trade	0.0020 (0.0023)	0.0018 (0.0024)
d.urban	−0.0399** (0.1570)	−0.0616* (0.1554)
inf	0.0066 (0.0054)	0.0056 (0.0054)
rx(d.gov_spen ≤ λ)	0.4968*** (0.1799)	0.0122 (0.0749)
rx(d.gov_spen > λ)	−0.0381 (0.0616)	−0.2461*** (0.0524)
Constant	0.1180*** (0.0263)	0.1703*** (0.0285)
Threshold	5.3440%**	6.7570%*
Confidence region (lower and upper limit)	4.8850 5.4010	5.8490 6.7890
***F*-statistics**	4.49	6.05
***F*-probability**	0.0002	0.0000

Note: ***, ** and * denote statistical significance at 1%, 5% and 10% level, respectively. Standard errors are in parentheses. The bootstrap method with 300 replications was used in the study. *d* indicates first difference.
Source: Authors' own calculations

Table 4 presents the estimation results of the models regressed using Equation (6), where public health spendings are taken as the threshold. In the first column of Table 4, the out-of-pocket health spendings of households are selected as the regime-dependent variable. Here, the threshold value for public health spendings is 5.34%. Below the threshold, *i.e.*, when the government's out-of-pocket health spendings are relatively lower, an increase in households' out-of-pocket health spendings has a positive significant effect on health status while above the threshold, no signifi-

cant effect is found. In the second column of Table 4, in which the public health spending is selected as the regime-dependent variable, the threshold value for public health spendings is estimated as 6.75%. Below the threshold, no significant effect of public health spendings on health status could be detected. On the other hand, when the public health spendings are above the threshold value, the increase in public spendings negatively affects the health status. In other words, a further increase in public health spendings is found to induce health inefficiencies.

Table 5: Panel threshold regressions (private health spending threshold)

Dependent variable	**Regime-dependent variable (rx)**	
d.hea_sta	***d.hou_spen***	***d.gov_spen***
d.gov_spen	−0.1820*** (0.0469)	–
growth	0.0057 (0.0056)	0.0077 (0.0052)
d.trade	0.0006 (0.0024)	0.0012 (0.0023)
d.urban	−0.0446* (0 .1561)	−0.0013 (0.1555)
inf	0.0078 (0.0054)	0 .0059 (0.0054)
rx(hou_spen ≤ λ)	0.1410 (0.0706)	−0.0757* (0.0432)
rx(hou_spen > λ)	0.2316** (0.2128)	−0.3875*** (0.0799)
C	0.1651*** (0.0287)	0.1584*** (0.0275)
Threshold	3.0010%**	2.8560%**
Confidence region (lower and upper limit)	2.9300 3.0500	2.8160 2.8860
***F*-statistics**	5.04	7.33
***F*-probability**	0.0000	0.0000

Note: ***, ** and * denote statistical significance at 1%, 5% and 10% level, respectively. Standard errors are in parentheses. The bootstrap method with 300 replications was used in the study. *d* indicates first difference.

Source: Authors' own calculations

Table 5 presents the empirical results estimated by means of Equation (7), where private health spending is specified as the threshold. In the first column of Table 5, in which out-of-pocket health spendings of households are selected as the regime-dependent variable, the threshold value for private health spendings in households is found to be 3%. Above this threshold, that is, when the health spendings of the households are relatively higher, a significant and positive effect of the private health spendings of the households on the health status is obtained. Contrarily, no significant effect is detected below the threshold (3%). In the second column of Table 5, in which the public health spendings is the regime-dependent variable, the threshold value for private health spendings by households is estimated as 2.85%. It is found that both below and above the threshold (2.85%), public health spendings have a significant and negative effect on health status. Similar to Table 4, the findings obtained here support the conclusion that the effect of private health spendings by households on health status is stronger than that of public spendings. These findings are in line with the existing literature (Turner, 1991; Anand and Ravallion, 1993; Gupta *et al*., 2001; Berger and Messer, 2002; Hanmer *et al*., 2003; Issa and Quattara, 2005; Arthur and Oaikhenan, 2017; Rahman *et al*., 2018), which shows that private health spendings have a stronger effect on health status than public health spendings for OECD economies, which are at a relatively high development level.

4.3 Robustness check

Our decision to use a dynamic panel threshold method – the dynamic panel threshold analysis method introduced by Kremer *et al*. (2013) – to check the robustness of the findings obtained with fixed-effects panel threshold analysis in this part of the study underlines the methodological excellence of our research. Indeed, as we have already mentioned, the problem of heterogeneity in panel data analysis cannot be adequately addressed using linear models as structural linkages may differ significantly across units. Therefore, threshold models that account for structural linkages and breakpoints based on threshold levels are very important as they provide a more direct representation of economic phenomena. In this framework, the dynamic panel threshold technique with endogenous regressors developed by Kremer *et al*. (2013), which is used in this study to test the robustness of the results, is effective in revealing potential distinctions between values falling below and exceeding an estimated threshold level. In our study, we investigate the impact of public and private health spendings on health status using the dynamic panel threshold model with endogenous regressors. This model captures the non-linear effects of public and private health spendings in different situations and mitigates endogeneity issues.

The dynamic panel threshold analysis uses the forward orthogonal deviation transformation proposed by Arellano and Bover (1995) and integrates the instrumental variable estimation

of the cross-section threshold model introduced by Caner and Hansen (2004) with the panel threshold model of Hansen (1999). As a result, endogeneity in important control variables is no longer an issue in the dynamic model. This methodology alleviates endogeneity concerns and takes into account dynamic features of the data that the Hansen model may miss. The dynamic panel threshold model makes it easier to estimate threshold effects using panel data, even when endogenous regressors are present. The general representation is as follows:

$$y_{it} = \mu_i + \beta_1^{'} X_{it} I\left(q_{it} \le \gamma\right) + \delta_1 I\left(q_{it} \le \gamma\right) + \beta_2^{'} X_{it} I\left(q_{it} > \gamma\right) + \varnothing z_{it} + \varepsilon_{it} \tag{8}$$

Here, y_{it} denotes the health status of the country i in the period t, which is the dependent variable of our model; μ_i represents the country-specific fixed effect removed by forward linear transformation as specified by Arellano and Bover (1995). In this way, the serial correlation of converted errors is avoided. In the analysis, X is the explanatory variables (public and private health spending) and q is the threshold variables (public and private health spendings) that separate the regimes. *I(.)* also has an indicator function that refers to the regimes defined by the threshold variable q. It splits the threshold variable into two regimes, above and below the level of the unspecified threshold parameter γ. The regression vector is divided into (i) a subset of exogenous variables z_{1it}, which are uncorrelated with the error term defined for each model analysing health status; and (ii) a subset of endogenous variables z_{2it}, which are correlated with ε_{it}. The methodological procedure starts with the estimation of a reduced-form regression of endogenous variables including z_{1it} across the instruments. Then the endogenous variables in Equation (8) are substituted by the estimated values $\hat{z_{2it}}$. Following this, the threshold value γ is determined by $argminS(\gamma)$ to determine the value of γ that minimises the sum of squared error terms of the regression, *i.e.*, the $\hat{z_{2it}}$ estimate of (1). After determining the threshold value that minimises the sum of squared error terms, the slope coefficients are estimated using the GMM approach for the predefined instruments and the estimated threshold value. β_1 and β_2 are regime-dependent slope coefficients. δ_1 represents the constant regime coefficient common to all cross-sections; ε_{it} is the independent and identically distributed error term.

Following the methodological procedure of Kremer *et al*. (2013), we first determine the effects of health spendings under the public health spending threshold in Table 6.

Table 6: Dynamic panel threshold regressions (public health spending threshold)

Dependent variable *d.hea_sta*	**Regime-dependent variable (rx)**	
	d.hou_spen	***d.gov_spen***
Threshold estimate Impact of *gov_spen*	5.363%**	6.737%**
Regime 1: $(\hat{\beta}_1)$	1.5626*** (3.80)	−0.1869 (−0.89)
Regime 2: $(\hat{\beta}_2)$	−0.1981 (−1.32)	−1.1004*** (−7.12)
Impact of Covariates		
L.d.hea_sta	−0.2137*** (−8.36)	6.737*** (−7.98)
d.hou_spen	–	0.7103*** (3.39)
growth	0.0235*** (4.66)	0.0335*** (3.67)
d.trade	0.0014 (0.67)	−0.0027 (−0.82)
d.urban	1.3632*** (4.22)	3.1894*** (5.53)
inf	0.0020 (0.19)	−0.0050 (−0.45)
Constant	0.0332 (0.96)	0.1419*** (2.44)
Observations	660	660

Notes: (i) *,** and *** indicate significance at 10%, 5% and 1%, respectively. (ii) Each regime contains at least 5% of all observations in accordance with Hansen (1999). (iii) Threshold values are valid for the estimates, hence between 95% confidence intervals. (iv) *t*-statistics are given in parentheses. (v) For definitions of variables, see the text.

Source: Authors' own calculations

According to Table 6, we find evidence supporting the positive effect of private health spending under the public spending threshold, which is consistent with the Hansen (1999) panel threshold results in Table 4. On the other hand, public spending has a destructive effect on health status when it exceeds the threshold level. Likewise, the empirical findings being consistent with Hansen (1999) results, the threshold values are also found to be similar to the previous estimations in Table 4.

Table 7: Dynamic panel threshold regressions (private health spending threshold)

Dependent variable ***d.hea_sta***	**Regime-dependent variable (rx)**	
	d.hou_spen	***d.gov_spen***
Threshold estimate (%) Impact of *hou_spen*	2.974%*	2.855%**
Regime 1: $(\hat{\beta}_1)$	−0.0703 (−0.29)	−0.3691** (−2.38)
Regime 2: $(\hat{\beta}_2)$	0.6419*** (3.23)	−2.0238*** (−4.57)
Impact of covariates		
L.d.hea_sta	−0.2512*** (−14.73)	−0.3093*** (−9.40)
d.gov_spen	−0.7312*** (−7.15)	–
growth	0.0335*** (4.82)	−0.01509 (−1.14)
d.trade	0.0006 (0.43)	−0.0103*** (−3.57)
d.urban	3.3122*** (10.56)	3.642*** (6.17)
Inf	−0.0182** (−2.29)	−0.0221** (−2.09)
Constant	−0.1246*** (−2.81)	0.1168 (1.47)
Observations	660	660

Notes: (i) *,** and *** indicate significance at 10%, 5% and 1%, respectively. (ii) Each regime contains at least 5% of all observations in accordance with Hansen (1999). (iii) Threshold values are valid for the estimates, hence between 95% confidence intervals. (iv) *t*-statistics are given in parentheses. (v) For definitions of variables, see the text.

Source: Authors' own calculations

Finally, Table 7 reports the empirical findings under the private health spending thresholds, which are also in parallel with the empirical results in Table 5 derived from Hansen's (1999) estimations. On the private health spending side, we find a beneficial impact on health status above the private spending threshold. On the other hand, public health spending worsens the health outcomes both above and below the private health spending thresholds.

5. Conclusion

Undoubtedly, health spending is one of the most important determinants of health status. However, especially under the argument of government failure, it is evident that the issue of the effectiveness of different types of financing rises to prominence beyond the level of health spendings. In this framework, the main purpose of our study was to analyse the changing roles and effects of public and private health spendings on the health status of OECD countries. Within this scope, we proceeded with two main research questions, which are: "*Should health spendings really be considered a market failure and be subject to government intervention, and if so, should there be a certain limit to government intervention?*" and "*To what extent does government intervention in the health market create a failure?*" Our research questions were based on the theoretical grounds in terms of health service market failures and the resulting government intervention.

We employed Hansen's (1999) fixed-effects panel threshold analysis for 33 OECD countries over the period 2000–2021, which enabled a non-linear perspective to answer the aforementioned research questions. First, the *gov_spen* variable was used as a threshold variable in order to evaluate the effectiveness of public health spending. Where private health spending was taken as the regime-dependent variable, we found that private health spending has a positive effect on health status when *gov_spen* is below the threshold value determined as 5.34%. On the other hand, when public health spending was determined as the regime-dependent variable and *gov_spen* exceeded 6.75%, public spending became inefficient and appeared to have a negative impact on health status. These initial findings were further reinforced in the models, where *hou_spen* was specified as a threshold to evaluate the efficiency of private health spending. As a matter of fact, in the case where private health spending was defined as the regime-dependent variable, the positive effect of private health spending on health status was observed when *hou_spen* exceeded the threshold 3%. On the other hand, when public health spending was taken as the regime-dependent variable, public health spending had a negative effect on health status regardless of the threshold value of 2.85% for *hou_spen*. We also used the dynamic panel threshold approach of Kremer *et al*. (2013) to test the robustness of our results and found that our results are consistent with the fixed-effects panel threshold approach of Hansen (1999).

To summarize, the findings of our study, which aimed to evaluate the relationship between health spendings and health status, seem to be closer to the government failure argument than to the market failure approach for the sample OECD countries. It is evident that the health spending has an upward trend globally with regard to a number of demand and supply-oriented grounds. Moreover, the share of the government in the health sector seems to be still apparent due to the market deficiencies. Following our findings and arguments, it is vital to establish optimal health spending composition and allocation in terms of efficiency. More specifically, considering

the inefficiencies caused by the increasing share of the government sector, it is extremely important to return to a structure that is oriented towards ensuring efficiency and, moreover, to establish a strong complementarity relationship between public and private spendings.

As policy reflections of our findings, implementations on monitoring and evaluating health outcomes, investing in preventive healthcare services, developing healthcare technology and digitalisation, analysing patients' health demand and behaviour, expanding the coverage of private healthcare services, improving technology and innovation incentives, promoting private health insurance would be worthwhile to provide a more efficient and effective resource allocation in the health system.

To sum up, we conclude that the non-linear effects of public and private health spendings in terms of different spending levels on health status are remarkable. In this aspect, beyond the common literature focusing on the linear effect of health spendings, we provide an original contribution by means of a multi-dimensional and non-linear approach on the impact of both private and public health spendings. In the meantime, there might be some other extensions of our research to examine different channels affecting health status. Developing the models by a wider range of health indicators and other economic factors influencing health status would be worthwhile and a fruitful area for future research.

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