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ITALIAN ABSTRACT

Mentre le economie perseguono l'obiettivo di raggiungere una crescita e uno sviluppo sostenibili, non possiamo sottovalutare il ruolo cruciale della salute in questo processo. La salute rappresenta un pilastro fondamentale dello sviluppo umano e può influenzare significativamente lo sviluppo economico. L'argomento risulta però delicato e complesso, in primis per la difficoltà nell'individuare una relazione diretta tra i due fattori, essendo molti gli elementi che intervengono e che potrebbero influenzare in modi diversi l'andamento di entrambi. La disponibilità dei dati e l'eterogeneità dei paesi rende complicata l'analisi e la conseguente comparazione tra di essi. Si ritiene però in generale che una migliore salute e qualità della vita possano portare a miglioramenti anche nella crescita economica. Tuttavia, persiste ancora un vivace dibattito su come allocare in modo ottimale le risorse nell'ambito dell'assistenza sanitaria al fine di massimizzare i benefici economici. Nel mio studio osservo la letteratura scientifica relativa agli effetti della salute e della spesa sanitaria pubblica e privata sulla crescita economica e analizzo, tramite il modello della regressione lineare multipla, l'effetto degli indicatori HALE (che forniscono informazioni sull'aspettativa di vita aggiustata per la qualità della vita) sul tasso di crescita del PIL pro capite di lungo periodo, nel periodo dal 2000 al 2019. Nell'analisi, ho incluso altre variabili di controllo come il livello di educazione, il grado di effettività del governo o la percentuale di persone al di sotto della soglia di povertà. I risultati suggeriscono la presenza di una relazione positiva tra salute e crescita economica.

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Index

INTRODUCTION AND SUMMARY

As economies strive to achieve sustainable growth and development, the role of health in contributing to this process cannot be ignored. Indeed, health is a necessary component of human development and can have consequences on economic development. The relationship between health and economic development has been a topic of interest for several years now, with different studies suggesting a positive correlation. Nevertheless even without the support of scientific research, it is obvious to think about how improved health can lead to increased productivity, better workforce participation and therefore economic growth. However, there is still much debate on the best way to allocate resources towards health care to maximize economic benefits. It is therefore important to understand what is meant in the first place by health expenditure.

Health expenditure means all expenses relating to the provision of healthcare, family planning, nutrition and emergency aid, except for drinking water and sanitation costs.

According to the International Classification for Health Accounts (ICHA), we can divide healthcare expenditure into a three-axis system, identifying functions, service provider industries and sources of healthcare funding.

By functions we mean the type of need to be satisfied or the goal to be achieved, and they can be curative care (to relieve symptoms or reduce the severity of a disease or an injury), rehabilitative care (services to stabilize , improve impaired body functions), long-term care, ancillary services, medical goods, preventive care, governance and health system and financing administration and other health services not included in the previous categories.

For health care service provider industries we find hospitals, residential long-term care facilities, providers of ambulatory health care, providers of ancillary services, retailers and other providers of medical goods, providers of preventive care, rest of the economy and therefore households as providers of home health care and other industries.

We then find the sources of finding health care, which allow us to make an initial distinction, which will be useful for the rest of the paper, on public and private health

expenditure. In fact, public ones are those founded and provided by the government, private ones are founded and provided by individuals or private entities, such as private insurance companies or employers. Public spending often covers expenses considered essential, private spending is determined by individual preferences and can be used to access services not provided by public healthcare, such as elective surgeries or treatments. The proportion of public vs private is very country dependent and can have significant implications for the quality and accessibility of services.

The choice to categorize spending into these three dimensions was made following an awareness of their importance for health policy and reforms, and for monitoring structural changes. The first studies that measured health expenditures in developing countries were carried out by Abel-Smith et al (1963-1967) at the beginning of the 1960s, and starting from the 1970s, the OECD nations also began to estimate health expenditures, with related information on public and private expenditures. The most important documents on the systematization and collection of information relating to healthcare financial flows have been "A system of Health Accounts" (SHA 1.0) published by OECD in 2000 and the "Guide to Producing National Health Accounts", published by WHO in 2003.

The significance of health expenditure in driving economic growth has been explored in numerous studies, which have highlighted the impact of improved health indicators on productivity and economic development. However, the specific consequences of increased health expenditure on economic growth remain subject to multiple factors and country-specific contexts. To shed light on this issue, this thesis will be divided into two main chapters. The first concerns a literature review, taking into consideration the most important studies on the subject to date. First, research on the effect of health in general on economic growth will be analyzed, and how improved life expectancy, lower mortality and better health can influence the productivity of the economy and economic development, leading to an increase in the growth rate of GDP. It will be seen that no real consensus has been reached on the issue, and that the expected consequences may depend on multiple factors and vary from country to country. I will then list, in the same way, the most relevant research and studies regarding medical spending and its effects on economic growth, focusing first on public spending and then on private spending. On the latter, the available material is not vast.

Moving on to the second chapter, an empirical and analytical examination will be conducted, using a broad sample of 128 countries and the HALE (health and life expectancy) indicator to conduct a multiple linear regression. This empirical analysis aims to build upon the findings and insights derived from the aforementioned studies discussed in the literature review. By applying suitable econometric techniques and employing a comprehensive set of variables, this chapter will provide a robust assessment of the effect of health and healthcare expenditure on economic growth. The inclusion of a substantial number of countries in this analysis enhances the generalizability and significance of the conclusions drawn, allowing for a more comprehensive understanding of the relationship between health, healthcare expenditure, and economic growth.

The research questions that guide this thesis are the following: “To what extent does an increase in health-adjusted life expectancy impact economic growth? And, at the same time and under the same conditions, what influence do out-of-pocket spending and general domestic expenditure in health have on the growth rate of per capita GDP?”. My study therefore aims to add to the already existing scientific literature, providing ideas for future research in the field. As we collectively strive to unravel the intricate interplay between health, healthcare expenditure, and economic growth, my study seeks to lay the groundwork for future investigations, fostering a vibrant environment for knowledge expansion and driving scientific progress.

1. *LITERATURE REVIEW*

1.1 Background on the effect of health on economic growth

Attention to the effects of health on growth and economic development has only developed in recent decades, thanks primarily to improvements in health and measures in favor of it, which have also led to greater life expectancy. This has allowed more and more researchers to determine the impact of health, starting from the effects on productivity or on labor force participation. When we talk about the effects of health on economic growth, we can distinguish the various studies into two main strands, which can refer to the approach of Lucas (1988) and Nelson-Phelps (1966). The former focuses on positive effects on labor productivity and is followed by studies such as those by Romer and Strauss and Thomas, and the second focuses on a positive impact on the rate of innovations, and is followed by researchers such as Bloom and Malaney, Bloom and Sachs, Barro.

Chronologically speaking, a first recognition of the elements of human capital health and their influence on the development of a country was given by Mushkin (1962) and Becker (1964). Nelson and Phelps (1966), a few years later, also observed how a higher health stock could lead to technological innovations and stimulate growth, productivity growth being positively correlated with the level of health and especially correlated with the initial or the average life expectancy of a country or region at a given time.

Building upon these initial insights, Preston (1975) provided empirical evidence to support the various effects of health on economic growth. His research further solidified the understanding that health plays a vital role in driving economic development. These pivotal contributions laid the foundation for subsequent investigations into the intricate interplay between health, human capital, and economic growth.

We can use the Preston curve (Preston, 1975), to note how health can be important for economic development. In fact, the graph shows the relationship between income and life expectancy, and illustrates a positive relationship between income and health outcomes, confirming how countries with a better level of health have a higher income than those with a lower level of health. However, the curve also suggests that the impact

of income on health exhibits diminishing marginal returns, implying that the health benefits derived from additional income diminish as income levels rise. To read it better, let's observe how in the horizontal axis we find the per capita income or GDP per capita, while in the vertical axis we find the life expectancy, measured in years. The curve shows the relationship between the two. Generally, the curve slopes upward from left to right, showing how countries with higher per capita income or GDP per capita tend to have higher living standards. We can find the different nations at different points on the curve, or above or below it. In fact, their distance from the curve can give us different information, indicating how they might have more effective health systems or other factors favoring a better health outcome, for the countries above, or demonstrating how they might have weaknesses in the health system, if they are below.

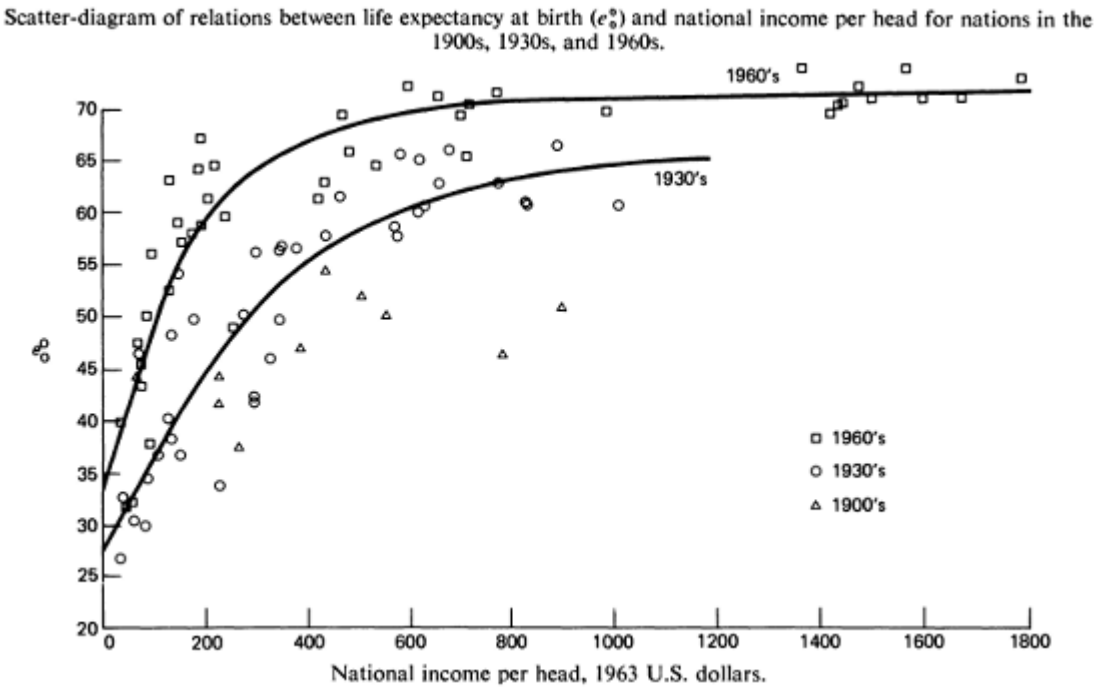

Figure 1 Preston curve. Source: "The Changing Relation between Mortality and Level of Economic Development", Preston (1975)

Romer (1986) has worked on the theory of endogenous growth focusing on factors such as human capital, population, technological process and public policies. He therefore found that human capital is seen as a positive externality on the accumulation of capital and positively favors the economic growth and well-being of a nation.

Strauss and Thomas (1998) explored the relationship between health and economic growth, focusing on how health levels can affect labor outcomes. They suggested that demonstrating it could lead to increased investment in health, creating a positive feedback loop. They then studied the impact of height and weight on wages in the United States, using them as indicators of population well-being. They found that a 1% increase in height leads to an 8% increase in wages, highlighting the potential link between health and economic productivity.

Strauss and Thomas then developed a function of health outcomes based on a vector of health inputs and labor supplies. However, their analysis omitted factors such as initial health levels and education received, which could affect the relationship between health and labor outcomes.

Knowles and Owen (1995) used health capital in the Solow model and found a strong and relatively robust link between life expectancy and income per capita. Bloom and Malaney (1998), examining the macroeconomic consequences of the mortality crisis that occurred in Russia in the 1990s (life expectancy decreased from 70 to 65 years), noted an estimate of income forgone between 1.8 and 2.7% of Russia's GDP in those years.

The possible indirect health payoffs were then observed by Bloom and Sachs (1998), Gallup and Sachs (2001), Alleyne and Cohen (2002).

Building on Bloom and Sachs (1998), their study involves a cross-country regression analysis of 77 African and non-African nations over the period 1965 to 1990. The results revealed slower growth in African economies but that, when the variables health impacts are included in the analysis, the negative impact of being located in Africa disappears. In other words, if initially being in Africa had a negative impact on economic growth, adding the health variables this negative effect disappears, suggesting that these variables play an important role in a country's growth. These are therefore

significant for the research carried out. Gallup and Sachs (2001) then explored the link between malaria and economic growth, exploring the effects of this disease and wondering if its elimination could improve the economic conditions of less well-off nations. In fact, their research explains how countries with severe malaria in 1965 had poorer economic growth over the next 25 years, by about 1.3% lower economic growth per year. On the other hand, reductions in malaria over the period 1965-1990 are associated with a growth of 0.3% for a reduction in the malaria index of 3%. The study then found the result that eliminating malaria would lead to an annual growth of 2.6%.

Alleyne and Cohen (2002) then discuss the relevance of health in the development process, both as an outcome and as an income. In fact, a good level of health generates positive outcomes such as a demographic dividend, more productive workforce and reducing poverty traps. They also explain the difficulty in identifying the value of health in the formation of human capital, as the variables that can influence it are difficult to obtain. Indeed, life expectancy is often used, even though it does not capture all aspects of an individual's current state of health.

It was Barro (2005) that incorporated the concept of health capital expanding the neoclassical growth model and stated that an improvement of the health status would have reduced the mortality and disease rate, increasing in this way the level of human capital.

The concept of health is very broad and sometimes it is difficult to talk about how it can affect economic growth, if we keep the general term of "health". For this reason, Weil (2006) has tried to evaluate the role that differences in health have in explaining the differences in income between more or less poor countries, observing the estimates of the effect of the variation of health inputs (understood as nutrition, or other physical aspects that can alter the health of individuals) on individual wages. In fact, Weil is able to estimate the variations on wages without bias, provided that the latent health is understood as scalar, or that can be represented by a single number or score, assuming a single underlying health factor. If latent health is not understood as scalar, but as a multidimensional factor, it could lead to the emergence of some conceptual problems, failing to define the effects on economic growth and health outcomes well. For this it uses some health indicators, such as the average height of adult men, the adult survival

rate for men and age of menarche for women, considering none of them ideal, but each with its own advantages, due to the information that each of them can provide. Subsequently, he carries out a cross-country analysis using the same indicators. Despite this, the author underlines that there are limitations and biases when it comes to health, as there are several indirect channels through which health influences a country's output.

Cole and Neumayer (2006) then found that health affects growth with total factor productivity and poor health can reduce aggregate productivity. Aisa and Pueyo (2006) found that better health and longevity could aid in economic growth, especially in less developed countries. As far as developed countries are concerned, however, increasing longevity could be more difficult and also more expensive, so it could even harm economic growth.

To demonstrate the actual difficulty in carrying out similar research and to differentiate themselves from previous studies were Acemoglu and Johnson, who in 2007 defined the previous studies as "inconclusive", as they did not prove a direct cause-effect relationship, but may have been distorted from other variables. Acemoglu and Johnson's study therefore exploited the international epidemiological transition (a series of public health measures and the introduction of new drugs and medicines which took place starting from the 1940s and which led to an improvement in life expectancy in many countries) to measure the effect of general health conditions and to measure life expectancies. In fact, the transition has allowed researchers to isolate changes in health unrelated to other factors. Their results showed that an increase in life expectancy led to a 1% increase in population but not enough to compensate for the negative impact on income per capita that the population increase. They therefore found no evidence that this led to a significant increase in per capita GDP over the period 1940-2000. The same study was then revisited several times, as in the case of Bloom, Canning and Fink (2014), who contested the fact that the study by Acemoglu and Johnson did not include initial life expectancy but used mortality from a number of diseases, which is highly correlated with initial life expectancy. This therefore meant that the instrument used may not be independent of the variable of interest. and their study invalid due to potential endogeneity and omissions of important variables from the analysis. To address this concern, Acemoglu and Johnson responded by including the initial level of

life expectancy since 1900 in their study and using a nonlinear estimator suggested by Bloom et al.'s framework, managing to keep their findings robust.

Aghion et al., in a 2009 study, questioned whether health could explain the cross-country differences and growth rates of income, considering it important to justify the promotion of new health programs.

They used two approaches from two different studies, those by Acemoglu and Johnson (2007), which followed a Lucas-type approach, and those of Lorentzen, McMillan and Wacziarg (2008), who followed a Nelson-Phelps approach, trying to find a significant effect on per capita GDP growth on the average child and adult mortality rates between 1960 and 2000.

Combining the tools of these two approaches, they depicted a model where accumulation and level of health are both important to notice significant effects on economic growth and to improve understanding of their relationship. They then combined the regression of the two (thus regressing per capita GDP on level and accumulation) and compared the results with regressions using only one of the two elements (the so called “pure regressions”), then observing more closely the OECD countries. In this way, improved health standards have been shown to increase current productivity growth, according to the Lucas approach, and future productivity growth, according to the Nelson-Phelps approach. They found that reducing mortality, especially under the age of 40, promotes growth.

Hansen and Lønstrup (2015), to explore this further, also used a dataset similar to the one used by Acemoglu and Johnson, with more data points, to control for country-specific factors. They found that increases in life expectancy have a negative impact on a nation's per capita GDP growth rate, greater when initial life expectancy is higher. This happens at least in the short run, due to factors such as the dilution of productive resources.

Cervellati and Sunde (2011) addressed the debate by including the factor of demographic transition, i.e. the change from high mortality and high fertility to low mortality and low fertility. This transition can bring different effects, in fact, the reduction of mortality can improve productivity and increase total production. On the

other hand, increasing life expectancy may lead to higher population growth, which could reduce income per person. The article states that the effect of life expectancy on economic growth becomes positive starting from this transition and this suggests that economic development is not a linear process and that it is linked to non-monotonic population dynamics (i.e. changes in population growth can have effects depending on the context).

The study by Rocco et al (2021) expands the research on the issue to more countries, in order to take advantage of the empirical advantages of using larger samples, studying the role of mortality and morbidity in economic growth. The authors used newer, more easily comparable data and a composite measure called disability-adjusted life years (DALYs), which combines mortality and morbidity, and using ranges of estimates, rather than single-point estimates. The results recognize a 9.6% to 10.6% increase in 25-year GDP growth for a 10% reduction in DALYs, although results may vary depending on whether the country is high or low income. By calculating the net present value of the potential economic benefits and costs associated with policies aimed at slowing or accelerating mortality and morbidity and thus at 1% change in DALYs, they found that the two are symmetric. Looking at USA, China, India and Niger, they observed that USA and Niger had a higher economic impact (effects of 10% and 5.1% of their respective 2014 GDP per capita), while China and India had a smaller one (effects of 2% respectively and 0.3% of their 2014 GDP per capita).

The paper by Zhao et al (2021) incorporates the elements of energy and environmental pollution, which could threaten workers' health, and concludes by admitting that investing in human health is beneficial to economic growth.

In summary, the extensive and diverse body of literature on the relationship between health care expenditure and economic growth reveals a longstanding interest in this subject. The studies include a wide range of factors, countries, and time periods, reflecting the complexity of the topic. However, amidst the variations, a consistent thread emerges: health is intricately connected to economic growth, and advancements in health contribute to more robust and sustainable economic development.

The many studies underscore the significance of health as a determinant of economic well-being. By improving health outcomes and investing in healthcare, societies can

stimulate economic growth and enhance overall prosperity. Although the specific mechanisms and optimal levels of health expenditure remain open to further investigation, the existing literature establishes a compelling case for the connection between health and economic progress.

As we delve deeper into this field, it becomes increasingly apparent that nurturing a healthy population is not only a matter of social well-being but also a crucial driver of economic success. By prioritizing health and implementing evidence-based policies, we can pave the way for prosperous societies that thrive both in terms of individual well-being and sustainable economic growth.

1.2 Background on the effect of health expenditure on economic growth

The most important studies on the impact of health care expenditure on economic growth are listed below. Although we can deduce, by looking at the previous paragraph, that health has a positive effect on economic growth and that therefore, consequently, health expenditure will also have a positive effect, there have been studies demonstrating the contrary. In fact, higher health expenditure can have a negative effect on GDP. The presented literature observes several ways in which health expenditure can relate to economic growth. First, by having a direct one-sided relationship from health care expenditure, second, by having a one-way causality from growth to health care expenditure, then by having a two-way relationship between the two, and finally by having an absence of relationship.

First of all one of the most important studies was the Gerdtham and Löthgren (1998) one, that studied the link between health expenditure and GDP in 21 developed countries in the years 1960-1997, first testing if they were stationary (their values do not move with time) and finding the non-stationarity of both vectors. Then, they focused on the presence of a long-lasting relationship between the two, using cointegration tests, and found strong evidence in favor.

Narayan et al (2010), in their study of the relationship between health and economic growth, also encountered a positive, but very low, impact of health spending on growth.

In fact, their estimates, carried out with the DOLS estimator, are around a 0.3% increase in GDP for a 1% increase in health expenditure.

Wang (2011) analyzed the relationship between rising health care spending and economic growth starting from the health care expenditure data of 31 countries from 1986 to 2007. The study, using a quantile regression, explains how the former can help the economic development of a country but only up to a certain point, because the relationship depends on the level of development of a country.

Heijink, Koolman and Westert (2013) have then discussed the relationship between health expenditure and avoidable mortality (deaths that could have been prevented with timely and effective healthcare), using the latter as an outcome measure for the effectiveness of health systems. They used a disease-level perspective and data from 14 western countries between 1996 and 2006. The study did not find a consistent relationship between the two (1% increase in healthcare spending led to a decrease in avoidable mortality by 0.5%), suggesting that other factors, such as socioeconomic factors, may be more important in explaining differences in avoidable mortality across countries. Of course, the authors specify that, despite the results, the increase in healthcare spending may have brought other welfare gains that are more difficult to capture in the analysis.

Houeninvo and Sossou (2015), observing the relationship between spending on education and health and the economic growth of 46 African nations in the period 1996-2010, also found a negative effect. In this case, however, as the authors said, the results were due to inefficiencies, corruption, bureaucracy and underinvestment, and in any case, they found that health spending was more efficient and had a more positive impact than spending on education. Furthermore, they added that there is a minimum level of spending in the sector that must be met in order for positive effects to be observed, and below that level, only negative effects will occur.

Wang (2015) used the GMM (a statistical method called the Generalized Method of Moments), to analyze data from OECD countries from 1990 to 2009, to look at various factors such as the ratio of healthcare spending to GDP and other social expenditures. He admits that the relationship between health care spending and economic growth is complex and without a real answer to how much countries should invest in health care.

For this reason he chose the GMM (instead of other methods such as OLS, which would have led to distorted and inconsistent results) to identify optimal health expenditure. As a result, he identified that if the ratio between the two measures is less than 7.75%, then increases in health care costs lead to faster economic growth. If the ratio is greater than the identified percentage, this consequence does not occur.

Hatam et al (2016) focused on the association between economic development and health expenditure in ECO countries, finding a strong positive relationship between the two variables. Furthermore, they argued that health spending must be understood as an investment good, precisely because it increases worker productivity, in contrast to other theories that see spending as a consuming good, which would reduce spending in other economic areas.

Awaworyi Churchill et al (2015) instead studied the relationship between public spending on education and health and economic growth, with a meta-analysis based on 306 estimates from 31 primary studies. Although they found a positive relationship between spending on education and growth and between the sum of both spending and growth, they did not find the same results when analyzing health spending and economic development. In fact, there would seem to be a negative relationship between the two, due, according to the authors, to crowding-out effects and welfare losses from tax distortions, inefficient or inequitable allocation of public resources in the health sector, low quality of health expenditure and the rapid population aging in more developed nations.

Studying the case of Tunisia and Morocco, Guetat (2019) using control variables such as corruption, GERST, LEB, DTO, MR and inflation, applied different statistical tests to determine the type of relationship between the variables, wanting to demonstrate the presence between public health expenditure and GDP. Studies have demonstrated a positive impact of the former on the latter and a regional inequity on the distribution of health infrastructures and medical personnel. The author states that investment and innovation of the human capital stock in the health sector is necessary for long-term economic growth.

A more recent study by Ozyilmaz et al (2022) explains that as a society develops, its health indicators generally improve as well, and spending on health care can help

improve the health of individuals, leading to higher productivity. On the other hand, he admits that some studies show instead the negative effects of health spending on growth, given for example by an increase in the older population and it can also crowd out more productive investments. To study the link, the author used data from 27 European countries from 2000 to 2019 using the Panel Fourier Toda-Yamamoto Causality Test and the Random Forest Method. The results depended from country to country, with a bidirectional causality relationship on a panel basis, and on a country basis, this relationship could be seen in Denmark, France and Italy, with no causal relationship in the other countries. However, the analysis noted that health expenditure positively affected economic growth in most European countries, and that it was the most important variable for economic growth.

As already mentioned at the beginning of the paragraph, the literature concerning private health expenditure or the difference in the effects of public and private is very scarce. However, Beraldo, Montonio and Turati (2005) have found, albeit low, positive impacts of spending on economic growth. According to their studies, a 1% increase in total health expenditure would lead to an increase in GDP growth of 0.06%, the same increase in public health expenditure would lead to a relatively 0.04% and 0.033% growth in the GDP growth rate.

Bhattacharya and Xue Qiao (2007) have talked about how the two expenses are complementary to each other and can work together to achieve better results. Indeed, according to their study, when public programs are effective, then they can improve the productivity of private investment, leading to better overall health and economic outcomes. Their model also suggests that when public programs are ineffective or absent, chaotic fluctuations in the economy can occur. leading to significant impacts on people's lives and the economy as a whole.

Halıcı-Tülüce and Dumrul (2016) examined the relationship between health care spending and economic growth in 25 high-income countries in the period 1195 to 2012 and 10 low-income countries in the period 1997 to 2009, with GMM and a two-stage system GMM procedure. Their study demonstrated a significant positive impact of public health spending on growth and, surprisingly, a negative impact of private health spending. These effects were found similarly in high-income and low-income countries,

most visibly in high-income countries. This is also due to the fact that in low-income countries, the impact of private healthcare spending is very low and in general, its negative effect can be due to the negative relationship with fixed capital investments.

In conclusion, the studies reviewed provide valuable insights into the intricate relationship between health care expenditure and economic growth. While there is a prevailing notion that health has a positive impact on economic growth, the findings are not always consistent. Some studies have demonstrated a positive relationship, highlighting the potential benefits of increased health expenditure for economic development. However, other research has uncovered contrasting results, indicating potential negative effects or an absence of a significant relationship between health expenditure and GDP.

It is crucial to consider various factors that influence this relationship, such as the level of development of a country, the efficiency of health systems, and the quality of spending. The literature also emphasizes the importance of distinguishing between public and private health expenditure, as their impacts can differ. Although research specifically focused on private health expenditure is limited, there are indications of positive effects, albeit relatively low, on economic growth.

Overall, these studies underscore the complexity of the relationship between health care expenditure and economic growth. While there is no definitive answer to the optimal level of health expenditure, it is evident that investing in health care can bring about potential benefits in terms of improved health outcomes and increased productivity. However, careful consideration of factors such as resource allocation, efficiency, and equitable distribution of health care resources is essential to maximize the positive impact on economic growth.

Moving forward, further research is needed to deepen our understanding of the mechanisms underlying the relationship between health care expenditure and economic growth, particularly regarding the differential impacts of public and private spending. By expanding our knowledge in this field, we can inform evidence-based policy decisions and foster sustainable economic development while prioritizing the well-being of individuals and societies as a whole.

2. EMPIRICAL ANALYSIS

2.1 Data and Methodology

In this section, my analysis focuses on conducting an empirical examination of the data, with a specific emphasis on exploring the relationship between health and economic growth. To achieve this, I carefully consider 11 key variables and employ a multiple linear regression framework. For my study, I sourced data from the reputable World Bank database for all variables except the Health Adjusted Life Expectancy (HALE) indicators. To ensure accuracy and precision in measuring the HALE indicators, I relied on the results provided by the Global Burden of Disease Study (GBD).

My study takes into consideration the time period spanning from 2000 to 2019, primarily because of the availability of comprehensive and reliable data for all variables considered. In particular, as the observations on the HALE indicators conclude in 2019, this time frame ensures methodological consistency and data completeness. By aligning the time frame with the availability of HALE data, I aim to enhance the overall robustness and comprehensiveness of my analysis.

To provide a better overview, I present in the next page a summary table showing the variables employed in my study, along with a statistical description of the collected observations.

Variable	Obs	Mean	Std. dev	Min	Max
Long Run GDP Growth Rate	162	2.308541	1.950685	-.774036	10.55338
HALE at birth	168	61.26351	7.217818	41.33029	72.62299
Log initial GDP per capita	162	7.750811	1.622247	4.823991	11.31892
Poverty headcount ratio at national poverty lines (% of population)	130	30.02357	16.39447	4.3	82.3
Hospital beds (per 1,000 people)	162	3.08987	2.527057	.2	15.13
School enrollment, secondary (gross)	163	2.14985	30.16666	5.93235	157.6243
OECD countries	169	.183432	.3881704	0	1
Log population over 65 years old	169	12.67333	2.315837	5.103822	18.59742
Out-of-pocket expenditure (% of current health expenditure)	169	33.8324	19.4462	.1143715	78.42256
Domestic general government health expenditure (% of current health expenditure)	164	50.66426	21.53885	4.939312	89.27162
Government Effectiveness: Estimate	167	-.0400074	.9698787	-2.12362	2.14985

As a dependent variable I use the long run growth rate of GDP per capita, which I calculate taking into account the gross domestic product of each country in the initial year 2000 and in the final year, 2019. As an indicator of the level of health of each country I use HALE (Health Adjusted Life Expectancy), an indicator used to evaluate the health status of a population, which takes into account both life expectancy and quality of life, calculating the healthy years of life that one can expect to live. This indicator takes into account years of life lost to disease, disability or other health problems, and provides a more comprehensive measure of a population's health than life expectancy alone. I then include the logarithm of the initial GDP per capita as a control variable, which allows me to better isolate the specific effect of the other independent variables on the dependent variable and to address basic differences between countries, such as level of economic development or the availability of resources. The "Poverty headcount ratio at national poverty lines (% of population)" is an indicator that can be used to measure the proportion of the population living below the national poverty line in a given country. The inclusion of the "Hospital beds per 1000 people" indicator provides an approximate measure of the availability of hospital beds relative to the population, in order to assess the accessibility of medical care and the capacity of the health system to provide adequate medical care. The presence of a higher number of beds may indicate a greater availability of health resources and facilities, which could positively affect the quality of health services offered. I then use an estimate of government effectiveness, which attempts to summarize the quality of public services and their credibility within the observed country. I also include a dummy variable that allows me to differentiate the countries belonging to the OECD from the others, the logarithm of the population over 65, and two indicators of health expenditure, the first relating to out of pocket expenditure and the second to domestic general government health expenditure.

The choice of the multiple linear regression model is justified for several reasons.

First, the model allows for the simultaneous analysis of the effect of several independent variables on the dependent variable, providing an overall and detailed view of the existing relationships.

Furthermore, it is widely used in economics to study the causal relationships between variables, allowing the effect of health to be evaluated in a systematic and quantitative way.

Finally, the multiple linear regression model allows to control and take into account other factors that can influence economic growth and to isolate the specific effect of health on the dependent variable.

The model equation is as follows:

$$Long\ Run\ GDP\ Growth\ Rate = \beta_0 + \beta_1 * HALE\ at\ birth + \beta_2 * LogGDP2000 + \beta_3 * povertyratio + \beta_4 * hbeds + \beta_5 * senrollment + \beta_6 * OECD + \beta_7 * logover65 + \varepsilon$$

I performe the statistical analysis with Stata software, which automatically handles the missing observations in the data analysis process. In fact, Stata ignores missing observations when calculating the results, allowing you to obtain valid estimates based on the available observations. Therefore, no manual intervention is required to handle the missing observations in the Stata software and I end up with a total of 128 observations complete with all variables.

I use the software to then run diagnostic tests on the variables to make sure they fit the analysis best. First of all, I research unusual and influential data, with the aim of looking for outliers, points with high leverage and influence, using the commands *describe*, *summarize*, *graph matrix* and *scatter*, to observe the data, and *predict r*, *rstudent*, *stem r*, *predict lev*, *leverage*, to analyze outliers and leverage. I have not noticed any anomalous data. I then check the normality of the residuals graphically, using the commands *kdensity r*, *pnorm r* and *qnorm r*. Here too I am able to observe how the residuals are distributed in a normal way. To make sure of the homoskedasticity of the residuals, I make a graph between these and the fitted values with *avfplot* and I run the Breusch-Pagan test, which does not provide evidence of heteroskedasticity. For multicollinearity, I run the VIF test, which does not produce worrying results (all lower than 5, with a mean VIF of 2.70)
After making sure the variables fit and the model works, I proceed to do the econometric analysis and related regression using the software's *regress* command.

2.2 Results

	(1) longrungdp	(2) longrungdp	(3) longrungdp	(4) longrungdp	(5) longrungdp
hale	0.159***	0.0776**	0.0756**	0.0590*	0.0423
	(0.0267)	(0.0256)	(0.0258)	(0.0268)	(0.0286)
loggdp2000	-1.072***	-1.636***	-1.603***	-1.551***	-1.587***
	(0.117)	(0.154)	(0.162)	(0.157)	(0.157)
avgproportionofpeoplelivingbelow		0.0218	0.0183	0.0266	0.0266
		(0.0231)	(0.0238)	(0.0229)	(0.0228)
avghospitalbedsper1000people		0.275***	0.279***	0.296***	0.278***
		(0.0555)	(0.0559)	(0.0557)	(0.0564)
avggovernmenteffectivenessestima		0.629**	0.689**	0.746**	0.798**
		(0.240)	(0.258)	(0.243)	(0.244)
avgschoolenrollmentsecondarygros		0.0235**	0.0231**	0.0245**	0.0221**
		(0.00743)	(0.00747)	(0.00734)	(0.00744)
logover65		-0.0136	-0.00192	-0.0536	-0.0409
		(0.0559)	(0.0589)	(0.0585)	(0.0587)
oecd			-0.284		
			(0.437)		
avgoutofpocketexpenditureofcurre				0.0154*	0.0275*
				(0.00743)	(0.0106)
avgdomesticgeneralgovernmentheal					0.0194
					(0.0122)
_cons	0.834	7.201***	7.064***	7.496***	7.457***
	(1.134)	(1.552)	(1.570)	(1.538)	(1.528)
N	161	128	128	128	128
R^2	0.350	0.605	0.606	0.619	0.627
adj. R^2	0.342	0.582	0.580	0.593	0.598

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Five multiple regressions performed with the variables presented are shown above. In the previous table showing the totality of the variables used, a larger number of observations were initially available. However, due to the presence of missing data in certain variables, the final one is conducted using a reduced sample size of 128 observations. The exclusion of these observations is necessary to ensure the integrity and reliability of the regression results. In model (1) I want to carry out the regression focusing solely on the HALE indicator and a single control variable, i.e. the logarithm of the initial GDP per capita (in the year 2000). The results demonstrate a positive effect of the health indicator on the dependent variable and an increase of one unit is associated with a 0.159 percentage point increase in the GDP growth rate. Furthermore, the coefficient is significant at the level of $p<0.001$. Nonetheless, we note that R squared is relatively low, which may indicate that the independent variables included in the model are not strongly associated with the dependent variable, or that the model itself is inadequate to explain the data. I am unable to regress only the health variable on economic growth, primarily because it would not take into account the many social and economic differences of the countries, and furthermore because the simple relationship would lead to a negative coefficient, which would not be the desired result. To further explore the relationships, additional variables are added to the regression analysis in subsequent models, with the exception of the OECD dummy variable. Notably, the positive effect of the health indicator persisted even after introducing the additional variables, indicating its robustness. Specifically, a one-year increase in the health indicator is associated with a 0.0776 percentage point increase in the long-run GDP growth rate. We then note how other variables included in the model have a positive effect on the variable depends, such as an increase in the number of beds per 1000 people, the percentage of students enrolled in secondary school and the government effectiveness index. In this model we observe how R squared is higher and reaches a value of 0.605, explaining about 60.5% of the variation in the dependent variable, "longrungdp". The adjusted R-squared (Adj R-squared) is 0.5818, which accounts for the number of predictors in the model and provides a better estimate of the fit of the model to the data.

This first analysis, albeit very simple, is in agreement with the first studies by Porter (1975), who wanted to underline a link between health and economic growth.

To maintain consistency with the earlier sections of our paper, two variables related to healthcare expenditure are also added to the regression analysis. These variables include the out-of-pocket expenditure, which represents the expenses incurred by citizens for unreimbursed medical care, and the domestic general government health expenditure, which represents the healthcare spending dedicated by the respective nations. Initially, the analysis considers only the out-of-pocket expenditure, revealing a significant positive effect. Subsequently, the domestic general government health expenditure is also included, showing significance only in the case of expenditure carried out by citizens.

The regression results therefore lead to valuable insights into the relationship between health and economic growth, thus adding to the already existing scientific literature on the subject. It is remarkable how the consistent positive effect of the health indicator (HALE) persists across all five models and a one-unit increase of it, thus a one-year increase in adjusted life expectancies is associated with a significant increase in the rate per capita GDP growth, supporting the hypothesis that health has an impact on growth. Furthermore, factors related to health infrastructure, education and government play significant roles in explaining this relationship. This can be seen through improvement in model fit as indicated by R squared and adjusted R squared values. Indeed, in the latest models, a higher R-squared explains how a larger portion of the variation in the dependent variable is explained by the independent variables included in the model, suggesting better explanatory power. Despite this, the research still has severe limitations and imperfections. For example, due to missing data, it is not possible to proceed with the analysis in a number of countries greater than 128, excluding a significant number of countries, which would have contributed to a better evaluation. Related to this, there is also the problem of the inaccuracy of some data, which in the case of some countries could be less reliable due to the sources or the problem of confounders, which cannot be resolved completely with the control variables. In fact, countries with higher GDP per capita or more robust economies could have better health indicators and therefore invalidate the research, as already stated by Ozyilmaz et al (2022), Heijink, Koolman and Westert (2013) and Wang (2011), as well as conversely, countries with a more fragile economy will have lower HALEs due to factors other than those considered, as Houeninvo and Sossou (2015) noticed previously. My study is in

agreement with the others already mentioned above, both regarding the aspect of health alone and that of healthcare expenditure. However, more comprehensive data and more rigorous methodologies are needed to further explore the already complex relationship between health and economic growth.

2.3 Conclusions

In revisiting and concluding this paper, it is crucial that we revisit the central arguments and questions that have guided it from the outset. By doing so, I am best able to reinforce the core focus of this research but also to provide a clear context for summarizing the main and key findings and for drawing meaningful conclusions. My study aimed to address the effects of health on economic growth, also looking at health care spending, observing significant indicators to arrive at results.

Focusing on the literature and past studies, I highlighted how first of all a greater focus on this topic has increased only in the last few decades, but that in any case scientific research in this regard has been prolific and has branched off into two main currents, starting from Lucas (1988) and Nelson-Phelps (1966) respectively. Preston (1975), with his curve, demonstrated and brought empirical evidence on the connection between health and economic development. Other studies followed, but in general it can be said that there is a relationship, more or less subtle depending on various factors, difficult and complex to identify and analyze, and above all dependent on the nation under consideration. In fact, here we can deepen and talk about the difficulty in managing this topic, mainly due to the breadth and complexity of the health sector, especially if applied to the economy and its development. Why, in fact, is it not so immediate to notice this relationship and its consequent effects? We can say first that distinguishing the direction of causality between economic growth and health is difficult, as is isolating the specific impact of health. Indeed, health outcomes can be influenced by multiple factors, such as the socio-economic conditions of a country, education or cultural practices. Furthermore, these two factors are often endogenous, which means that they interact and influence each other simultaneously. For example, healthier populations may contribute to economic growth through increased productivity, while higher economic growth can provide resources for improved healthcare. The endogeneity makes it challenging to establish a clear causal relationship between the

two variables. Or, health can impact the economy and its growth in different ways and pathways, such as labor productivity, human capital formation, innovation and demographic changes. Another obstacle can be the limitations that the data has. Health data are subject to variations in their complexity, consistency and availability, making it difficult to analyze and compare across countries and regions, precisely because of their heterogeneity. In addition to this, the data that can be found may not be sufficient to capture the full complexity of the relationship. No less important is the presence of long time lags, for which the effects of health on the economy could take years or decades to manifest themselves concentratedly.

For these reasons and difficulties, each researcher focuses on health indicators that are different each time, to try to capture a possible interaction in the best possible way and in an ever clearer way. One of these indicators is health expenditure, i.e. the money allocated to medical care, which can be, as better analyzed in the introduction, belonging to the private or public sphere. I therefore focused on the scientific literature that we have available on this topic and its impact on economic development, starting from the studies of Gerdtham and Löthgren (1998), who found a long-lasting relationship between health expenditure and GDP in developed countries . I also tried to identify those studies that question the difference between public and private health expenditure and their effects, as done by Bhattacharya and Xue Qiao (2007) or Halıcı-Tülüce and Dumrul (2016). Here too, as in the previous case of health taken individually, the study of these variables is difficult for various reasons. The heterogeneity of nations in terms of health systems is even more pronounced, as is their levels of development and their approaches to health. Or, the same challenge of time lag and long-term effects remains, due to the time investments need to yield measurable economic benefits.

Despite this, I wanted to get involved and try to carry out my analysis on the effects of health, with a small parenthesis on those of health care costs, through simple multiple linear regression models carried out thanks to the Stata software.

During the research, I used the HALE indicators, which proposed a life expectancy adjusted for the level of health, and the long run GDP per capita growth rate, calculated using the initial growth rate of GDP per capita and the final one of 2019, to observe and search for a significant relationship between health and the economy of 128 countries of

the world. To do this, I also used some control variables necessary to explain the differences between countries and therefore the reasons that would have led to a different growth of my dependent variable, including the initial level of GDP per capita expressed in dollars in the year 2000, the percentage of people living below the poverty line, the percentage of students enrolled in secondary school, the number of hospital beds per 1000 people and the degree of government effectiveness.

The results demonstrated coherence with scientific research, as they revealed a positive effect of both health and health spending conducted by citizens and governments on economic growth.

These results should not remain an end in themselves, but serve as a starting point for countries to improve their policies. In fact, despite the difficulties in research, it is still evident how investments in the health system can drive economic development. In fact, one could think of improving preventive healthcare or improving the efficiency of current healthcare, promoting equity within it and ensuring that there are no disparities in its access.

By leveraging the insights from this study and adopting evidence-based policies, policymakers can steer their nations towards sustainable economic growth and improved population health.

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