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Determinants of increased health care spending: Colombia in the international context

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Abstract: *Financial sustainability in health refers to the balance over time between income and expenditure, so expenditure is a major fiscal challenge and its determinants require monitoring. The objective of this study is to define and measure the most important determinants that influence increases in health expenditure in 80 countries at different income levels, and to determine how the average level of increase compares with Colombia. A literature review was conducted to define the determinants. Then, a fixed-effects panel regression model was estimated to reveal the contribution of these determinants to the increase in spending. The results indicate that demographic variables and technological innovation have the greatest impact on the increase in health spending (45% and 43%, respectively). In conclusion, the study validates what is reported in the international literature with regard to upper-middle-income countries, where the evidence identifies that demographic and technological factors have the greatest impact on the increase in spending. There is also a need to include institutional and outcome variables to ensure that a fuller array of health spending determinants are considered, quantified, and explored.*

Keywords: Health expenditure, financial sustainability, demographic transition, technological innovation, health efficiency, health policies.

JEL classification: I12, I18, J11, O31, H21, I38.

Introduction

Financial sustainability in health systems is often the subject of debate in political, economic, and social circles. However, the debate is rarely accompanied by a clear idea of what it means for a health system to be financially viable or how to assess financial sustainability or, indeed, what the economic and policy implications of this problem are (Kutzin, 2008). The probable reason for this is that the meaning of *financial sustainability* is conceived as self-evident because the presence of an imbalance between the obligations of a health system and its capacity to cover them can shed light on the understanding of its functioning. While this idea is accurate, it is inadequate, as it says nothing about (i) the nature of the problem itself, (ii) the economic, political, and demographic implications of financial sustainability / unsustainability, or (iii) behavior and monitoring of the level at which resources (revenues) and uses (expenditures) should be aligned.

To understand financial sustainability, it is essential to carry out an analysis of the resources that are allocated to health financing and/or to analyze spending behavior (OCDE, 2015). Although it is not possible to determine how much a country should spend on health (Savedoff, 2007), the pressure is on their governments, *a priori* and irrespective of other factors, as there is a predominance of public funding in different health systems (WEF, 2012). This is why rising health costs put significant pressure on national budgets, even more so when spending grows faster than economic growth (Global Burden of Disease Health Financing, 2017).

To assess financial sustainability in health, it is necessary to analyze income and expenditure behavior independently, but most studies concentrate on containing the increase in expenditure (OCDE, 2015); (European Commission, 2014); (Appleby, 2013); (Abellán, 2010) & (WEF, 2012). On the income side, the need for greater priority of government resources and diversification of funding sources is discussed (WHO, 2010). Governments therefore seek to ensure greater prioritization and efficiency in the allocation of resources (OECD, 2015).

On the expenditure side, the impacts of different determinants are considered where, at the international level, technological innovations, the increase in prices and quantities of health services, the level of per capita income, population dynamics (particularly ageing), suboptimal use of resources, awareness of the value of health, lifestyles, population expectations, and insurance coverage are the main determinants contributing to increased expenditure and

leading to substantive fiscal pressures on governments⁴ (Willemé, P & Dumont, M, 2014); (European Commission, 2014); (Herwartz, H., & Theilen, B, 2014); (Cluter, D, 1995) & (Newhouse, 1992).

From a review of the relevant literature, variables that allow measuring the determinants of the increase in expenditure are selected for this study. These variables include technological innovations in health, demographic changes, price inflation in health, and income growth. Further, two additional variables are proposed that are rarely measured in the literature, namely an outcome variable (health efficiency) and a policy variable (corruption). These latter two variables are fundamental to assess the increase in spending. Understanding the determinants of increases in health spending is particularly pertinent at the time of writing given the contemporaneous global crisis which has unfolded because of the COVID- 19 pandemic which has necessitated increased public funding as well as adjustments and controls in financing policies to respond to the disease (Joe Kutzin, 2020).

Colombia has taken significant steps in the search for universal health coverage, which implies fiscal pressure on the government. Insurance coverage had reached 97% of the population by 2017, there is an equal benefit plan for the entire population, and in addition, out-of-pocket spending is low according to data from the WHO data repository for 2016 (16.4% of total health spending) compared to the average for Latin American countries (31.6%) and the OECD countries (30.7%). However, although significant progress has been made, there is concern about the continuity of the system's achievements and challenges, so it is important to understand the need to contain the increase in health spending pursuant of ensuring the financial sustainability of the system.

Despite its importance, a broad and informed debate is not appreciated in Colombia, as there is no consensus on what sustainability really means, how to evaluate it, nor how to follow it up (GES, 2017). Therefore, there is a pressing need to measure the determinants of the increase in health expenditure pursuant of understanding its impact in countries with different income levels. This understanding could then be leveraged to optimize design specifications which can ensure financial sustainability in the near- and long-term.

⁴ The literature thus far does not address the effects that a pandemic could or would have on planning, organization, and reconfiguration in the development of measures to increase health financing. Doing so could help facilitate a rapid and organized response to deal with, for example, COVID 19. This particular pandemic, and others which may arise in future, has substantive impacts on expenditures affecting the financial sustainability of health systems, especially based on the determinant of technological innovation in health.

For this study, a sample of 80 countries spanning different income levels was chosen, making use of a classification by the World Bank. The selection of countries was determined by the availability of information and the objective herein is to compare the average level of increase in spending across countries with that in Colombia so as to understand and inform the status and possible future trajectories of this Latin American country. The sample period spans 2000-2016, with the terminal year reflecting the lag in the data vis-à-vis the financing of health systems. Therefore, the year 2016 reflects the most recent data on total expenditure on health (% of GDP) at the time of writing. In sum, the results indicate that technological innovation is the main determinant of increased spending, followed by demographic changes, institutional variables, and outcome variables.

Based on this general framework, the following question is posed as a guide to advance this study: How much do different determinants contribute to the increase in health system spending? To answer this question, a panel data econometric methodology with fixed effects and intragroup estimators within dummies is employed.

I. Literature Review

The extant literature in this domain points to a lack of consensus regarding the definition of financial sustainability in health. The Health Economics Group (GES) at the University of Antioquia constructed a definition from a panel of experts for the Colombian case, which considers that financial sustainability concerns the temporal balance between the resources and the needs of the population or the objectives of the health system, in such a way that expected future expenditure corresponds to the available income of the next generations (GES, 2017).

The literature identifies a series of determinants of the increase in health spending, the most important of which are technological changes or innovations, demographic trends, and price and quantity trends in health (Appleby, 2013); (Abellán, 2010); (Newhouse, 1992) & (Cluter, D, 1995). It also identifies a number of determinants that have less of an impact namely income growth, sub-optimal resource utilization, health expectations, healthy habits, and chronic diseases (OECD, 2015), (Mello-Sampayo, F & Sousa-Vale, S, 2009); (Herwartz, H & Theilen, B. , 2000).

Importantly, the literature also identifies a critical problem, that is presented as a global level issue: the increase in countries' health spending exceeds their levels of economic growth (Global Burden of Disease Health Financing, 2017).

The literature also contains estimates of the contributions of different determinants to health spending increases. Technological innovation is the most important determinant, estimated to represent between 50% and 75% of the increase in expenditure (Newhouse, 1992); (Ginsburg, 2008); (Appleby, 2013). Demographic changes reflecting falling fertility rates and increasing life expectancy increase spending by between 2 to 38 per cent (Thomson, 2009), (WHO, 2006); (Dormont B, 2006); (Seshamani M, 2004); (Seshamani M, 2004), and (Office, 2007). Another factor of great interest is that related to inflationary trends in health, since the increase in prices and quantities can increase spending between 2 and 35%. (Abellán, 2010) & (Cluter, D, 1995).

Although some studies refer to a single determinant to understand and explore health spending increases, others bring together different variables as a proxy for observing the effect on health expenditure. For example, the *Productivity Commission Research Report* (2005) uses investment in technology development in Australia as a proxy for measuring technological change in health. The study estimated an ordinary least squares (OLS) model to perform a regression between health expenditure and investment in technology expenditure. The results therein suggested that a 1% increase in health expenditure given R&D translates into a 0.25% increase in per capita expenditure.

With regard to demographic aspects, Przywara (2010) defines an index by taking the proportion of the population that is either over 80 or under 20 years of age; this index is then used as a determinant of health spending in a fixed effects panel data model. The results of that study suggested that as the population ages, the pressure on health spending increases in response to greater demand. While Herwartz & Theilen (2000) took the percentage of the population aged 65 and over as a determinant and employed an OLS regression for OECD countries; they found that this segment of the population influenced health spending relatively strongly.

Other studies focus on socio-economic conditions to measure the determinants of increased health spending. Mello-Sampayo & Sousa-Vale (2009) measured per capita income in health with respect to expenditure using a common correlated effects (CCE) regression, applied to 30 OECD countries from 1989 to 2009; they found that expenditure increases as income per person increases. Bigel & Tran (2013) use a dynamic fixed effects panel model for data covering 10 Canadian provinces between 1975-2002; relative prices, per capita income, percentage of public spending, life expectancy at birth, and the percentage of population over 65 years were all included as explanatory variables and the results suggested that the determinants with the greatest impact are those related to demographic and outcome variables.

In the case of Colombia, some approaches have been developed to measure the determinants of the increase in health expenditure. Gutiérrez (2018) carried out a study for Fedesarrollo and the results indicated that technological change has explained between 35% and 59% of the increase in spending. The study projects that public spending on health will reach 6.2% of GDP in 2020, where 44% of the growth will be explained by technological change, 38% by population growth, 12% by the change in demographic structure (aging), and the remaining 6% by the projected change in the epidemiological profile towards chronic diseases, which implies a fiscal pressure that generates particular challenges in relation to the sustainability of the system.

Bardey & Buitrago (2017) use a fixed-effects panel model to predict health expenditure for OECD countries and Colombia, and also proxy-evaluate the determinants of increased expenditure, identifying that demographic variables are positively related to such increases.

In this context, it is important to emphasize financial sustainability within the framework of the right to health and the regulation of the Colombian system, especially with regard to the inclusion of technologies, since not only is the increase in spending determined by the variables defined by the literature review but there are also some legal aspects that influence spending fluctuations. Thus, the institutional adjustment which came into effect in Colombia following the enactment of Law 100 in 1993 (and then notably modified by the Statutory Law on Health, Law 1751 in 2015), imposes an additional challenge on sustainability to the extent that there is a high degree of judicialization, with a significant impact on the sector's finances (Gutiérrez, 2018).

II. Estimating the determinants of increased health care spending

The methodological design is based on the construction of a panel data model in Stata 14, which includes a sample of 80 countries by income level for the period 2000-2016. The main objective of this method is to capture unobservable heterogeneity among countries. On the basis of a Hausman test, a fixed effects model is estimated, rather than its random effects counterpart (Baltagi, B., 2008); (Cameron, A. C. and Trivedi, P. K., 2005).

The World Bank's classification by country group and loans is used to define the income level of each country. Herein, 30 high-income, 21 upper-middle-income, 23 lower-middle-income, and 6 low-income countries are taken. This selection was informed by data availability, selecting those countries for which complete information is available for the requisite variables. Each of the 80 countries is observed for 17 years, thus $n = 1360$.

Given the criterion that sample countries must not be associated with missing information, in this sense, the panel data method is consistent in measuring the determinants of increased health expenditure for the set of countries (Bardey, D & Buitrago G, 2017); (Willemé, P & Dumont, M, 2014); (Bilgel, F., & Tran, K. C , 2013); (Xu, K; Saksena, P & Holly, A., 2011) & (Przywara, B, 2010) and allows, by means of intragroup estimators with dummies, to compare the average level of expenditure increase taking Colombia as a reference.

It is complex to find specific data for each of the countries with respect to the determinants. Therefore proxy variables are defined for technological innovation in health, price and quantity increases in health, and income growth, while variables for demographic change, outcome, and institutional variables are constructed based on the relevant literature (Herwartz, H., & Theilen, B, 2014); (Bilgel, F., & Tran, K. C , 2013); (Baltagi, B & Moscone, F, 2010) & (Przywara, B, 2010).

Impact variable				
Name		Variable	Type	Source (2000-2016)
Total Health Expenditure (% of GDP)		GTSS	Quantitative	WHO repository
Explanatory variables				
Determining	Name	Variable	Type	Source (2000-2014)
Technological innovation	Investment and Technology Development Expenditure	GIDT	Proxy	World Bank
Price and quantity inflation	General Inflation	CPI	Proxy	World Bank
Income growth	GDP per capita	PIBpc	Proxy	World Bank
Demographic changes	Population Growth Rate	TCP	Quantitative	World Bank and WHO Repository
	Aging Index	Envj	Quantitative	WHO repository
Health Outcomes Variable		Vrsalud	Quantitative	World Bank and WHO Repository
Institutional variable		CORRUP	Qualitative	Transparency International

Table 1. Variables for measuring the determinants of increased health expenditure

The variables taken as proxies are as follows. First, Investment and Technological Development Expenditure (GIDT), which serves as an approach to technological innovation in health (Productivity Commission Research, 2005). Second, GDP per capita (GDPpc) is taken as a proxy for income growth (Herwartz, H., & Theilen, B, 2014).

For the demographic variables, the Population Growth Rate (PGR) and an aging index (Envj) are constructed. The PCR is a state indicator that shows the situation of each country in terms

of population evolution. It allows measuring the growth or decrease of a population in a given period based on the changes that a society experiences due to three demographic phenomena: birth rate, mortality, and migration (Marble, M, 2008). The birth, death, and migration rates are b , d , and m , which are a function of the total number of individuals in a country for a given period. Where $N(t)$ represents the number of individuals alive at time t , analogously for $N(t+\Delta t)$ and using the obtained rates:

$$N(t+\Delta t) = N(t) + b.\Delta t.N(t) - d.\Delta t.N(t) + m.\Delta t.N(t) \quad (1)$$

Taking limits when Δt tends to zero:

$$\lim_{\Delta t \rightarrow 0} N(t+\Delta t) = \lim_{\Delta t \rightarrow 0} N(t) + b.\Delta t.N(t) - d.\Delta t.N(t) + m.\Delta t.N(t) \quad (2)$$

$$\lim_{\Delta t \rightarrow 0} \frac{N(t+\Delta t) - N(t)}{\Delta t} = b.N(t) - d.N(t) + m.N(t) \quad (3)$$

The following mathematical model is obtained:

$$N'(t) = (b-d+m).N(t) \quad (4)$$

Equation 4 represents the number of individuals in a time period, which is the solution of a differential equation. This equation is complemented by an initial condition $N(0)=N_0$ that corresponds to the number of individuals in an initial instant:

$$M_1 = \begin{cases} N'(t) = (b-d+m).N(t) \\ N(0) = N_0 \end{cases} \quad (5)$$

Equation 5 is a homogeneous linear differential equation of order one and when complemented with the initial condition, a single solution is obtained:

$$N(t) = N_0 e^{(b-d+m)t} \quad (6)$$

Equation 6 is defined as the *exponential growth rate of a population*. Where r is the intrinsic rate of population growth

$$N(t) = N_0 e^{rt} \quad (7)$$

In Equation 7, r reflects the population growth rate that measures the increase in a country's health expenditure given demographic change. Therefore, if r is greater than zero, the population grows. If r is less than zero, the population decreases, and if it is equal to zero, the population remains constant over time, and therefore health spending is expected to grow, decrease, or remain constant as the population growth rate varies.

To measure the aging index (Envj), the ratio of people 60 years and older to people under 15 years of age is calculated as (ECLAC, 2012). This makes it possible to appreciate the intergenerational changes resulting from the ageing process, as it highlights the changes in social demands generated by the elderly (ECLAC, 2012).

A health outcome variable is also constructed (Vrsalud), which makes it possible to establish efficiency ratios for the health system, since it is expected that the better the health outcomes of countries, the lower the expenditure (OECD, 2015). This variable is defined by taking the under-five mortality rate per 1,000 (U5MR), maternal mortality per 100,000 live births (MMR), and life expectancy at birth for each country (LER).

Then, by taking rates of variation, the health outcome variable can be decomposed as the product of nTMI, MMR, and VTE rates over a period of time:

$$Vrsalud_t = nTMI_t \cdot TMM_t \cdot TEV_t \quad (8)$$

Obtaining equation 8 in periods t and $t-1$, and dividing it by Vrsalud

$$Vrsalud_t = \frac{nTMI_t}{nTMI_{t-1}} \cdot \frac{TMM_t}{TMM_{t-1}} \cdot \frac{TEV_t}{TEV_{t-1}} \quad (9)$$

$$Vrsalud_t = \frac{nTMI_t - nTMI_{t-1}}{nTMI_{t-1}} \cdot \frac{TMM_t - TMM_{t-1}}{TMM_{t-1}} \cdot \frac{TEV_t - TEV_{t-1}}{TEV_{t-1}} \quad (10)$$

Since the rate of life expectancy at birth runs counter to the rates of infant and maternal mortality, the reverse applies to the latter.

$$Vrsalud_t = \left[\frac{nTMI_t}{nTMI_{t-1}} - 1 \right] \cdot \left[\frac{TMM_t}{TMM_{t-1}} - 1 \right] \cdot \left[\frac{TEV_t}{TEV_{t-1}} - 1 \right]^{-1} \quad (11)$$

Equation 11 is defined as a health outcome indicator, where positive outcomes are expected to reduce or contain the increase in spending, while negative outcomes increase it. In other words,

the relationship between HSSG and ill-health is expected to be negative (Bilgel, F., & Tran, K. C , 2013).

The institutional variable (CORRUP) is taken from the corruption perception index developed by Transparency International, which evaluates three characteristics in the administration to control corruption risks: visibility, institutionality, control and sanction. With this information, the institutional variable can be related to the increase in health spending, and countries can be classified according to their level of risk to corruption (Table 2).

100	89.5	Low risk
89.4	74.5	Moderate risk
74.4	60	Medium risk
59.9	44.5	High risk
44.4	0	Very high risk

Table 2. Level of corruption risk

Source: Transparency International

Finally, having the description of each of the explanatory variables for the model, the growth rates of each of these are estimated. Similarly, the growth rate of Total Health Expenditure (as a % of GDP) is estimated to serve as the impact variable (GTSS). From this, a panel data model with fixed effects is developed, since the aim is to analyze how the determinants influence the increase in health spending and how they vary over time.

Therefore the estimated model is as follows:

$$GTSS_{it} = \beta_1 GIDT_{it} + \beta_2 IPC_{it} + \beta_3 PIB_{pcit} + \beta_4 TCP_{it} + \beta_5 Envj_{it} + \beta_6 Vrsalud_{it} + \beta_7 CORRUP_{it} + (\alpha_i + \mu_{it}) \quad (12)$$

Where α_i is the individual effects and μ_{it} is the error term. When using equation (12), it is assumed that within individual units (countries), the explanatory variables (determinants) can be affected or biased, so fixed effects allow the impact of these time-invariant characteristics to be eliminated in order to assess the net effect of the determinants on the increase in health expenditure for the set of countries.

To determine the average level of health expenditure in each country and compare it with Colombia, a panel data model with fixed effects and intragroup estimators within dummies is used; these binary variables measure the variation between the units of analysis (countries) assuming that the slopes remain constant (Stock, J & Watson, M, 2003). This means that this model provides a mechanism for understanding the pure effects of the determinants on the

increase in spending as a whole, controlling for unobserved heterogeneity (Cameron, A. C. and Trivedi, P. K, 2005). It also allows for a comparison of the average level of increase in Colombia's spending with respect to other countries. In other words, the model would take the following form:

$$GTSS_{it} = \alpha_i + \sum_{j=2}^{80} \alpha_j d_j + x'_{it}\beta + \mu_{it} \quad (13)$$

Where α_i is the effect of the first individual (in this case Colombia) which is used as the base country, d_j are the binary variables which take the value 1 if the data corresponds to individual j (another country different from the base) and zero in another case (base country), α_j are the coefficients of the dummy variables and represent the degree to which the values of the country intercepts differ from the base country, X_i represent the explanatory or determining variables of the increase in expenditure.

In this way, the determinants of increased spending can be estimated for 80 countries by income level. This will make it possible to answer the question concerning the contribution of the determinants for all countries. In addition, the average level of increase can be compared with respect to Colombia.

Analysis and results

A statistical analysis of the variables suggests that there is greater variation within the sample as a whole than between or within countries. Given that the variables exhibit a positive relationship with the increase in health expenditure, which implies a direct relationship between this and the level of countries' income (Figure 1), the problem of growth in expenditure above the rate of economic growth is evident (Global Burden of Disease Health Financing, 2017).

Figure 1. Per Capita Health Expenditure and Per Capita GDP 2016 (80 countries by income level)

Source: World Bank, based on a study by the Global Burden of Disease Health Financing Collaborator Network, 2017 Own calculations.

By estimating the model with an intragroup estimator within dummies, a 94% correlation coefficient and a statistically significant F test are obtained ($p < 0.05$); therefore the hypothesis that all estimators are simultaneously equal to zero is rejected. Therefore, the model absorbs the pure effects of the determinants on the increase in spending and the differential values between individual units (countries) taking Colombia as a reference.

This can be seen from the model developed in equation 13, where each country represents a unit of analysis. The first country is the basis for comparison of the average level of increase in health expenditure. Thus, Colombia is the reference value or base for the study; all the other country coefficients are the differentials that provide information with respect to the base. In addition, since this is an average growth value for the study period, the increase in annual health expenditure for Colombia and the other countries can be obtained.

Table 2⁵ describes the joint contribution of the determinants of the increase in expenditure for the 80 countries with different income levels and the average level of expenditure increase based on Colombia. This provides a ranking of the countries from highest to lowest increases for the period under study.

With regard to the contributions of the various determinants of the increase in spending, technological innovation in health (TIIH) is statistically significant. Specifically, for each unit

⁵ See annex 2

increase in health spending across the countries as a whole, this variable contributes 43% of the increase. When the variables that represent demographic change are analyzed, it is discerned that the Envj variable is statistically significant and its contribution to the increase in spending is 13% for each unit of spending increase. Next, TCP increases health spending by 34%.

Analysis of the outcome and institutional variables shows 32% of each one unit increase in health spending can be attributed to the CORRUP variable, given the low level of transparency and high risk of corruption in many countries. While the Vrsalud variable generates a reduction or containment of the increase in spending by 21% due to the good results achieved by some countries, especially high-income countries (OECD), both variables are statistically significant.

The inflation of prices and quantities in health (CPI) was found to be an insignificant determinant of health spending dynamics in this particular empirical context. The determinant of income growth (GDPpc) is statistically significant, but it does not generate effects on the increase of expenditure. This estimate identifies the income elasticity of spending as being between 0 and 1, which shows that for countries as a whole, health is a basic or necessary good (Baltagi, B & Moscone, F, 2010).

When the medium level of expenditure increase is arranged with reference to Colombia, the problem of the fiscal pressure faced by countries, especially those with high and medium-high incomes, is validated (WEF, 2012). In turn, this fiscal pressure can be understood in terms of the determinants on the increase of health expenditure. Most high-income countries have higher growth rates than Colombia, excepting Greece, Hungary, Israel, Poland, and Austria. Moving on, only three upper middle-income countries have higher growth rates, namely Bulgaria, Ecuador, and Romania. Colombia exceeds all other upper-middle income, lower-middle income, and low-income countries except Malawi, ranking 30th among the 80 countries in the sample.

This validates the hypothesis that countries with different income levels face a trend of increasing health expenditure, since when looking at Table 1 all countries tend to increase the GTS (% of GDP) and this trend is also evident for Colombia.

Finally, the effectiveness of the model is evaluated. Specifically, statistical inference tests are performed on cross-dependence or contemporary correlation, which allows us to infer whether

the residuals are correlated with the units of analysis⁶. This test indicates that the null hypothesis that the residuals are not correlated with the units of analysis cannot be rejected ($P = 0.399 > 0.05$). In this sense, there is no contemporary autocorrelation (sectional dependence).

Moreover, since we have several units of analysis that are confronting each other, it is quite possible that we are faced with a problem of heteroscedasticity, that is, we are faced with very different variances between countries. Then, to correct this, a robust standard error model can be made to⁷ validate the consistency of the values obtained in the results.

III. Discussion and conclusions

The study demonstrates what is confirmed by the literature regarding the problem of increasing health spending in countries according to their income levels (Global Burden of Disease Health Financing, 2017). This common fact across countries makes it necessary to study the financial sustainability of health systems, because as demand and supply interact, a series of determinants are established that contribute to the increase in expenditure (WEF, 2012). In this regard, countries are making efforts to diversify resources and prioritize funding for health systems (WHO, 2010). But since resources are scarce, priorities must be defined so that a balance is struck between meeting the needs of the current population on the one hand and ensuring fiscal responsibility so that the needs of future generations can also be met on the other hand. Hence why studying the determinants of increased health spending is so important.

In more detail, by identifying, quantifying, and exploring the determinants, health policy-makers and other salient decision-makers can monitor and evaluate the extent to which increases in health expenditure are being contained. This is of critical importance because public funding of health services generates a tax burden for the countries (WEF, 2012). Further, it is also necessary to include a series of variables that the literature does not take into consideration to broaden the analysis, such as outcome variables that can provide a reading of the efficiency of the health system, as well as institutional variables that reflect the priority of governments over the health of the population.

These variables are fundamental, particularly nowadays, given the scale and scope of the contemporaneous COVID-19 crisis. This pandemic has necessitated a channeling of resources

⁶ Annex 3

⁷ Annex 4 and 5

into health systems, along with adjustment and control interventions. This increased spending can be demarcated to be a function of technological innovation as well as an increase in prices due to the increased quantities of different goods and services which have been required to deal with the surge in demand for healthcare services (Joe Kutzin, 2020).

This study measured the most important determinants that contribute to the increase in health spending in 80 countries at different income levels and validated what was found in the literature, showing that technological innovation in health and the demographic transition are the determinants that contribute most to the increase in spending (Table 3).

In this sense, Colombia shows a similar trend to high and upper-middle income countries with respect to increased spending. Therefore, the determinants of the increase in health expenditure have important implications for countries, and it is essential to develop tools that make it possible to contain this increase, especially in relation to technological innovation in health, demographic trends, and institutional aspects. Although progress has been made in drug price control policy and relationships with the pharmaceutical industry in this respect, there is still a lack of clarity as to how far market decisions can influence the health of the population and it is also important to make progress in terms of transparency and reducing corruption.

For Colombia to leverage, and advance on, the achievements already made and thus successfully navigate the challenges of the continued operation of the health system, it is essential to increase negotiation strategies in the assignment of health providers based on the country's various needs, assets, and constraints. Similarly, it is necessary to discourage negotiation strategies based on extreme payment mechanisms and liabilities such as reimbursement. It is also important for the design of benefit plans and prioritization mechanisms to make it widely and transparently clear to the population what their rights and duties are when accessing the health system.

Determinants	Newhouse (1992)	Cutler (1995)	Abellán (2012)	Fedesarrollo (2018)	Espinal (2020)
Technological change	65%	49%	50% - 75%	44%	43%
Avoidable administrative costs	-	14%	-	-	-
Medical price inflation	-	19%	8 %	-	-0.007%
Revenue growth	23%	3%	-	-	0
Health Insurance	10%	13%	-	-	-
Chronic Non-Communicable Diseases	-	-	-	6%	-
Population growth	-	-	-	38%	34%
Aging	2%	2%	2 - 15%	12%	13%
Results variables	-	-	-	-	-21%
Institutional variables	-	-	-	-	32%

Table 3. Determinants of the increase in health expenditure (literature and own results)

Source: Spending on health and social care over the next 50 years why think long term? John Appleby. Sostenibilidad financiera del Sistema de Salud en España, Abellán, 2012 and Fedesarrollo 2018

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Annexes

Annex 1. Hausman test: fixed or random effects

	Coefficients			
	(b) fixed	(B) random	(b-B) Diference	sqrt(diag(v_b-v_B)) S.E.
gidt	0.4326	0.2240	0.2086	0.8120
ipc	-0.0073	-0.0001	-0.0074	0.0063
pibpc	0.0000	-0.0002	-0.0002	0.0000
envj	0.1274	-0.0015	0.1259	0.0191
tcp	0.3374	-0.0662	-0.0325	0.2258
vsalud	-0.2163	-0.1425	-0.0358	0.0786
corrup	0.3262	-0.0354	0.2908	0.3081

b=consistent under Ho and Ha; obtained from xtreg

B=inconsistent inder Ha; efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

$$\begin{aligned}\text{chi2}(6) &= (b-B)'[(v_b-v_B)^{-1}](b-B) \\ &= 21.47\end{aligned}$$

$$\text{Prob}>\text{chi2} = 0.0019$$

Annex 2. Determinants and average level of increase in the GTS (% of GDP) for 80 countries by income level, 2000-2016

	SS	df	MS	Number of obs = 1360
Model	810.757277	86	9.4274102	F(86, 1113) = 150.67
Residual	19983.788	1113	17.9548859	Prob > F = 0 .0000
Total	20794.5453	1199	17.3432405	R-squared = 0.9409
				Adj R-squared = 0.9142
				Root MSE = .72589

Variables	Coef.	Std. Err.	t	P> t
GIDT	0.432647	. 067467	0.49	0.000
CPI	-0.007354	. 022715	-1.61	0.104
PIBpc	0.000023	. 004218	0.01	0.000
Envj	0.127441	. 016148	0.19	0.000
TCP	0.337429	. 058628	0.53	0.000
Vrsalud	-0.216348	. 028058	-0.69	0.002

CORRUP	0.326264	.010693	1.66	0.092
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Country	Base country	GTS ratio (% of GDP)	Increment. GTS (% of GDP)	t	P> t
Colombia	_cons	4.436429	4.4364	1.64	0.000
Country	Ranking	GTS ratio (% of GDP)	Increment. GTS (% of GDP)	t	P> t
Luxembourg	1	3.77525	8.2117	1.63	0.000
Singapore	2	3.63976	8.0762	1.66	0.097
Sweden	3	3.01416	7.4506	1.01	0.032
New Zealand	4	3.21650	7.6529	1.78	0.076
Netherlands	5	2.91900	7.3554	1.39	0.016
Norway	6	2.62006	7.0565	1.20	0.022
Switzerland	7	2.60132	7.0378	1.00	0.031
United Kingdom	8	2.46676	6.9032	1.18	0.023
Finland	9	2.31033	6.7468	0.78	0.043
Denmark	10	2.26667	6.7031	0.91	0.036
Canada	11	2.23928	6.6757	1.01	0.029
Japan	12	2.13989	6.5763	0.65	0.041
Australia	13	2.12383	6.5603	0.99	0.032
Ireland	14	2.05450	6.4909	1.09	0.027
Belgium	15	1.89722	6.3337	0.81	0.041
Spain	16	1.78623	6.2227	0.75	0.045
Germany	17	1.46114	5.8997	0.53	0.019
Iceland	18	1.07257	5.5090	0.44	0.039
France	19	1.05028	5.4867	0.45	0.034
Chile	20	1.02847	5.4649	0.65	0.041
Italy	21	.961097	5.3577	0.33	0.040
Portugal	22	.877727	5.3142	0.34	0.316
United States	23	.771616	5.2080	0.29	0.017
Uruguay	24	.721690	5.1581	0.40	0.000
Ecuador	25	.275476	4.7119	0.71	0.047
Bulgaria	26	.181597	4.6180	1.25	0.000
South Korea	27	.165367	4.6018	1.06	0.000
Malawi	28	.154832	4.5913	0.84	0.000
Romania	29	.069974	4.5064	1.30	0.000
Colombia	30	4.43642	4.4364	1.64	0.000
Costa Rica	31	-.047830	4.3886	1.02	0.000
Croatia	32	-.181930	4.2545	0.72	0.000
Greece	33	-.285177	4.1513	-1.65	0.100
Morocco	34	-.300067	4.1364	0.27	0.002
Malaysia	35	-.449193	3.9872	0.19	0.000
Hungary	36	-.541128	3.8953	0.73	0.000
Poland	37	-.569352	3.8671	0.28	0.000
Nicaragua	38	-.583022	3.8534	1.56	0.120
Guatemala	39	-.719126	3.7173	1.55	0.120
Georgia	40	-.780768	3.6557	1.48	0.140

Philippines	41	-.894685	3.5417	0.53	0.000
Israel	42	-.908578	3.5279	0.23	0.000
Honduras	43	-.967488	3.4689	0.91	0.000
Mexico	44	-.994567	3.4419	-1.67	0.091
Thailand	45	-1.07737	3.3591	0.53	0.000
Paraguay	46	-1.11692	3.3195	0.05	0.000
Ukraine	47	-1.0902	3.3462	-0.83	0.000
Ethiopia	48	-1.11785	3.3185	0.21	0.008
Austria	49	-1.14716	3.2893	-1.01	0.014
Kenya	50	-1.15018	3.2863	-1.06	0.001
Haiti	51	-1.18808	3.2483	0.92	0.059
Panama	52	-1.21123	3.2249	0.76	0.006
Jamaica	53	-1.21256	3.2239	-0.87	0.000
Brazil	54	-1.30829	3.1281	1.69	0.107
Peru	55	-1.32442	3.1120	-0.35	0.000
Turkey	56	-1.43166	3.0048	-1.03	0.000
Indonesia	57	-1.46165	2.9748	-0.43	0.000
Bangladesh	58	-1.48258	2.9538	-0.53	0.000
Egypt	59	-1.56531	2.8711	-0.94	0.012
Vietnam	60	-1.56751	2.8689	-0.71	0.038
China	61	-1.59916	2.8373	-0.57	0.000
India	62	-1.64077	2.7957	-0.81	0.000
Uganda	63	-1.64075	2.7957	0.30	0.000
Senegal	64	-1.68092	2.7555	-0.56	0.002
Russia	65	-1.69028	2.7461	-0.43	0.000
Sri Lanka	66	-1.72129	2.7151	-0.82	0.000
Angola	67	-1.72849	2.7079	-0.12	0.000
Ghana	68	-1.91621	2.5202	-0.84	0.000
South Africa	69	-1.91682	2.5196	0.49	0.000
Venezuela	70	-1.92767	2.5088	-0.51	0.003
Nigeria	71	-2.06146	2.3750	-0.11	0.000
Albania	72	-2.88388	1.5525	-0.66	0.006
Argentina	73	-3.66994	0.7665	-1.90	0.370
El Salvador	74	-2.10888	2.3227	0.37	0.019
Jordan	75	-2.117121	2.3193	0.62	0.000
Bolivia	76	-2.164403	2.2720	1.65	0.099
Pakistan	77	-2.486661	1.9498	0.21	0.000
Cameroon	78	-2.850825	1.5856	-0.53	0.002
Zambia	79	-3.569325	0.8671	-1.74	0.807
Madagascar	80	-3.584767	0.8517	-0.69	0.001

Annex 3. Statistical inference test on contemporary cross-dependence or correlation

xtcsd, pesarn abs

Pesarn's test of cross sectional independence =	12.36,	Pr = 0.0000
Average absolute value of the off-diagonal elements =		0.371

Annex 4. Heteroscedasticity test

Modified Wald test for groupwise heteroskedasticity
in fixed effect regression model

H0: $\sigma(i)^2 = \sigma^2$ for all i

chi2 (80) = 20741.28

Prob>chi2 = 0.0002

Annex 5. Robustness test

gtss		
variable	corrected rob~o	robusto
gidt	0.4321 (0.48)	0.2203 (0.57)
ipc	-0.0043 (-1.55)	-0.0014 (0.98)
pibpc	0.0000 (0.01)	0.000 (-0.58)
envj	0.1231 (0.18)	0.0015 (0.63)
tcp	0.3356 (0.52)	0.5295 (0.60)
vsalud	-0.2118 (-0.67)	-0.1425 (-0.48)
corrup	0.3238 (1.50)	0.7641 (1.76)
Constant	4.138 (11.27)	0.7852 (10.67)
N	1360	1360
r2	0.920899	
r2_a	-0.873155	

legend: b/t

Figures

Figure 1

Per Capita Health Expenditure and Per Capita GDP 2016 (80 countries by income level) Source: World Bank, based on a study by the Global Burden of Disease Health Financing Collaborator Network, 2017 Own calculations.

Supplementary Files

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