THE IMPACT OF PHYSICIANS' DECENTRALIZATION ON HEALTH SERVICES AND ECONOMIC GROWTH

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This research uses the Zon and Muyken (2001) model to investigate the effect of physicians' decentralization of health care production, human capital accumulation, and economic growth. All three sectors are interrelated, since the overall level of health affects both workers and the accumulation of human capital, while a higher level of human capital is related to better quality of health. And, finally, health and human capital affect the output of the economy. From the economic growth point of view, the results seem to be positive. The physician's decentralization from denser municipalities to smaller ones impacts the health and wellbeing of the population positively overall. It's important to point out the necessity of a public policy that may be able to allocate the physicians throughout the country more efficiently, the suggested proposal is federal public tender for the physicians. Increasing physicians per inhabitant availability in municipalities of the North and Northeast, South and Southeast regions with a population above or below fifty thousand inhabitants, raises productivity in the health sector. This increase ultimately improves labor productivity, resulting in increased capital accumulation and economic growth. On the other hand, it is estimated a reduction in the propensity to consume when there is a smaller portion of the labor force allocated in the health sector.

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1. Introduction

The theory of endogenous growth suggests the integration of health production and economic growth through the accumulation of human capital. A decrease in growth may be explained by health preference that is positively influenced by rising per capita income or by many physicians within a country. Growth may even disappear in countries with high rates of health deterioration or low productivity in the health sector (ZON e MUYSKEN, 2001).

On the other hand, if the health sector is dynamic, economic growth will be favored both by technological progress in this sector and by better access to the health of the workforce. Health and education are important factors for development as they affect the production capacity of individuals. The decentralization of physicians from bigger municipalities to smaller ones impacts the nation's health and wellbeing. The more qualified and healthier, the more productive are the workers and consequently the higher the income of the economy, with more physicians available to attend the population, the last one will have more access to health.

It is no coincidence, therefore, that education and health expenditures are two of the most representative items of public spending in the developed world. Education expenditure in the Organization for Economic Co-Operation and Development - OECD accounted for 5.2% of Gross Domestic Product - GDP, 4.5% of GDP financed by the public sector, while health costs are approximately 6% of GDP (WORLD BANK, 2014).

The literature on economic growth has given priority to education because of its more direct correlation with development in papers like Baumol (1967), Lucas (1988), Romer (1990), and Barro and Sala-i-Martin (1995). More recently, however, health has attracted attention because of its rising costs associated with aging, therefore there is a greater need for more physicians to attend this aging population. Thus, not only education is important for economic growth, but health as well.

According to the endogenous growth model of Lucas (1988), education impacts the formation of human capital for growth and development. However, for people to provide effective human capital services, they must be healthy. Therefore, the health of the population in general influences the growth and well-being of all. Health contributes to well-being and economic performance because healthy people increase labor productivity.

This research uses the Zon and Muyken (2011) model to investigate the effect of physicians' decentralization of health care production, human capital accumulation, and economic growth. The model, therefore, includes a health sector, education sector, and a production sector. All three sectors are interrelated, since the overall level of health affects workers and the accumulation of human capital, while a higher level of human capital is related to better quality of health. And, finally, health and human capital affect the output of the economy.

The results appear to be positive from the point of view of economic growth. When the number of physicians per inhabitants increases, increasing labor availability raises productivity in the health sector, which ultimately improves labor productivity resulting in increased capital accumulation and economic growth. On the other hand, it is estimated a reduction in the propensity to consume when there is a higher portion of the labor force allocated in the health sector, that is when the ratio of physicians per inhabitants increases.

The research is organized into seven sections, including this introduction. The second section presents a literature review on decentralization, while the third on economic growth and health. The fourth section introduces the endogenous growth model used in the research. The fifth section shows the calibration performed for the model, to reflect how the ratio variation of physicians per inhabitants affects the Brazilian economy in 2014. The sixth section presents the results and the seventh section, the final considerations and policy suggestions.

2. Decentralization and Health

In recent years, the tendency of decentralization on public expenses has increased, because of its relationship with the decrease in public spending (DONAHUE, 1997). With decentralization, the local institutions have more detailed information about the inhabitants of the region. The public policies applied may be more efficient because it is directed to the local population's preferences and necessities.

Even if the federal government wants to decentralize its responsibilities to the state government, the last one wants the opposite. The equilibrium between the two will depend on the government legitimacy and how strong the institutions are (POSE AND GILL, 2003). Besides the fact that strong or weak institutions affect the development of different countries (NORTH, 1991), verified empirically for a variety of nations (ACEMOGLU et al., 2001), the culture also influences

economic growth. The culture presents a causality effect in economic development according to data analyzed for European regions (TABELLINI, 2010). Another important factor is that political institutions affect corruption level, and therefore economic growth (FERRAZ, 2010).

Central government transfers to local government transfers increase the public spending more than increasing in the private income (MATTOS et al 2011). This phenomenon is known as flypaper, the higher transfers can induce less efficiency in collecting taxes than increases in income. Therefore, the public finance empirical literature identified the flypaper effect around de 1970's, according to Mendes and Fontes (2004). This flypaper effect is the receiving of lump sum fiscal transfers by subnational governments, in which implies in increasing local public spending proportionally greater than the ones that would be generated by an equivalent increase in the personal income. Decentralization presents difficulties such as externalities, "tax war" and tribute exportation. Then, the fiscal transferring from higher to lower government levels appeared as an important tool in a vertical and horizontal solution to imbalances, besides the externalities' correction.

Various countries have been studying object to analyze the effect of decentralization of health public spending. According to Kruse et al (2009), municipalities' decentralization decreases the public health spending in Indonesia. Besides the spending, how the government allocated its resource is very relevant. Also, the public policies in the health sector will differ between municipalities, especially when these policies are directed to the population with lowest incomes, the effect of decentralization is related to the allocation of scarce resources.

This effect is being observed throughout different developing countries that present a high number of poor families. The management of these sources will have a positive or negative impact on the families who need basic need the most. Like in Indonesia, the municipalities have legal responsibility to guarantee its population, primary care, meanwhile there is freedom to decide what taxes should be directed to the public health service, besides, these municipalities do not present the legal necessity to justify to the central government how their money is spent, the justification is given to the municipalities' Parliament.

Meanwhile, in Brazil, there is a significant amount of bureaucracy, closed and detailed. By closed, meaning when the resources are received from the union, they are already predetermined where the spending will be allocated, there is no freedom to allocate the money in the most efficient way by the responsible municipalities' manager, one of the consequences is the difficulty to

manage health public spending. Of course, the manager's ability to manage influences the allocation of the resources, even with all the bureaucracy, besides the corruption within the country increases greatly the inefficiency on public health spending. Also, the lack of punishment to the politicians who steals money from the people presents a negative impact on the money allocation. Therefore, the public health which is very important to the nation's development, it is negatively impacted by these factors. According to Mosca (2007), decentralization is a public spending determinant, which the territorial decentralization evolves responsibilities transfers from the central government to minor levels of government.

Decentralization is observed in the literature with a higher frequency in recent years as an object of study. Within the decentralization context, "economic dividend" has economic advantages in the transferring of power from national institution to lower levels of the ruling (RODRIGUEZ-POSE AND GILL 2005). This economic dividend appears from the decentralized administrations' ability to adapt the public policies to the local need, generating innovation in the provision of service through intraterritorial competition, also to stimulate participation and accountability decreasing the distance between the ones in power and its constituencies. Some governmental systems may bring negative implication towards economic allocation. Gains and losses that the devolution can generate are contingent with what government level is being responsible for a public policy.

The subject of devolution is also explored by other authors. The capacity of regional devolution to overcome the democratic deficit and to introduce a more effective government is observed by Morgan (2002). The author's paper supports the hypothesis that the Northern regions in England would present positive economic dividend. The local government regulation may present better results in the economic development compared to higher levels of government (JONES, 2001). Which means political interventions managed by municipalities or states presents more positive results than the central government. The idea of managing a municipality locally is being more accepted among policy makers and scholars, in order to equalize the economies deficit in a regional scale. On the other hand, the decentralization of power is giving politicians incentives to make political decisions strategically in order for them to obtain more power, other than solving the economic deficit problem.

With the objective to point out the government quality, Rothstein and Teorell (2008) proposes a coherent and specific definition of the government quality, with the impartiality of

institutions which have the government's authority. The motivation of such a paper is due to the fact that government with strong institutions tend to influence positively economic growth, as observed empirically. The idea of impartiality is related to a series of critics in the public management, public choice, multiculturalism, and feminism. The theory of impartiality is observed in a general context of government quality, such as democracy, rule, law, efficiency, and accuracy.

Application of such a theory is studied by Nicholas Charron, Lewis Dijkstra and Victor Lapuente (2014). To measure the government quality, the authors use what is known as, the "European QoG Index". A good government quality is understood to present a low corruption index, impartial public services, and rule of law. Empirically, twenty-seven countries in the European Union were studied, at national and lower levels of government. In this experiment, Italy and Spain evidenced better government quality than the other nations.

To analyze the government quality and investment return, Rodríguez-Pose and Garcilazo (2015) examines the relationship between local and regional government quality, and regional economic performance, relating government quality with return fund in the European Union. It was possible to analyze the importance of government quality as a determinant of economic growth, besides the efficiency of structural public spending. As result, he observed that a better government quality is more important to the regional development than additional public investment.

Corruption affects the allocation of resources in different countries, especially in Brazil. With this in mind, Ferraz and Finan (2008), measure the audits effects, finished and published in the election results. According to the authors, during the year of 2003, the Brazilian federal government started to select municipalities randomly to audit their spending with resources coming from the federal transfer. This auditing was part of a national program against corruption and its outcomes were released publicly. Comparing the election results of audited municipalities before versus after t the 2004 election, with the same level of reported corruption, it was evidenced that the audit had a significant impact in the elections. It was possible to observe as result, that a more informed electorate, besides a present media, such as the radio that released the audit results, all these have important roles in the political election.

Still, the government revenue and political corruption are evidenced in the work of Brollo (2010). The authors could observe that federal transfers to government municipalities change according to the population. To measure the causality effect of higher federal transfers in political

corruption and observed characteristics from political candidates at the local level, it is used a discontinuity regression. As result, according to the theories' provision, higher transfers increase political corruption and decreases the quality of candidates who are running for mayor.

How the money is allocated to the health sector is extremely important, because a good health contributes to the individuals' well-being. The health sector affects directly the economy and increases in health expenses has brought great challenges, even for countries with high quality of life (CHARLES, 2016). With decentralization in mind, besides health expenses, the decentralizing number of physicians may increase the nations' health quality. Thus, allocating physicians from the capitals to small municipalities will give an opportunity for the poor families to have basic health care. Until last century there was no health system in Brazil. Only the rich families were treated in private institutions. But with the Sistema Único de Saúde (SUS), a unique health system was founded and guaranteed by the Federal Brazilian Constitution of 1988, a universal free public health system. Especially the Programa Saúde da Família (PSF), a program that gives primary care to almost every single municipality in the nation, 5.295 municipalities. One of the positive results was that mortality by infectious diseases decreased from 23% total deaths in 1970 to less than 4% in 2007. Despite some success by the SUS, there are serious problems such as lack of investment, corruption, mismanagement, and lack of human resources, especially physicians (ALMEIDA-FILHO, 2011).

3. Economic Growth and Health

Health has been a priority in the public and private expenditures of developed countries. According to the OECD (2016), on average the countries of the organization spent 9% of GDP on health in 2015, with the highest spending in the United States (16.9% of GDP), Switzerland (11.5% of GDP) and Japan (11.2% of GDP). Brazilian numbers are very close to the average for rich countries. According to the OECD (2015), Brazil spent 9.1% of GDP in 2013 on health.

However, given income differences, per capita expenditure in US dollars is much higher in the OECD than in Brazil. The average per capita expenditure in the OECD in 2015 reached US$ 3,815, while in Brazil it was only US$ 1,471 in 2013.

It is the public sector the main funder of health spending. In the OECD, of the 9% of GDP earmarked for health, 73% comes from governments (6.6% of GDP). In this way, 15% of all OECD

public spending goes to the health sector. In Brazil, 46% of health spending was financed by public resources in 2012, so that the health sector accounted for only 7.9% of total public spending in 2012 (WHO, 2015).

Health has therefore played a central role in both government and household spending. And one of the main theoretical motivations for public spending on health is related to the economy. The hypothesis is that a healthy population will be more productive and capable of generating more wealth for the country. However, health took the time to be considered an important factor for economic growth. It is only in the twenty-first century that the subject has become central for growth economists.

Initially, health was incorporated into growth models through human capital. Health affects labor supply, either by working hours or labor market participation. The consequence of this modeling strategy is predictable - the higher the overall health, the greater the human capital and the higher the rate of economic growth. Good health is important to sustain high levels of human capital, with positive effects on productivity and growth (LOPEZ et al., 2005). A healthy workforce would be less prone to disease and more willing to work. Raising productivity by improving workers' health would be greater for manual workers, so increased health may have a particularly significant impact on the growth rates of less developed countries.

The second channel between health and growth is demography. Improved health not only allows an increase in life expectancy but also an increase in the number of productive years for each worker. On the other hand, more health means reducing child mortality. Considering the two effects, health improvement helps population growth which is one of the foundations of economic growth. Still, in this line, better health also favors growth by increasing life expectancy that encourages the population to save more, with positive effects on capital accumulation (WEIL, 2005).

Positive externalities associated with health also impacts economic growth. The level of health of an individual does not only depend on whether he cares for himself but also depends on the general state of health of the entire population. Low levels of the general health of the population can not only reduce human capital but also negatively influence production, reducing investment and the accumulation of physical capital. Lucas (1988) model although not directly concerned with health, has been the most relevant theoretical basis in the development of endogenous growth models related to health.

However, the literature is not unanimous about the positive relationship between health and growth. Zon and Muysken (2001) argue that the health sector is not a productive activity and that it competes with production activities for scarce resources of the economy. They suggest that when health is incorporated into the utility function, the relationship between health and economic growth may be negative.

Empirical analysis reinforces the relationship between growth and health. Studies with a panel of countries for the period 1960-85, found a positive correlation between health and economic growth, both Knowles and Owen (1995) and Mankiw et al. (1992). Similar models, such as Rivera and Currais (1999) and Hashamati (2001), suggest that health spending has a positive impact on growth in OECD countries. Another paper with a panel of countries between 1960 and 1990 concluded that good health has a positive and statistically significant impact on aggregate output (BLOOM et al., 2001). A similar result was found in Latin America, the relation between the composition of public expenditures and the economic growth of Latin American countries between 2000 and 2010. The countries that allocated more resources to health had higher rates of growth (MACÊDO AND BEUREN, 2014).

In the national literature, two papers found completely different results, Mora and Barona (2000), and Cermeño (2000). Both studies estimate the relation between growth and health for the Brazilian States. Mora and Barona (2000) uses the Barro model (1996) and the other the model, of Mankiw, Romer and Weil (1992). Interestingly, Mora and Barona (2000) found a negative relationship between growth and health, while the second, Cermeño (2000) suggests a positive relationship between the two variables. Another article, Figueiredo et al. (2003), observed whether health status impacted Brazilian economic growth in the 1990s based on an econometric estimation of the Solow model (1956). As for the result, the health status contributes directly and positively to economic growth but also influences the accumulation of human capital. A worsening of health status tends to reduce the positive impact of education on growth.

This present research contributes to the Brazilian literature to analyze the influence of the health sector for growth with an endogenous growth model. The national literature has focused on applied econometric studies and the use of endogenous growth models represents an innovation in Brazil. These models allow us to capture the externalities of the health sector, as well as its influence on the accumulation of human capital and output.

4. Model

4.1 Longevity

The model is based on van Zon and Muysken (2001). The population is divided into two parts. Young people who work in the production of output, health services, and human capital formation, and old people who consume output and health services. People live up to age *T*, and are active in production up to age *A*. It is assumed that every period *n* people are born living *t* years with health *g* and human capital *h*. By hypothesis, longevity *T* is proportional to the average health level *g* of the population. Therefore

$$T = \mu \cdot g \tag{1}$$

Where μ is a constant. Inactive people are equal to $(T - A) \cdot n$ and an increase in longevity will increase the number of inactive people in the economy, increasing consumption of health services. In the steady state the population remains constant, that is, the number of birth per period equals the number of deaths.

The utility function considers the link between health, longevity, and total population size,

$$U = \int_0^{\infty} e^{-\rho\tau} \left(g^{\gamma}\left(\frac{C}{L}\right)^{1-\gamma}\right)^{1-\theta} \frac{L}{(1-\theta)} d\tau \quad 0 < \theta < 1 \tag{2}$$

Where ρ is the discount rate and $1/\theta$ is the intertemporal substitution elasticity, $0 \leq \gamma \leq 1$ measures the relative contribution of health to utility. Total private consumption is *C*, while $L = n \cdot T$ is the size of the population. Note, therefore, that longevity is an implicit argument of the utility function that contributes positively to households' welfare. The total effective labor supply, which considers the level of human capital and the quality of health, is therefore $h \cdot g \cdot n \cdot A$.

4.2 Production of Health Services

To integrate health and growth in the context of endogenous growth, productivity is considered to increase due to human capital accumulation and decreasing returns. It is assumed

that the production of health services is performed by medical specializations so that a fraction v_i of effective work is employed in the production of knowledge of the medical specialization *i*. It is assumed that the number of medical specializations is proportional to the size of human capital, $\Omega = \pi \cdot h$. Thus, the average increase in the level of health quality is given by:

$$\frac{dg}{dt} = \int_0^{h\pi} \psi(hgv_i \frac{nA}{nT})^{\beta} \cdot di = \psi \cdot \pi \cdot h \cdot (\frac{hgvA}{\pi h \mu g})^{\beta} = \psi \cdot (\frac{A}{\mu})^{\beta} \cdot \pi^{1-\beta} \cdot h \cdot v^{\beta} \quad (3)$$

The ψ is the productivity parameter and v is the fraction of the total effective labor supply employed in the health sector. And inequality $0 < \beta \leq 1$ guarantees the hypothesis of decreasing returns in the production of health services.

The increase in the general level of health and medical specializations also has costs. The more specialties, the greater the demand for medical care, which includes an increase in visits to doctors and a growing number of lab exams, which leads to a reduction of work due to technological developments. It is assumed that this loss is proportional to the number of specializations by a factor ς:

$$\frac{dg}{dt} = \left[\psi \cdot (\frac{A}{\mu})^{\beta} \cdot \pi^{1-\beta} \cdot v^{\beta} - \varsigma \cdot \pi \cdot g\right] \cdot h \quad (4)$$

It is then possible to obtain the steady-state health quality level:

$$g^* = \frac{\psi}{\varsigma} \cdot (\frac{A}{\pi \cdot \mu})^{\beta} \cdot v^{\beta} = z_0 \cdot v^{\beta} \quad (5)$$

Where $z_0 = \frac{\psi}{\varsigma} \cdot (\frac{A}{\pi \cdot \mu})^{\beta}$. Note that the more work destined to the production of the health sector, the higher the quality of health.

4.3 Output and Human Capital Accumulation

The production function can be represented by a Cobb-Douglas function:

$$Y = B \cdot [(1 - u - v) \cdot h \cdot g \cdot n \cdot A]^{\alpha} \cdot K^{1-\alpha} \quad (6)$$

Where *Y* represents output, *K* is the capital stock and *B* is a constant productivity parameter. The fraction *(1-u-v)* of the labor supply is used in the output, and the remaining fractions *u* and *v* are used on human capital accumulation and production of health services respectively.

The process of human capital accumulation considers the health of the population:

$$\frac{dh}{dt} = \delta \cdot u \cdot g \cdot h \quad (7)$$

Where δ is the productivity parameter. Finally, the accumulation of physical capital is given by:

$$\frac{dK}{dt} = Y - C \quad (8)$$

4.4. Model Solution

To solve the model, Social Planner should maximize intertemporal utility (2) with respect to *c*, *u* and *v*, subject to conditions (6), (7), (8) e (4).

Therefore, after obtaining the first-order conditions, the steady-state solution of the model must satisfy the following simultaneous equations:

$$v = \frac{c^2 - \alpha c + \alpha(1-\alpha)(1-\theta)(1-\gamma)/(\theta + (1-\theta)2\gamma)}{c^2 - \alpha c + (\frac{1+\beta}{\beta})\alpha(1-\alpha)(1-\theta)(1-\gamma)/(\theta + (1-\theta)2\gamma} \quad (9)$$

$$c = 1 - \frac{(1-\alpha) \cdot r}{\big(\theta + \gamma(1-\theta)\big) \cdot r + \rho} \quad (10)$$

$$r = \frac{\delta(1-v)z_0 v^{\beta} - \rho}{\theta + \gamma(1-\theta)} = \frac{\delta g^{*}(1-v) - \rho}{\theta + \gamma(1-\theta)} \quad (11)$$

$$u = \frac{1-c}{1-\alpha}(1-v) \quad (12)$$

Where *c* is the average propensity to consume and *r* is the balanced growth rate of the economy.

5. Calibration

For calibrating the model, most information is taken from Instituto Brasileiro de Geografia e Estatística - IBGE's National Accounts 2014. The estimated population for every single municipality in the country is also taken from IBGE 2014, and some parameters were acquired from literature. All the database in the present work is in 2014, because that is the most recent Nacional Accounts` data, and to be coherent, all the database is in the same year. The number of physicians in each municipality were acquired from Cnes Data SUS 2014, because of the Census 2010, contains a lot of missing variables for the number of physicians. That is because from the Cnes database some physicians are registered to more than one municipality, so it may receive fund from the government to attend the people, even though a lot of these physicians do not show up for work at the appropriate time, and even in some hospitals, they never attend patients, although they should.

The Census does not have a representative number of physicians because there are too many missing values. A very high number of municipalities does not have any physicians, especially the ones with low estimated population and with families of low wages. To assure that the Cnes SUS is a good database, the number of physicians from this database is practically the same compared to the Federal Council of Medicine in Brazil, approximately 350 thousand physicians in Brazil. The data from Census IBGE was analyzed with detail for every Brazilian state in a separate dataset. The estimated population of each municipality was combined with the number of physicians in the Cnes SUS data set to the respective municipality.

For the calibration, the endogenous variable “v” has its value fixed and represents the number of physicians divided by inhabitants of the municipality, which is different from the “v” used in the work of Zon and Muysken (2001), because in their work the “v” variable represented the total number of workers in the health sector divided by all workers in all sectors. That is because in the present work I intend to observe how the economy reacts allocating a higher or lower ratio of physicians per inhabitants in different municipalities for the respective regions. All

municipalities with estimated population above fifty thousand inhabitants are considered, also the ones with an estimated population below fifty thousand. In both cases, the calibration is done for the municipalities in the South and Southeast region together, and the North and Northeast regions together are also investigated. The fifty thousand inhabitants cut off is a good measure because according to IBGE, approximately 90% of the Brazilian municipalities have a population below 50 thousand inhabitants.

The Center region of Brazil has not evaluated because of its homogenous economical characteristics, besides its extremely high productivity in the agricultural sector which makes harder to represent the Brazilian reality. For the simulation, the "v" value is substituted by the number of physicians for the whole country divided by the whole population. The same steps are done throughout all four calibrations and four simulations. Thus, the first calibration studies how the fixed value of physicians' number per inhabitants in municipalities for more than fifty thousand inhabitants in the South and Southeast regions affect the economic growth.

Then, for the simulation, the ratio number of physicians in the country divided by the whole population is substituted to the former "v" value to observe how the economic variables react. The second calibration is done with the same region but with a population below fifty thousand. The third calibration is done for the municipalities within the North and Northeast regions of inhabitants above fifty thousand, and the fourth calibration, below fifty thousand. In all simulations, the same "v" value is substituted by the old value of v, which is the national value for the number of physicians divided by the population.

The average propensity of consumption, c, was calculated using the consumption/GDP ratio obtained from the National Accounts - $c = 0.6152$. The balanced growth rate, r, was calculated from the last 20 years average GDP growth rate, $r = 3.055\%$. The discount rate was estimated at $\rho = 0.019$. This value comes from the equation, $\rho = -log(1/(1+R))$, in which R is the real interest rate calculated by the difference between the accumulated Brazilian national interest rate (Selic) in 2014, 10.96% and IPCA (inflation) in 2014, 6.40%. (BACEN, 2014). That is, 10.96% - 6.40% = 4.56%. With R = 4.56%, substituting back into the ρ equation, $\rho = 0.019$.

The share of capital income in output was also obtained from National Accounts of 2014, $\alpha = 0.33$, besides as an assumption $\beta = \alpha = 0.33$. With this information, we can calculate the relative contribution of health to utility, γ and the inverse elasticity of substitution θ by equation (9) and (10) simultaneously. Which gives the values of $\gamma = 0.89$ and $\theta = 2.089$. From equation

(11) it is possible to calculate the level of health quality at steady state, $g^*= 0.5333$. Assuming that the productivity parameter, δ, is equal to 0.1. Using the equation, $g^* = z_0 \cdot v^{\beta}$, as result, z_0 = 3.848. Finally, from equation (12), it is possible to obtain the participation of effective labor in the production of human capital, $u = 0.5729$. The same steps are repeated to investigate the North and Northeast regions.

6. Results

To estimate the impact of the decrease or increase in number of physicians per inhabitant represented by *v*, the new *v*, $v = 0.001705$, which is the total number of physicians in the country by the populations, is substituted back into the equations in place of the old *v*, $v = 0.002506$, which represented the number of physicians divided by the inhabitants into municipalities with population above 50 thousand people. The same is done later, for the North and Northeast regions together.

The four equilibrium equations - (9) to (12) - are solved simultaneously with the following results:

Table 1. Municipalities with population above 50 thousand, South and Southeast Region

Variable	Initial Steady State	Final Steady State
Balanced growth rate (*r*)	3,05%	2,49%
Level of health quality (*g**)	53,32%	46,95%
Participation of effective labor in the production of human capital (*u*)	57,29%	53,04%
Share of effective labor in the production of health services (*v*)	0.002506	0.001705
Average propensity to consume (c)	61,52%	68,22%

Source: Author´s elaboration.

Table 1 shows the results for the municipalities with a population above 50 thousand, that is the Southeast and South regions. The cities in these regions are populous and the number of physicians is also high. Thus, the ratio between a number of physicians per municipalities` population is still higher compared to the national ratio. As result, when the fixed value of *v*, from the final steady state, representing the national ratio, is substituted in the first *v*, it means the new value of *v* is less than the one before. Therefore, as the value of v decreases, the balanced growth rate is decreased as expected. The level of health quality is reduced because now there are fewer

physicians than before. The inverse relation between the average propensity to consume and the ratio of physicians per number of inhabitants is also noticed, the v decreased and the *c* increased.

Tabela 2. Municipalities with population below 50 thousand, South and Southeast Regions

Variable	**Initial Steady State**	**Final Steady State**
Balanced growth rate (*r*)	3,05%	4,12%
Level of health quality (*g**)	53,24%	65,19%
Participation of effective labor in the production of human capital (*u*)	57,38%	63,15%
Share of effective labor in the production of health services (*v*)	0.000923	0.001705
Average propensity to consume (c)	61,52%	52,00%

Source: Author´s elaboration.

The same regions are studied in Table 2. The municipalities observed has a population below 50 thousand, which explains why the value of *v* increased. As result, the balanced growth rate also raised, and so did the level of health quality since there are more physicians to attend the population. When v increases, the average propensity to consume decreases as observed. Besides, the participation of effective labor in the production of human capital also increases.

Table 3. Municipalities with population above 50 thousand, North and Northeast Regions

Variable	**Initial Steady State**	**Final Steady State**
Balanced growth rate (*r*)	3,05%	3,23%
Level of health quality (*g**)	53,28%	55,30%
Participation of effective labor in the production of human capital (*u*)	57,34%	58,50%
Share of effective labor in the production of health services (*v*)	0.001523	0.001705
Average propensity to consume (c)	61,52%	59,65%

Source: Author´s elaboration.

As for Table 3, the municipalities with a population above 50 thousand, in the North and Northeast regions presents a ratio of physicians per inhabitants still less than the national average. Because the v increases the balanced growth rate, r increases. It is intuitive that now with more physicians the level of health quality raises as shown in Table 3. And also the average propensity

to consume decreases. The participation of effective labor in the production of human capital has a little increase.

Table 4. Municipalities with population below 50 thousand, North and Northeast Regions

Variable	Initial Steady State	Final Steady State
Balanced growth rate (r)	3,05%	5,46%
Level of health quality (g^*)	53,33%	80,20%
Participation of effective labor in the production of human capital (u)	57,29%	68,03%
Share of effective labor in the production of health services (v)	0.000492	0.001705
Average propensity to consume (c)	61,52%	43,91%

Source: Author´s elaboration.

Finally, Table 4 analyzes the last situation, municipalities with a population below 50 thousand located in the North and Northeast regions. In this case, the variation in the transition from the initial steady state to the final steady state is the highest compared to the other situations. Part of this is because the number of physicians in the North and Northeast for municipalities with a population below 50 thousand is scarce. Thus, in the simulation, the v value increasing, the level of health quality and also the balanced growth increases, while propensity to consume decreases. The participation of effective of effective labor in the production of human capital has an increase.

Increasing the ratio of physicians per inhabitants raises the economy's long-term growth rate, improves the average quality of health, and increases the share of effective labor in the production of human capital. On the other hand, it reduces the participation of effective labor employed in the production of health services and the propensity to consume.

The mechanisms behind the results are as follows. The increase in a number of physicians per estimated population of the municipality increases the productivity of the health sector. The hypothesis is that with more effective work the sector becomes more productive. On the other hand, the amount of effective work allocated to the health sector is reduced due to increased productivity. The net effect is an increase in the general level of health, g^* and a reduction in the fraction of effective labor used in the production of health services, v.

The expansion of the average level of health positively affects the production of human capital, equation (7). Workers with better overall health will be able to become more productive.

The increase in the rate of accumulation of human capital is reflected in the increase in the long-term growth rate of the economy. Thus, the economy starts to grow at higher rates.

The increase in the rate of human capital accumulation increases the demand for effective labor in this sector. In this way, a larger fraction of the effective labor is used to produce human capital, that is, *u* increases.

Finally, the average propensity to consume, c, tends to decrease. This is because the increased productivity of the health services sector and the human capital accumulation sector makes an investment in both sectors more interesting, shifting resources from consumption to investment. It is important to realize that there will be no decrease in consumption since the output will grow faster, but consumption will represent a slightly lower percentage of GDP.

7. Conclusions

This research used the model of Zon and Muysken (2001) to investigate the effect of increasing or decreasing the value of *v* in different regions, the number of physicians divided by its respective municipality, on the production of health services, the accumulation of human capital and economic growth in Brazil. All three sectors are interrelated, since the overall level of health affects workers and the accumulation of human capital, while a higher level of human capital is related to better quality of health. And, finally, health and human capital affect the output of the economy.

The results appear to be positive from the point of view of economic growth. The increase in working time raises the economy's long-term growth rate, improves the average quality of health, and increases the share of effective labor in the production of human capital. On the other hand, it reduces the participation of effective labor employed in the production of health services and the propensity to consume.

Brazil has health spending as a proportion of GDP comparable to that of rich OECD countries. However, the public sector invests relatively little, accounting for less than half of the expenditure, while in developed countries the public sector disburses almost ¾ of the total. In fact, these figures indicate the low quality of Brazilian public health, a result of low investment and the population's efforts to pay for private plans to have better care. What this exercise suggests is that a more pronounced public sector investment effort in health can help the Brazilian economy to

increase its rate of growth. The federal government could allocate the physicians in different municipalities throughout all states in the country to make the ratio of physicians per inhabitant more homogenous, increasing the number of physicians in municipalities that need them the most, this would influence economic growth.

The decentralization of physicians from denser municipalities to smaller ones impacts the health and wellbeing of the population positively overall. There is a necessity to formulate a public policy to allocate the physicians within the country more efficiently, the suggested proposal is federal public tender for the physicians. The public contest would allocate the physicians in a better way, as a result, physicians per inhabitant would increase in municipalities with greater need for these professionals. Therefore, decentralizing the physicians, would better attend the population, especially the poor who live in municipalities with few inhabitants and with almost no physician.

Of course, there is a huge need for reductions in inefficiencies, waste, and mismanagement in the Brazilian public health sector, so that only putting more resources may not be enough to improve the average Brazilian health level. However, despite the problems, Brazilian public underfunding is a fact when making international comparisons, and although it is not a sufficient condition, it is a necessary condition for improving health quality, with positive potential impacts on the economy.

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