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## Health Capital and Worker Productivity in the Moroccan Regions: A Dynamic Panel Data Model

### Le capital de la santé et la productivité des travailleurs dans les régions marocaines : un modèle de données de panel dynamique

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## **Health Capital and Worker Productivity in the Moroccan Regions: A Dynamic Panel Data Model**

### **Abstract**

This article is part of a national context marked by the pursuit of the Moroccan government to ensure the right to health care and medical coverage<sup>1</sup>. It's part of an international context guided by the 17 SDGs Declaration<sup>2</sup>.

As well, in the empirical studies, several works have been devoted to the study of the determinants of Productivity in Morocco. However, all of the analyses carried out by these works have remained at a global macroeconomic level without taking into consideration the data from the regions and the qualitative dimensions of health and education.

This study investigates the impact of health on worker productivity for a sample of 16 Moroccan regions from 1994 to 2019. Firstly, to estimate this relationship, we use two proxies that take into account the quantitative and the qualitative dimensions of health: the number of doctors per capita and the number of consultations of public physicians reported to the labor force by region.

The empirical methodology is based firstly on the employ of both Pedroni and Kao cointegration tests and the Dumitrescu and Hurlin causality test. Secondly, we apply the regression of an endogenous growth model augmented by human capital to explain worker productivity.

The results of the cointegration tests accept the existence of long-term relationship between proxies of health and the productivity of Moroccan workers. However, Dumitrescu\_Hurlin causality test results accept the short-term two-way causality relationship just for one proxy of health. The results of the regression assert that only the proxy of quality of public health capital affects positively and significantly worker productivity.

Faced with these results, and to improve worker productivity, the authorities must make more effort to improve the efficiency of public health capital. It is not enough to increase the number of human resources but it is necessary to improve the quality of health service and facility access.

**Keywords:** Health capital, Worker Productivity, regions and Morocco.

**JEL Classification:** I15

**Paper type:** Empirical research

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<sup>1</sup>The requirements of the new constitution of 2011 specified the national context, which has devoted rights directly related to the formation of the human capital.

<sup>2</sup>Declaration of the United Nations of the 17 Sustainable Development Goals (SDGs) in 2015.

## 1. Introduction

The importance of human capital in economics has been revealed, first, through the works of the promoters of the theory of human capital ( (Mincer, 1958), (Schultz, 1961), and (Denison, 1962)). They have studied the value of human capital through the measure of its influence on worker productivity. After that, the economists of new models of endogenous growth have enriched this debate ( (Romer, 1986), (Barro, 1991), (Mankiw et al., 1992) and (Barro & Sala-i-Martin, 1995)).

In the empirical studies, we detect three mechanisms by which health capital may influence worker productivity growth:

1- The increase in the stock of human capital through promoting health can augment the worker's capacities to produce, which increases national production ( (Schultz, 1961), (Rivera & Currais, 2004), (Narayan & al., 2010), (Combarry & Traore, 2021)).

2- The rise in the stock of human capital can raise the worker's productivity by promoting innovation capacities and the use of new technologies ( (Benhabib & Spiegel, 1994). (Cole & Neumayer, 2006), (Siddique et al., 2020)).

3- Improving conditions of access to health is an important determinant for reducing inequalities and increasing the employment of poor populations ( (UNESCO, 2015), Sharafat & Najid, 2013), (Ray & Linden, 2018)and (Combarry & Traore, 2021)).

Three main elements characterized the research context: firstly, the empirical validation of the main theoretical models shows a divergence of results about the effects of health on productivity and economic growth. ( (Islam, 1995), (Caselli et al., 1996) and ( (Pritchett, 2001)). Secondly, the Morocco development model was questioned by the reports of international institutions: ( (Krugman, 2017), (OCDE, 2018)) and even national institutions such as the Economic, Social and Environmental Council (2016).

As a result, His Majesty King Mohamed VI called for a review of the current model of development in his speech delivered to people in 2017 on Throne day. After a broad participatory process of listening, debate and reflection around the renovation of the development model, which began in December 2019. Morocco adopts the roadmap for the new development model in May 2021<sup>3</sup>.

This model focuses on strengthening human capital<sup>4</sup> as a vector for improving the well-being of citizens and a lever for the country competitiveness in the future.

Thirdly, the international context was marked by the Declaration of the United Nations of the 17 Sustainable Development Goals (SDGs) in 2015, among these goals; two goals determine the conditions necessary to promote health: allowing all to live in good health and promoting well-being in addition to reducing inequalities.

Given the insufficient efforts to deal with the increased demand for health sectors and the requirements of international institutions to achieve the United Nations goals, Morocco made several health sector reforms. The main reforms of the Moroccan health system came with the adoption of the strategy and action plan 2008-2012, and the establishment of basic medical coverage through the generalization of social protection by 2025. In addition, these reforms bring also the launch of the Health Sector Strategy for the period 2017-2021, the National Health Plan 2030 and framework law N°06-22 relating to the health system<sup>5</sup>.

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*3 On December 12, 2019, the King of Morocco Mohammed VI appointed the members of a special commission responsible for rethinking the new development model.*

*4 "Strengthening human capital is required given the high citizen's expectations for the quality of education and health care, the demographic dynamics which lead to a sustained increase in demand for public services and the central role of knowledge in as key determinant of economic growth" (SCDM-Members, 2021)*

*5 This law will make it possible to establish new governance of the health system, the development of human resources, the upgrading of the care offer and digitalization of the health system.*

Several works have been devoted to the study of the determinants of Productivity in Morocco. However, all of the analyses carried out by this work have remained at a global macroeconomic level in the national framework or the framework of the countries of the Middle East and North Africa without taking into consideration the data from the regions of Morocco. (Fadlallah & Chakhat, 2019), (Giupati et al., 2022) and (Safae & Radouane, 2023)). The objective of this work is to evaluate the impact of health on the productivity of Moroccan workers based on the theories of endogenous growth. To do this, we mobilized an empirical study applied to panel data by regions over the period 1994-2019.

In this paper, I discuss first a theoretical and empirical literature review. Then I talk about the characteristics of the Moroccan economy. After that, I present the empirical approach, data sources, variables used. Afterward, I offer the results obtained to come up with a conclusion.

## **2. Theoretical and empirical literature review**

Through the literature review of the main empirical studies related to the context of Morocco, I identified: First, several works have been devoted to the study of the determinants of Productivity in Morocco. However, all of the analyses carried out by this work have remained at a global macroeconomic level in the national framework or the framework of the countries of the Middle East and North Africa, they discussed productivity without taking into consideration the data from the regions of Morocco. (Fadlallah & Chakhat, 2019), (Giupati et al., 2022), (Safae & Radouane, 2023)).

Second, I detected a few studies that measure the qualitative dimension of health. (Combarry & Traore, 2021), (Cole & Neumayer, 2006). However, most of the literature uses proxies that take into consideration only quantitative aspects of health.

Third, I found that most studies use econometric models that combine education and health as explanatory variables of productivity, which can lead to biased and inconsistent estimates given the risk of endogeneity bias. It seems to me that the relative originality of this research work can be focused on the study of the determinants of productivity in the regions of Morocco, for the first time to my knowledge, as well by taking into consideration the quantitative and qualitative dimensions of health and by using econometric techniques to correct endogeneity bias.

This study allows me to introduce two basic concepts linked to our research: Health and productivity. So I will begin with productivity. The choice of productivity is explained by the topicality of the issue and its importance in the national and international economic context. Indeed, recent news has highlighted the importance given by our companies to productivity as an important determinant of their competitiveness.

According to (Islam, 2008) the productivity differences are more important than differences in accumulation rates in explaining per capita income differences across. The second reason is methodological; in paying attention to productivity differences, researchers have resorted to growth regressions with extended specifications.

(OCDE, 2023) defined "Productivity as a ratio between the output volume and the volume of inputs. In other words, it measures how efficiently production inputs, such as labor and capital, are being used in an economy to produce a given level of output".

(Da Silva & Santugini, 2013), assert that labor productivity refers to partial productivity which "informs us about the efficiency with which workers transform their effort into production. This is calculated from the ratio between total production and the quantity of work necessary to produce it. This definition can be used to define the productivity of capital (machinery).

The economic theory of productivity measurement goes back to (Tinbergen, 1942) and (Solow, 1957). It has since developed due to the major contributions of (Jorgenson, 1995,

2009), (Griliches,1967,2000) and (Diewert & Nakamura, 2007), they reformulated productivity measures in production function setting and linked it to the analysis of economic growth.

There are different measures of productivity and the choice between them depends either on the purpose of the productivity measurement and/or data availability. These indicators are usually grouped into two main categories:

The single-factor productivity measures or else partial productivity measures (relating a measure of output to a single measure of input) or multi-factor productivity measures (relating a measure of output to a bundle of inputs) (OCDE, 2001).

The constitution of the World Health Organization adopted in 1946 affirms that health is “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity”. Also, (Lilja & Ahmad, 2023) said that the main function of a national health system is thus to provide equitable quality healthcare services for the whole population.

Many theories attempt to explain the impact of health on productivity. We distinguish two main theoretical representations, a micro-economic conception and a macro-economic conception.

At the microeconomic conception, we mainly differentiate between the human capital theory, the signaling theory, the resource and skills theory and the theory of wage incentives. The relevance of the notion of productivity was because that could be a management tool at the firm level. When the volume of production is correlated to the volume of work implemented and when the products in question are the subject of sustained demand on the markets, then the productivity indicator becomes an objective criterion of organization and remuneration of work.

The role of health in the accumulation of human capital has been studied in the theory of human capital, since the articles of (Schultz, 1961) and (Mushkin, 1962). They have confirmed that investment in health leads to enhanced health outcomes, improved education attainment, and augmented labor productivity.

The theoretical debate in the microeconomic approach opposes the neoclassical approach based on hypotheses that considerably limit the possibilities of analyzing the functioning of the firm and the "evolutionary approach" supported mainly by the signal theory.

**Tableau 1 Summary of the main empirical studies**

<b>Author(s) and Date</b>	<b>Model &amp; Method</b>	<b>Dependant variable, Country(s) and period</b>	<b>Health indicator(s)</b>	<b>Main findings</b>
(Ullah et al., 2019)	Barro model, ARDL approach	Worker productivity, Pakistan, 1980-2010	life expectancy	1% rise in health result 13.39% increase in worker productivity and productivity will increase by 0.18% due 1% increase in education
(Mehmood et al., 2022)	Augmented Solow model, GMM	Worker productivity, Pakistan, 1991-2010	life expectancy	1% change in LE causes a 2.92% variation in worker productivity. The study also reveals secondary education brings a 0.0544% change in worker productivity.
(Abdelgany & Saleh, 2022)	Augmented Solow model, GMM	Worker productivity, 39 developing countries, 2000-2019	life expectancy	the results show that primary education has a more significant impact on labor productivity than health
(Rivera & Currais, 2004)	Augmented Solow model, OLS panel	Worker productivity, 17 Spanish regions, 1973-93	GHE, HCE and HIE	Government health spending has consistently positive effects, while governmental investment in health care has no effect
(Combarry & Traore, 2021)	Model Rubin, instrumental variables	Agricultural productivity, 540 households Burkina Faso	Health services use Distance from home-Health center	The availability and the quality of HSPC services in rural areas influence positively productivity.
(Ray & Linden, 2018)	Simultaneous model-Kuznet	GDP per capita, 194 countries 1990-2014	infant mortality rate and health expenditures	In the poorest countries, the possible Kuznets' hypothesis and involved low-income high-inequality trap can be eliminated by raising health
(Mohamed & Aziz, 2023)	Solow model augmented, GMM	Worker productivity, 6 North African countries including Morocco, 1991 to 2021	Life expectancy	1% change in education causes a 0.06% variation in worker productivity. Life expectancy brings a 0.67% change in worker productivity.
(Siddique et al., 2020)	Method of Bloom, OLS panel	Worker productivity, 75 middle-income countries 1991-2016	life expectancy and undernutrition	1% increase in life expectancy causes a 0.918% productivity 1% increase in undernutrition causes a 0.104% productivity
Cole & Neumayer(2006)	Method of Hall and Jones, OLS panel	Worker productivity, 52 countries 1965 – 1995	malnutrition	the impact of poor health on TFP to be negative, significant, and robust across a wide variety of specifications

*OLS: Ordinary Least Squares, GMM Generalized method of moments, ARDL autoregressive distributed lag, GHE Government Health Expenditure, HCE Health Consumption Expenditure HIE Health Investment Expenditure.*

**Source: Conducted by the author.**



The real starting point for an analysis that detaches itself from neoclassical principles is the fundamental contribution first of (Akerlof, 1978) who introduces asymmetry information in the analysis of market mechanisms. And secondly, the fundamental contribution of (Simon, 1978) who substitutes limited rationality for substantive rationality.

Signal theory was initialized and developed by (Spence, 1973) and (Stiglitz, 1975). they study the relationship between the employer and job seekers by integrating the hypothesis of asymmetry information. The theory of resources and skills was initially founded by (Wernerfelt, 1984) drawing inspiration from Porter's work on competitive advantage published in (1980). This concept considers that a company with diversified resources is likely to benefit from a competitive advantage leading to superior financial performance.

In the macroeconomic conception, we distinguish Models that explain growth through the accumulation of knowledge, innovation and health. The importance of health has been enriched by the work of theorists models of ((Barro, 1991), (Barro & Sala-i-Martin, 1995) and (Barro, 2005))... which incorporate health in the function of production. Barro (2005) expanded the neoclassical growth model of (Solow, 1957) by incorporating health capital, and constructed a framework for studying the effect of health on economic growth. This model reveals the direct impact of health on productivity.

### **3. Macroeconomic environment, health capital, and productivity in Morocco**

Since independence, Morocco has implemented several social and economic policies to ensure the integration of the Moroccan economy in the way of development. We distinguish three periods of reforms: the period between 1965 and 1983, authorities made strong interventions in the economy to restructure the industrial sector and substitute products importation by local production. During the period between 1985 and 1999, the Moroccan economy saw the introduction of the structural adjustment plan under the advice of international financial institutions, which made a significant impact concerning the increase of the rate of growth, the control of inflation, and the improvement of trade terms. However, the expected results are insufficient in particular concerning the reduction of poverty and inequality.

The period between 2000 and 2020 was marked by social and economic reforms focused on several levers: improving working conditions with the new labor code established in 2003. Modernization of industrial, and agricultural fabric and promotion of exportations because authorities implemented the emergence plan in 2005 and applied the green plan in 2007.

The measures of the National Human Development Initiative (NHDI) in 2005, the introduction of the program of Assistance Medical Obligatory (AMO) in (2005) and the generalization of the medical assistance scheme since 2011.

Referring to data from the World Bank, the Moroccan economy has been growing steadily over the past two decades with an average growth rate reaching 4.58% during the period 2002-2012 and 2,99% during the period 2013-2023<sup>6</sup>. This loss of almost 1,5 points in the percentage growth rate of gross domestic product (GDP) is due to the impact of the exogenous supply shocks which originate is (Covid-19 crisis, war in Ukraine, and structural drought <sup>7</sup>) which came to alter its observed dynamics.

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<sup>6</sup> During the period 2013-2023, the Moroccan economic had a growth rate of -7,17% in 2020 and 8% in 2021, I have ignored these rates while estimating the average. if we take these rates into account the average rate will be 2.5%

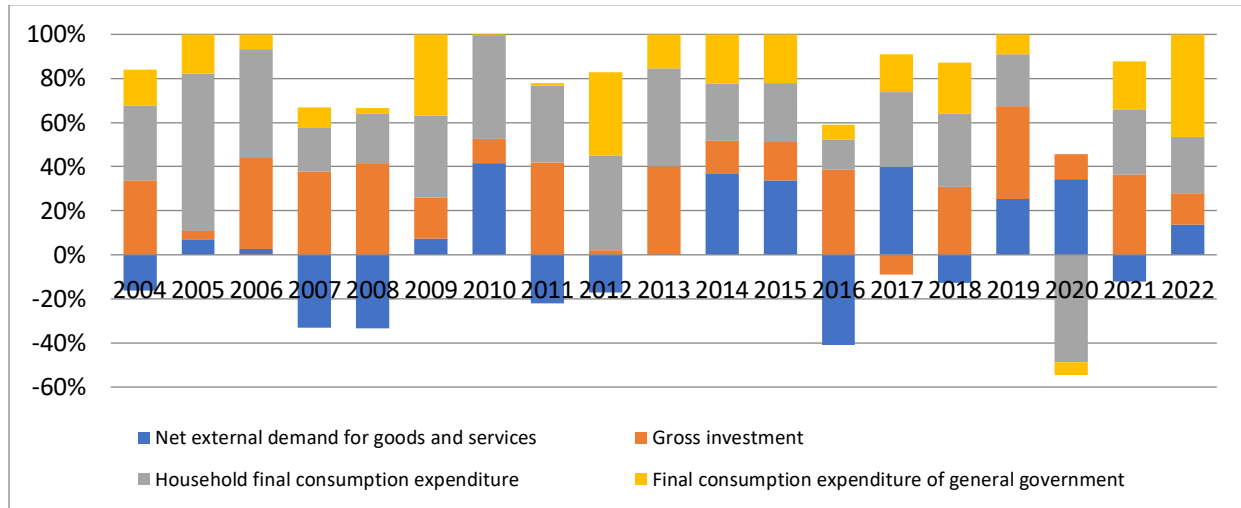
<sup>7</sup> I mean sustainable in time.



The inflation rate has been maintained at an average rate of 0.8% during the period 2013 to 2023 compared to 1.7% during 2002-2012.

According to (OCDE, 2017), (World Bank, 2019), and (Amachraa, 2023) these performances are due to the emergence of new growth drivers such as automotive, electrical and electronic, aeronautics industries and offshoring.

**Figure 1 Evolution of the determinants of demand growth in Morocco between 2004 and 2022.**

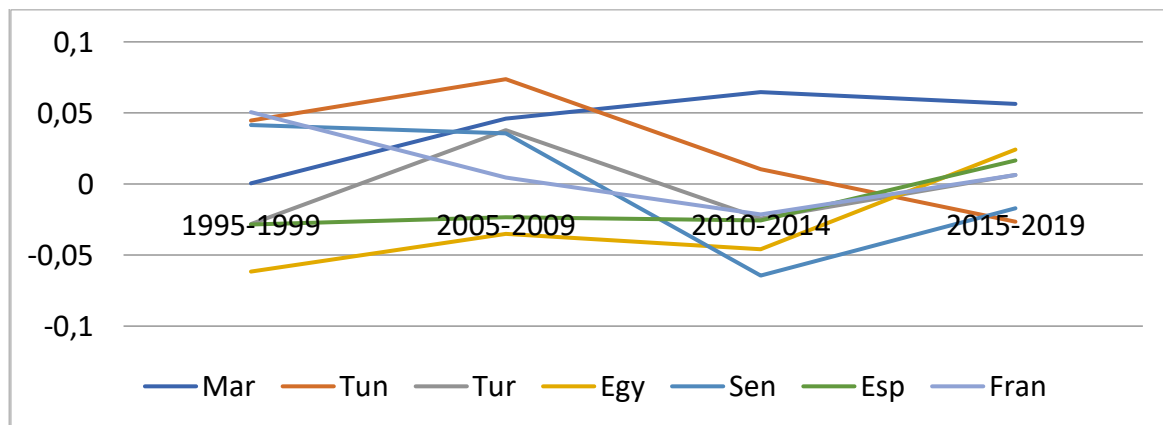


Source: HCP (2023)

The main determinants of the dynamics of economic growth are household consumption expenditure and gross investment with an average contribution rate of 50 % in average and 20% for expenditure of government between 2000 and 2022.

In this context, it appears that Moroccan economic policy is based on encouraging household spending to revive economic activity which is marked by a sustained effort from the state budget in favor of the social sectors and an expansionist monetary policy. However, the balance of trade outside contributed negatively to the economic growth.

**Figure 2 Evolution of Total Factor Productivity (TFP)**



Source: World Penn Table, 10, 2024.

Comparing the Total Factor Productivity of Morocco firstly with economically similar countries including Egypt, Tunisia, and Turkey, and secondly developed countries such as France and Spain, we distinguish three different periods:

8 I have ignored the inflation rates of 2021 and 2022 respectively 6,6% and 6,3% (The Russian invasion of Ukraine has led to a substantial increase in the prices of energy and food) if we take these rates into account the average rate of inflation will be 1,6 in the place of 0,8%.

We note that during the period 1995-1999, the TFP growth rate on average is lower than the TFP rate of France, Tunisia, and even Senegal. During the decade 2005-2014, Morocco's TFP growth rate increased rapidly and became the highest among the panel of selected countries. Thus, during the period 2015-2019, TFP increased but at a lower rate.

According to (HCP, 2016, 2018) this development is explained by the implementation of a new generation of economic and social reforms and the acceleration of capital intensity. I think this efficiency of the combination of production factors is for the most part attributed to political stability which offers the necessary incentives to ensure confidence to the holders of national and foreign investments.

These incentives were lost in the case of Tunisia and Egypt after the events of the Arab Spring. Furthermore, European countries were strongly impacted by the effects of the war in Ukraine, which limited their economic dynamics.

In terms of health data, the efforts of authorities have improved several quantitative indicators such as number of physicians, number of hospitals...But, if we refer to the report of the special commission on the development model (CSMD, 2021) the main dysfunctions of the health sector are four:

1-The quality of health services is low. Thus, Morocco is ranked 112th out of 195 countries.

2-Brutal lack of human resources and a regional imbalance in their distribution. This shortage is aggravated by the large flow of hundreds of doctors and nurses who leave the country for destinations that offer more attractive working conditions, particularly in Canada, Germany, and France.

3-Lack of optimal, rational, and efficient governance of human and financial resources. This observation is argued with the results of the mission reports of the Moroccan judges of the Court of Auditors.

4-The budget allocated by the State to public health does not exceed 6% while the WHO recommends a minimum of 15% of the general State budget to be devoted to the health sector. What's more the contribution of households from their own pockets is therefore abnormally high with a percentage of 50.7%.

By and large, we can conclude that despite the progress made over the past two decades, the public offering of health doesn't respond to the huge needs of people therefore, the stakeholders are called to invest more to live up to citizens' expectations.

## **4. The Empirical Approach**

### **4.1 Presentation of the data and the variables used**

The study covers data from 16 regions during the period between 1994 and 2019 collected from the annual and regional statistical yearbook published by the Office of the High Commissioner for Planning, which is the Moroccan institution in charge of statistical production, foresight, and economic analysis.

The dependent variable is the rate of productivity per worker calculated by industrial production reported to the number of workers by region. Physical capital is approximated from total investment relative to industrial production by region. After that, we have approximated health capital by two proxies that take into account the quantitative and qualitative dimensions of health: the number of doctors per capita and the number of consultations of public physicians reported to a number of doctors by region.

Thus, we took the value of exports related to industrial production by regions as proxy for the effects of the openness policy.

Tableau 2 Description of variables

Variables	Code
$S_{kit}$	INVESTPPROD
$\ln y_{it}$	PRODWORK
$p_{it}$	GRPOP
$S_{hit}$	DOCTRSP1000   CONSPDOC
$open_{it}$	EXPORTPPROD

Source: Author.

#### 4.2 Model description

To investigate the relationship between health and productivity we used an equation based on the endogenous growth model developed by (Hongyi & Huang, 2009), this equation promote the model developed by Mankiw, Romer and Weil (1992) by taking into account the effects of health dimensions.

Hongyi & Huang (2009) propose the Cobb Douglas production function augmented by human capital following the form:

$$Y_{it} = K_{it}^{\alpha} E_{it}^{\beta} H_{it}^{\gamma} (A_{it} L_{it})^{1-\alpha-\beta-\gamma} \quad \text{Où } 0 < \alpha, \beta, \gamma < 1 \text{ et } \alpha + \beta + \gamma < 1 \quad (1)$$

Where  $Y_{it}$  is a gross domestic product of country  $i$  at time  $t$ ,  $\alpha, \beta$  and  $\gamma$  denotes the elasticity of production about changes in the physical capital stock  $K_{it}$ , the stock of public education  $E_{it}$ , and the stock of public health  $H_{it}$ ,  $A_{it}$  represents technological progress and  $L_{it}$  indicates the quantity of labor, considering:

$$\begin{cases} L_{it} = L_{i0} e^{n_{it}t} \\ A_{it} = A_0 e^{g_{it}t} \end{cases} \quad (2)$$

As in the Mankiw et al. (1992) model, Li and Huang (2009) suppose that  $L_{it}$  and  $A_{it}$  progress to an exogenous growth rate  $n_{it}$  and  $g_{it}$  which are identical between countries. Also,  $s_{ki}, s_{ei}$  and  $s_{hi}$  are the share of income invested in physical capital, the stock of education, and the stock of health.

The equation of growth developed into the form:

$$\bar{y}_{it} = \bar{k}_{it}^{\alpha} \bar{e}_{it}^{\beta} \bar{h}_{it}^{\gamma} \quad (3)$$

The dynamics of factor accumulation are determined by:

$$\dot{\bar{k}}_{it} = s_{ki} \bar{y}_{it} - (n_i + g + \delta) \bar{k}_{it} \quad (4)$$

$$\dot{\bar{e}}_{it} = s_{ei} \bar{y}_{it} - (n_i + g + \delta) \bar{e}_{it} \quad (5)$$

$$\dot{\bar{h}}_{it} = s_{hi} \bar{y}_{it} - (n_i + g + \delta) \bar{h}_{it} \quad (6)$$

$\delta$  Is the rate of the depression of physical capital, which is similar to the stock of education and the stock of health. Considering  $\theta = 1 - \alpha - \beta - \gamma$ , the level of both stock of human capital and the stock of physical capital in the steady state are:

$$\bar{k}_i^* = \left( \frac{s_{ki}^{1-\beta-\gamma} s_{ei}^{\beta} s_{hi}^{\gamma}}{n_i + g + \delta} \right)^{1/\theta} \quad (7)$$

$$\bar{e}_i^* = \left( \frac{s_{ki}^{\alpha} s_{ei}^{1-\alpha-\gamma} s_{hi}^{\gamma}}{n_i + g + \delta} \right)^{1/\theta} \quad (8)$$

$$\bar{h}_i^* = \left( \frac{s_{ki}^{\alpha} s_{ei}^{\beta} s_{hi}^{1-\alpha-\beta}}{n_i + g + \delta} \right)^{1/\theta} \quad (9)$$

Substituting these values into the production function, supposing that  $p_i = n_i + g + \delta$  and introducing the logarithm. We obtain the following specification:

$$\ln y_{it} = \ln \frac{Y_{it}}{L_{it}} = \ln A_{i0} + gt + \frac{\alpha}{\theta} \ln s_{ki} + \frac{\beta}{\theta} \ln s_{ei} + \frac{\gamma}{\theta} \ln s_{hi} - \frac{1-\theta}{\theta} \ln p_i + \mu_i + \varphi_t + \varepsilon_{it} \quad (10)$$

Hongyi & Huang (2009) developed a panel specification that takes into account individual effects as the following form:

$$\ln y_{it} = \alpha_{i0} + \alpha_{i1} \ln s_{kit} + \alpha_{i2} \ln s_{eit} + \alpha_{i3} \ln s_{hit} + \alpha_{i4} \ln p_{it} + \mu_i + \varphi_t + \varepsilon_{it} \quad (11)$$

Where  $y_{it}$  refers to the Industrial production by worker,  $s_{kit}$  represents the stock of physical capital,  $s_{eit}$  refers to the stock of public education,  $s_{hit}$  refers to the stock of public health,  $p_{it}$  is the growth rate of the workforce ( $p_i = n_i + g + \delta$ )<sup>9</sup>,  $\mu_i$  is unobserved time-specific effects,  $\varphi_t$  is country-specific effects and  $\varepsilon_{it}$  is the error term.

The model used to estimate on Moroccan context is

$$\ln y_{it} = \alpha_{i0} + \alpha_{i1} \ln s_{kit} + \alpha_{i2} \ln s_{hit} + \alpha_{i3} \ln p_{it} + \alpha_{i4} \text{opent}_{it} + \mu_i + \varphi_t + \varepsilon_{it}$$

We have excluded public education and added the openness policy index ( $\text{open}_{it}$ ) which reflects Moroccan economic policy.<sup>10</sup>

### 4.3 Approach of estimation

The classic approach in empirical research is based on two steps: first, the researcher chooses a model from among all the existing models in the literature review. In a second step, it proceeds to the estimation of the parameters assuming that the chosen model is the appropriate model.

The methods used to estimate econometric models on panel data were discussed in the literature review. We generally distinguish between two methods; the ordinary least squares method with fixed effects and the ordinary least squares method with random effects ((Hedges and Vevea, 1998) and (Bartels, 2008)).

### 4.4 Cointegration test:

The theory of cointegration was initiated by (Granger, 1981), then later developed and popularized by (Johansen, 1988). The two-step test of Engle & Granger (1987) only allows the identification of the number of cointegration relationships in the case of two variables. Johansen & Juselius (1990) modified this test to study multiple variables.

We first used Pedroni's test (1999) and Kao's cointegration test to verify the results found. The test developed by (Pedroni, 1999) is part of the tests based on the residues, he proposes the stationarity test of Dickey-Fuller augmented with the residues to accept or reject the hypothesis of cointegration. Thus, the stationarity test is calculated from the residuals that result from the regression of the panel data with fixed effects. With the same idea, Kao developed another test in 1999.

### 4.5 Causality test

According to (Granger, 1969) the causality between  $X_t$  and  $Y_t$  means that the prediction of  $Y_t$  based on both the perception of the joint past of  $X_t$  and  $Y_t$  is better than the prediction based only on the past knowledge of  $Y_t$ .

The Granger causality test for the case of the two variables  $Y_t$  and  $X_t$  implies the estimation of the following autoregressive vector model (VAR):

$$Y_t = \alpha_1 + \sum_{i=1}^n \beta_i X_{t-1} + \sum_{j=1}^n \gamma_j Y_{t-j} + \varepsilon_{1t}$$

To conduct the causality test on the panel data we used the Granger non-causality test on panel data developed by (Dumitrescu & Hurlin, 2012). According to ((Fromentin, 2014),

<sup>9</sup>According to (Hongyi & Huang, 2009), for the sum of the depreciation rate and the technological progress, following Mankiw et al. (1992), it is assumed to be 0.05 (5%).

<sup>10</sup> Several empirical studies highlight the econometric problem of endogeneity between Public health and public education so I chose to exclude public education because I want to control this bias.

p.138) "Dumitrescu and Hurlin (2012) propose two standard statistics: W-Stat based on the moments of the asymptotic distribution of individual statistics, and Zbar-Stat based on an approximation of the moments of the distribution of a sample of fixed size ". Thus, this test is appropriate in small samples.

The test can lead to three results: bidirectional causality, unidirectional causality or no variable (X or Y) causes the other.

## 5. Results and discussion

### 5.1 Presentation of the results

#### 5.1.1 Unit Root Tests

To avoid the risk of a fallacious regression we performed a unit root test based on the Levin, Lin & Chu test.

*Tableau 3 Results of Levin, Lin & Chu unit root test*

Variables	Levin, Lin & Chu unit root test				
	Type of test	Retard	Significance of test		Conclusion
			T-stat	Pval	
<b>LPRODWORK</b>	Test with both constant and trend	2	0.26	0.6	Non stationary
<b>DLPRODWORK</b>	Test with both constant and trend	2	-9.96	0.000	Stationary
<b>LCONSPDOC</b>	Test with both constant and trend	2	0.74	0.77	Non stationary
<b>DLCONSPDOC</b>	Test with both constant and trend	2	-12.49	0.000	Stationary
<b>LDOCTRSP1000</b>	Test with both constant and trend	2	1.03	0.85	Non stationary
<b>DLDOCTRSP1000</b>	Test with both constant and trend	2	-5.46	0.000	Stationary
<b>LINVESTPPROD</b>	Test with both constant and trend	2	8.09	1.000	Non stationary
<b>D2LINVESTPPROD</b>	Test with both constant and trend	2	-3.82	0.000	Stationary
<b>LEXPORTPPROD</b>	Test with both constant and trend	2	-2.1	0.02	Stationary
<b>LGRPOP</b>	Test with both constant and trend	2	-11.06	0.000	Stationary

*Author calculs, software Eviews (10) results.*

Examining the results of unit root test, we concluded that, at the 5% threshold, the variables: exports related to industrial(LEXPORTPPROD) and the growth rate of the workforce (LGRPOP) are stationary in level. But, the variables : productivity per worker (LPRODWORK), the number of doctors per capita (LDOCTRSP1000), the number of consultations of public physicians reported to number of doctors (LCONSPDOC) are stationary in first difference and only physical capital is stationary in second difference (LINVESTPPROD). This implies a model that combines integrated variables of order 0, integrated variables of order 1 and integrated variables of order 2.

#### 5.1.2 Results of cointegration test

As seen in tables 4 et 5 whatever the proxies of health used, the results of Pedroni and Kao cointegration tests accept the hypothesis of a long-term relationship between the proxies used to measure health capital and the productivity rate per worker at the regional level.

The findings show the existence of a long-term relationship between the rate of productivity per worker and health capital. Referring to the papers that have studied the case of Morocco, these results are not similar to the outcome found by Bouoiyour (2000) and Sbaouelgi (2015).

**Tableau 4 Results of Pedroni residual cointegration test: determinants of the rate of productivity**

MODEL : DLPRODWORK D2LINVESTPPROD DLCONSPDOC DLDOCTRSP1000 LEXPORTPPROD LGRPOP				
Alternative hypothesis: common AR coefs. (within-dimension)				
	Statistic	Prob.	Statistic	Prob.
Panel v-Statistic	0.868858	0.1925	-3.001917	0.9987
Panel rho-Statistic	-1.714865	0.0432	-0.882290	0.1888
Panel PP-Statistic	-12.61406	0.0000	-13.93090	<b>0.0000</b>
Panel ADF-Statistic	-3.295050	0.0005	-4.082536	<b>0.0000</b>
Alternative hypothesis: individual AR coefs. (between-dimension)				
Group rho-Statistic	0.002915	0.5012		
Group PP-Statistic	-15.28509	<b>0.0000</b>		
Group ADF-Statistic	-2.609728	<b>0.0045</b>		

Author calculs, Eviews (10) software results.

**Tableau 5 Results of Kao residual cointegration test: determinants of the rate of productivity**

MODEL : DLPRODWORK D2LINVESTPPROD DLCONSPDOC DLDOCTRSP1000 LEXPORTPPROD LGRPOP				
Null Hypothesis: No cointegration, Included observations: 416				
			t-Statistic	Prob.
ADF			<b>-5.094468</b>	<b>0.0000</b>
Residual variance			2.860840	
HAC variance			1.199050	

Author calculs, Eviews (10) software results.

### 5.1.3 Results of causality test

As seen in the table, we found that the number of consultations per doctor is the only proxy of public health that causes in the Granger sense the rate of productivity per worker at the regional level. This means that the dependent variable is determined by the qualitative dimension of public health in the short term more than the quantitative dimension.

What's more, is that the rate of productivity per worker causes a qualitative dimension of public health, this result confirms the hypothesis of the theory of human capital and its theoretical and empirical extension.

**Tableau 6 Results of Dumitrescu\_Hurlin causality test: proxies of health**

Sample: 1994 2019			
Null Hypothesis:	W-Stat.	Zbar-Stat.	Prob.
<b>DLDOCTRSP1000 does not homogeneously cause D2LINVESTPPROD</b>	0.77353	-2.30419	<b>0.0212</b>
D2LINVESTPPROD does not homogeneously cause DLDOCTRSP1000	1.87544	-0.60374	0.5460
DLDOCTRSP1000 does not homogeneously cause DLCONSPDOC	1.70868	-0.84871	0.3960
<b>DLCONSPDOC does not homogeneously cause DLDOCTRSP1000</b>	0.89860	-2.11880	<b>0.0341</b>
<b>DLPRODWORK does not homogeneously cause DLCONSPDOC</b>	5.99858	5.87722	<b>4.E-09</b>
<b>DLCONSPDOC does not homogeneously cause DLPRODWORK</b>	4.45592	3.45855	<b>0.0005</b>
<b>LEXPORTPPROD does not homogeneously cause DLCONSPDOC</b>	6.82197	7.16817	<b>8.E-13</b>
DLCONSPDOC does not homogeneously cause LEXPORTPPROD	2.73594	0.76188	0.4461
LGRPOP does not homogeneously cause DLCONSPDOC	2.04479	-0.32173	0.7477
DLCONSPDOC does not homogeneously cause LGRPOP	3.13680	1.39038	0.1644
LGRPOP does not homogeneously cause DLDOCTRSP1000	2.63531	0.60410	0.5458
DLDOCTRSP1000 does not homogeneously cause LGRPOP	1.78735	-0.72536	0.4682
DLPRODWORK does not homogeneously cause DLDOCTRSP1000	1.51251	-1.15628	0.2476
DLDOCTRSP1000 does not homogeneously cause DLPRODWORK	1.91829	-0.52007	0.6030
LEXPORTPPROD does not homogeneously cause DLDOCTRSP1000	2.94302	1.08655	0.2772
DLDOCTRSP1000 does not homogeneously cause LEXPORTPPROD	1.72538	-0.82252	0.4108

Author calculs, Eviews (10) software results.



Therefore, the number of doctors causes a proxy of investment, so I could make a hypothesis that public health can help the government to stimulate the holders of investments to invest more.

These results show also that the capacity to export causes the number of consultations per doctor so I could explain this result by the fact that more resources or wages could incite workers to get medical care.

### 5.1.4 Regression results

Table 7 presents the results of the relationship between health proxies and worker productivity. Model 1 reports the results of the impact of both proxies of health, and Models 2 and 3 report the results for the individual impact of health proxies.

Tableau 7 Estimation on Panel data from 1994 to 2019 using ordinary least squares.

Independent variable		code	Specifications		
			1	2	3
Health capital	The number of doctors per capita	DLDOCTRSP1000	0.02 (0.95)	0.09 (0.75)	
	The number of consultations per doctor	DLCONSPDOC	0.14 (0.05)**		0.18 (0.01)***
Physical capital		D2LINVESTPPROD	-0.19 (0.00) ***	-0.19 (0.00) ***	-0.19 (0.00) ***
Openness		LEXPORPPROD	-0.09 (0.01) ***	-0.09 (0.01) ***	-0.27 (0.00) ***
Growth of work force		LGRPOP	0.04 (0.55)	0.05 (0.49)	0.01 (0.87)
Constant		Cons	0.02 (0.91)	0.05 (0.79)	-0.34 (0.1)
Test Hausman			36,89(0,00)	2,73(0,60)	36,16(0,00)
F-statistic			6,21(0,00)	6,26(0,00)	9,45(0,00)
Jarque-bera			8635(0,00)	11315(0,00)	10483(0,00)
Durbin-Watson			1,96(0,00)	1,95	1,9
Breusch-Pagan LM			433(0,00)	417,6(0,00)	347,98(0,00)
Qualité du modèle R <sup>2</sup>			33%	32%	33%

\*\*\*indicates the test is significant at the 1% level, \*\* indicates the test is significant at the 5% level, and \* indicates the test is significant at the 10% level. The values in parentheses represent the added value.

Author calcul, software Eviews 10 results.

Whatever the specification used, the Fisher test affirms the existence of unobservable individual effects that characterize the regions of Morocco. Using both Hausman and Breusch-Pagan tests, we found that these individual effects are fixed in specifications 1 and 3 and random in specifications 2.

Also, we distinguish three important variables that significantly affect the dependent variable. The number of consultations per doctor, which refers to the qualitative dimension of public health, affect positively and significantly the rate of growth of worker productivity.

In my empirical approach, I used the log-log specification so a 1% change in the independent variable is associated with x% change in the dependant variable when the other variables hold constant), the change of 1% in the number of consultations per doctor generates a change of 0,14 % of worker productivity at the 5% level.

Further, these results show a significant difference between the impact of the quantitative and qualitative dimensions of health capital.

The results for the individual impact of health proxies (specifications 2 and 3), confirm that only the number of consultations per doctor positively and significantly the rate growth of worker productivity: the change of 1% in the number of consultations per doctor leads to the change of 0,18 % of worker productivity at the 1% level

Also, whatever the specification, the investment rate has a negative and significant impact which shows the weakness of private investments made in the regions of Morocco. And, the rate of export has a negative and significant impact, which proves the low capacity of most regions of Morocco to export. These results can be explained by the concentration of activities of industrial companies in the northern and western regions of Morocco.

These results are similar to the results of the works of (Grieco & McDevitt, 2017), (Papanicolas et al., 2018), and (Bronsoler et al., 2022) which suggest that countries must employ additional efforts and make reforms to increase the level of quality of health.

## 6. Conclusion and perspectives

The central hypothesis of this paper was to evaluate the influence of health capital on worker productivity by applying an econometric study to panel data of 16 regions from 1994 to 2019. The employ of both Pedroni and Kao cointegration tests affirm the hypothesis of a long-term relationship between the proxies used to measure health capital and productivity rate per worker at the regional level. Then, Dumitrescu\_Hurlin's test of causality shows that only the number of consultations per doctor cause in the Granger sense the rate of productivity per worker at the regional level but the number of doctors per capita doesn't impact.

Most importantly, in all estimations, whatever the specification used, the results illustrate that only the qualitative dimension of health affect positively and significantly worker productivity. Therefore, the benefits of improving the supply of health are not automatic, the positive link between the growth of worker productivity and health capital is guaranteed only if the government makes additional efforts to increase the level of quality of health.

Faced with these results, the authorities must make more effort to improve the efficiency of public health capital. It is not enough to increase the number of human resources but it is necessary to improve the quality of health service and facility access.

The empirical results obtained in this article can be enriched on several levels. On a methodological level, it would be interesting to introduce the role of institutional dimension in the analysis of worker productivity. Finally, it would be promising to analyze the effects of social inequalities and spatial disparities on productivity.

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