ENCUENTRO DE ECONOMIA PUBLICA (30-31 Enero, Girona, 2014)

Draft 8 Novemeber 2013

DOES HEALTH ENHACE ECONOMIC GROWTH? AN EMPIRICAL EVIDENCE FOR THE SPANISH REGIONS

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Abstract:

Despite the recognized positive effects on the health-economic growth relationship, there is no too much research that estimates this effect for the case of the Spanish regions. In this paper it is analyzed the role of health capital on Spanish regional economic growth during the period 1980-2007 using an econometric approach based on Lorentzen, McMillan and Wacziarg (2008). We measured the direct and indirect impact of health and in line with previous studies this paper found empirical evidence about the positive relationship between health and wealth. Empirical results suggested that a greater risk of death is associated with higher levels of fertility and lower investment in physical and human capital. To this end, the main objectives for policy makers when deciding where to allocate the resources for development should be clearly directed to improve its citizens' health, through a direct way or the indirect channels there appear to be.

Keywords: Growth, Health, Mortality, Investment, Human Capital, Fertility.

JEL Classifications: I10, J10; O10

1. INTRODUCTION

The aim of this paper is to analyze the impact of health capital in Spanish economic growth over the period 1980-2007. The paper is related to some theoretical and empirical approximations. The role of health capital in economic growth is one of the best-known relations in international development (Bloom and Canning, 2000). Since Grossman (1972), there has been huge literature on health as a form of capital stock in complex ways. This relationship has been traditionally seen as a causal link in only one direction: wealth allows along others, better access to food, investments in health care or education. For example, Preston (1976) emphasized economic growth as the most important determinant of life expectancy. More developed countries can expand public goods and services and so, "wealthier nations are healthier nations" (Pritchett and Summers, 1996). On this relationship, there are countless contributions on testing for the luxury good hypothesis of health care (Newhouse 1977; Baltagi and Moscone 2010; etc).

Nevertheless, in recent years a sizeable body of research has addressed the reverse causation: healthy populations increase labour productivity and per capita income. The World Health Organization Commission on Macroeconomics and Health (2001) indicated that there was three main ways that disease impedes economic well-being and development: (i) avoidable disease reduces the number of years of healthy life expectancy; (ii) the effect of disease on parental investments in children; and (iii) the depressing effects of disease on the returns to business and infrastructure investment, beyond the effects on individual labour productivity. In this context, economic literature has developed models where health is incorporated in traditional growth models (Howitt, 2005; Van Zon and Muysken, 2005; Weil, 2007). Therefore, the theory of health economics supports the hypothesis that health is a determinant of economic growth.

With respect to the empirical evidence, the attention of researchers has shifted from the exploration of direct effects to the indirect ones. To begin with, Mayer (2001) studied the long-term impact of health on economic growth in Latin America. He found that a permanent increment of 0.8-1.5 percent of annual income is associated with adult and unexpectedly old aged health improvements. Moreover, the author points out that the channels of causation from health to income are diverse; and some of them may be indirect, so microeconomic studies are more precisely. In the same line, Bloom and

Canning (2005) observed that a 1 percentage point increase in adult survival rates increases labour productivity by about 2.8 percent. This effect would imply that differences in health would be responsible of the variation in labour productivity across countries. Acemoglu and Johnson (2007) studied the effect of life expectancy on economic performance, using a model based on a predicted mortality instrument. Unlike previous papers found that there is no evidence that the large increase in life expectancy raised income per capita. Lorentzen, McMillan and Wacziarg (2008), hence (LMW), explored three channels whereby adult mortality may affect growth. They found that a greater risk of death during the prime productive years is associated with higher levels of risky behaviour, higher fertility, and lower investment in physical capital. Similarly, Aghion, Howitt and Murtin (2011) found that only the reduction in mortality rates below forty generates productivity gains in OECD countries. Other authors, as Cervellati and Sunde (2011), suggested that life expectancy may have direct effects on economic growth. These effects appear to be non-monotonic and depend on the level of demographic development. French (2012) positively tested for some OECD countries that better health improves income while income in turn also affects health. Meanwhile, Cooray (2013) found that health capital does not have a robust and significant effect on economic growth unless through their interactions with health expenditure and education. Bloom, Canning and Fink (2013) revisited too Acemoglu and Johnson (2007) and found that their main result is mostly driven by their a priori exclusion of initial life expectancy from the economic growth model. Finally, Kumar and Chen (2013) who studied the impact of health and education on the growth rate of total factor productivity. They pointed out the importance of including health capital on the design of policies which facility technology diffusion.

Summing up, the literature shows two channels thought health affects economic growth: direct and indirect. The direct one is related to the idea that better health status generates higher productivity. Meanwhile the indirect one indicates that better health status reduces the depreciation of human capital, higher life expectancy which generates more investments (both, in physical capital and education), and so it enhances economic growth.

We build on this literature in two ways. First, in this paper we analyze the role of health capital in Spanish regional economic growth over the period 1980 to 2007. Under this time span, the key facts to carry out the analysis fall on: the observed growth of per capita income, the decline in mortality rates (as proxies for health capital), and both health capital and economic growth differences among regions[1]. Second, since there is a growing consensus on the indirect large effects that improving health can have on accelerating economic growth, the analysis measures the direct (with a linear panel data model) and indirect impact (structural system to focus on the different channels through economic growth is affected) of health through pathway results in infant mortality rates.

This paper contains various innovative approaches. Firstly, as far as we are concerned, this contribution is among the first to investigate the connection between health capital and economic growth for the Spanish regions, when using infant mortality rates as a proxy of health status. In doing so, we transmit a distinction on previous contributions. That is, this paper supposes a different point of view of the one done by Rivera and Currais (2004), who analysed how the composition of public health spending affects the productivity of the Spanish regions. Also, it departs from Oliva-Moreno (2012) who studied labour productivity losses associated with illnesses. Secondly, this paper uses an innovative method for testing of on hypotheses derived from economic theory, viz, whether health improves growth in per capita income. Thirdly, from a policy economic perspective, this paper encourages debates about the implications of government's involvement for the provision of health; the cost and benefits of health care programs; and therefore on the sustainability of national health care systems and sustained economic growth. When estimating the effects of infant mortality on economic growth, a structural model based on LMW to focus on the different channels through growth rates are affected, is used. Particularly, our indirect channels are: "Investment", "School" and "Fertility".

The remainder of this paper is organized as follows. Section 2 describes the model to be estimated, the data variables and the econometric strategy. Section 3 presents the empirical results. Finally, Section 4 summarizes the conclusions and policy implications.

[1] Although the index for the growth of per capita income is for Spain in both years below the EU-15 average (EU-15 = 100), it grows from 74.1 in 1980 to 83.7 in 2007. Additionally, in 1980 the index for Spain for mortality rates (100.22) was above the EU-15 average. In spite of, it drowned in 2007 to 97.5. (OECD Health Data, 2012). Among the Spanish regions, the standard deviation for infant mortality rates falls from 0.38 in 1980 to 0.20 in 2007 while for per capita income rises from 1.8 to 2.9. (Spanish National Institute of Statistics, INE).

2. MODEL AND DATA

In this Section we describe the conceptual framework and the methodology, variables and data resources employed in this paper.

2.1 The model

Following LMW, this paper aims to study the direct and indirect impact of health, through pathway results in infant mortality rates (as a proxy of health capital) on economic growth using an econometric panel data analysis (firstly, using a linear panel data model, while, ending with a structural system one) and data taken from several Spanish statistical resources.

But, how mortality affects growth? The main hypothesis is that mortality affects growth by diminishing incentives for behaviour with short-run costs and long-run payoffs. Hence, the logic effect of mortality on investment is as follows: given an instantaneous utility function $u(c_t)$; a probability of survival of p; and a discount factor β, in a two-period model agents optimize $u(c_t) + p\beta u(c_{t+1})$. Then, a reduction in the survival probability p, like a reduction in the discount factor β, brings lower savings and investment and thus lower growth. A similar procedure is used to determine human capital accumulation. Accordingly, whereas parents with altruistic feelings towards their children will benefit indirectly from physical capital investments, an early death destroys human capital investments before their full returns are realized. After all, we shouldn't forget that mortality might also affect growth through fertility rates. That is, in an environment of high uncertainty parents will have more children in order to minimize the risk of ending up with too few surviving descendants, resulting in higher net fertility and therefore higher population growth. Subsequently, a higher rate of population growth reduces the capital/labour ratio which limits economic growth.

Thus, our objective in this subsection is to account for the direct relationship between health, our considered "Channels" (*investment*, *school* and *fertility*) and economic growth and then, to develop the linear model to be estimated in the first methodological approximation to be performed.

Therefore the linear panel to be estimated would be:

$$\boldsymbol{Y_{it}} = \beta_0 + \beta_1(\boldsymbol{K_{it}}) + \beta_2(\boldsymbol{H_{it}}) + \beta_3(\boldsymbol{F_{it}}) + \beta_4(\boldsymbol{M_{it}}) + \boldsymbol{\beta}_{5\text{-}\ldots}(\boldsymbol{Z}) + \boldsymbol{\varepsilon_{it}} \qquad (1)$$

Where, Y_{it} is the aggregate per capita output of region *i* in period *t*; K_{it} is the investment rate; H_{it} is the stock of human capital, measured by the number of schooling years; F_{it} is a fertility rate; M_{it} is the infant mortality rate and *Z* stands for other control variables.

Taking logarithms and subtracting $logY_{it-1}$ for (1), we specify the base equation for growth in per capita Gross Value Added (GVA) as:

$$\Delta \log \boldsymbol{Y}_{it} = \beta_0 + \beta_1(-\log \boldsymbol{Y}_{it-1}) + \beta_2(\log \boldsymbol{K}_{it}) + \\ + \beta_3(\log \boldsymbol{H}_{it}) + \beta_4(\log \boldsymbol{F}_{it}) + \beta_4(\log \boldsymbol{M}_{it}) + \boldsymbol{\beta}_{5\text{-}...}(\boldsymbol{Z}) + \boldsymbol{\varepsilon}_{it} \quad (2)$$

In general:

$$\Delta \log \boldsymbol{Y}_{it} = \alpha_i + \boldsymbol{x}_{it}^{'}\boldsymbol{\beta} + \boldsymbol{\varepsilon}_{it} \quad (3)$$

where α_i is a region specific effect, $\boldsymbol{\beta}$ is a vector of parameters to be estimated and the $\boldsymbol{\varepsilon}_{it}$'s are random errors.

Secondly, a structural system to focus on the different channels through growth is affected (indirect impact of health on economic growth) as developed in the econometric strategy, is employed.

2.2 The data

Basic data used in this analysis are taken from several sources. Gross value added (*GVA, Y*) and gross fixed capital formation (*GFCF*), which exclude due to its volatility the value of the property rental sector, are obtained from the Regional database of the Spanish economy (BD.MORES). Therefore, *investment* is calculated by a ratio between the second between the first previous variables. As a "proxy" for the stock of human capital (*school*), we use series of average years of schooling from the Valencian Economic Research Institute (Ivie). The fertility (*fertility*) and infant mortality (*infant mortality*) rates, total population (*pob*), population density (*density*) and *urbanization,* are from the Spanish National Institute of Statistics (INE). The *government* variable is elaborated based on data from the Ministry of Finance and Public Administration and the Spanish Public Sector Economic Database (Badespe). Finally, *openness* is based on the Foreign Trade Statistics (DataComex). Table 1 presents the details concerning the definitions and sources of the variables.

[Insert: Table 1 Variables and data sources]

The analysis is based on a panel dataset for seventeen regions[2] over the period 1980-2007. Our study is restricted by the quality and the availability of the data. In order to use a balanced panel data of the main variables, observations start in 1980 and finish in 2007. Over this period, the Spanish National Health Service is characterized by a rapid asymmetric decentralization of health care to regions, which began in 1981 and ended in 2002, according to three models: (i) 5 regions (Catalonia, Galicia, the Canary Islands, Valencian Community, and Andalusia) kept health care expenditure responsibilities, but with actual fiscal responsibility limited, in the sense that they were held politically more than fiscally accountable. Therefore, most resources devoted to health care in those regions came from specific grants, with self-financing strongly constrained and playing a minor role; (ii) the two "foral" regions (Basque Country and Navarre) are both fiscally and politically accountable for the running of almost all public service provision within their boundaries. While they were granted autonomy in financing health care, they also enjoyed a high level of tax autonomy; (iii) 10 regions had no health care responsibilities until 2002. Before this date, the central government carried all responsibility for health care there. Nowadays, health care financing is covered by all regions through: regional taxes, shared taxes and block-grants from the central government, and copayments. Table 2 contains the descriptive statistics of the variables.

[Insert: Table 2 Descriptive statistics]

Thereby, Figures 1-4 show for year 2002 the relationship between infant mortality, economic growth and the three channels[3]. As expected, due to economic a priori criteria and previous evidence, there is a negative relationship between infant mortality and growth, physical and human capital. Meanwhile its relationship is positive with fertility.

[Insert: Figures 1, 2, 3, and 4]

2.3 The econometric strategy

The aim of this paper is to analyze the impact of health capital in Spanish economic growth over the period 1980-2007. The econometric analysis is divided into two steps: a

[2] Andalusia, Aragon, Principality of Asturias, Balearic Islands, Basque Country, Canary Islands, Cantabria, Castile-La Mancha, Castile and León, Catalonia, Community of Madrid, Extremadura, Galicia, La Rioja, Region of Murcia, Navarre and Valencian Community.

[3] This year is selected, since in 2002 health care financing in Spain is totally decentralized.

linear panel data model for the direct effect and a structural system to focus on the different channels through economic growth is affected.

We have previously indicated how health capital affects economic growth. The explanation is based on how individuals maximize their utility functions, that is: (i) individuals with higher life expectancy are likely to save more, then savings in turn feed back into capital accumulation and the subsequent economic growth; (ii) a lower risk of death induces individuals to invest more in education and also convey their decisions to their children; (iii) in an environmental market with low mortality, parents are likely to choose fewer children limiting total population growth and enhancing per capita income.

Thus, the dependent variable is the growth rate of GVA per capita ($\Delta\ logY_{it}$). Our main variable of interest is health capital, that we proxies for infant mortality. The three channels we use to analyse the indirect effect of health on growth are *investment*, *school* and *fertility*. Finally, following previous literature other control variables, mainly demographic as population density or urbanization, are used. Due to quality and data availabilities, we used as instruments lagged variables of both, infant mortality and the endogenous variables[4].

In our first pass at estimation, we seek to characterize the total effect of the main variables on economic growth by estimating (3). To do so, we introduce the infant mortality and the channels into the growth equation. The resulting reduced form growth specification is (4):

$$\begin{aligned}\Delta \log \boldsymbol{Y}_{it} &= \alpha_i + \boldsymbol{\beta}_1(\log \boldsymbol{Y}_{it-1}) + \boldsymbol{\beta}_2\textit{(Infant mortality)} + \boldsymbol{\beta}_3\textit{(investment)} + \\ &+ \boldsymbol{\beta}_3\textit{(school)} + \boldsymbol{\beta}_3\textit{(fertility)} + \boldsymbol{\beta}_{4\text{-}\dots}\textit{(Z)} + \varepsilon_{it} \qquad (4)\end{aligned}$$

where *Z* stands for the control variables, in order to check the robustness of the estimates. The inclusion of initial GVA per capita ($logY_{it-1}$) in is due to the hypothesis of convergence, which states that regions with a lower initial income have the potential to grow faster in subsequent periods. The estimations presented in the subsequent section, are obtained with fixed and random effects estimators for linear panel models.

Subsequent to, we turn to estimating the channel equations by applying (5) with an instrumental variables estimator. Equation (5), allows us studying the determinants

[4] While in other studies related to countries climatic factors and geographic characteristics are used; *investment*, *school*, *fertility* and its interactions are treated as endogenous whenever they appear on the right-hand side of channel equations.

of our three channels ("Investment", "School" and "Fertility") where the lagged values of the main variables and its interactions are used as instruments.

$$\boldsymbol{Channel}_{it} = \alpha_i + \beta_1(\log Y_{it\text{-}1}) + \beta_2\textbf{\textit{(Infant mortality)}} + \beta_{3\text{-}...}(Z) + \varepsilon_{it} \qquad (5)$$

We examine infant mortality relates to capital investment, human capital accumulation, and fertility rates. We have two goals. First, these relationships are interesting in their own right as evidence for the horizon effect of mortality. Second, they are a first step toward decomposing the total effect of mortality on growth into its various channels. For each of the three channels (*investment*, *school* and *fertility*), we estimate three different specifications: firstly, a barebones specification that includes no other regressor that the mortality; secondly, a specification which include the lagged logarithim of per capita income and infant mortality; and thirdly, the baseline specification with many more controls as for Equation (4).

We argued above that the effect of mortality is likely to work through investment in physical and human capital, as well as fertility. We now quantify the relative importance of these channels. That is, finally, we adapt the structural model by LMW to focus on the different channels through growth is affected. Our structural system for the simultaneous determination of the variables of interest would be the following:

[Insert: Figure 5]

We attend to make explicit the causal links between economic growth, the channels linking it to mortality, and the mortality variables to the Spanish case. The econometric methodology relies on Three-Stage Least Squares estimation (3SLS). 3SLS estimates a system of structural equations, where some equations contain endogenous variables among the explanatory variables. The dependent variable will have its usual interpretation as the left-hand-side variable in an equation with an associated disturbance terms and these dependent variables are explicitly taken to be endogenous to the system and are treated as correlated with the disturbances in the system's equations. The exogenous variables in the system that are excluded from a given equation are used as instruments for the included endogenous variable in that equation. It allows us to directly estimate the simultaneous equation for the mortality-growth relationship, which we have considered as indirect. Note that the effect of mortality is likely to work through investment in human and physical capital and with the fertility rate. Then, summing up the effect of the channel on growth multiplied by the effect of mortality on each channel, would give us the indirect effect of infant mortality on growth.

3. RESULTS

The estimation results are summarized in Tables 3 to 5. Thus, the first two tables contain the results of the direct effects estimation, while the last one shows the results concerning the structural model (indirect effects estimation). As it can be seen, coefficients are statistically significant and have in most cases the expected signs according to the a priori economic criteria and previous evidence. In any case, the overall effect of mortality on growth comes out negative and statistically significant.

3.1 Direct effects estimation

As previously indicated, Tables 3 and 4 contain the results concerning the direct effect of the explanatory variables on growth and the determinants of our three channels, respectively.

Thus, in Table 3 it can be tested, the estimates are robust and consistent to the inclusion of different variables. Note, it is shown how infant mortality (-0.014 to -0.015) and the fertility rate (-0.077) affect growth in a negative way while its effect is positive for *investment* (0.034 to 0.069) and *school* (0.200 to 0.346). It is also important to notice how the lagged value of the logarithm of GVA per capita *($logY_{it-1}$)* exerts a negative effect too (-0.020 to -0.196), which may imply a convergence process. Thereby, it is noticed that after applying the Hausman test (1978) we mostly use fixed effects instead of random effects.

[Insert: Table 3 Estimates of the growth regression, linear panel Dependent variable: GVApc growth]

In addition, if we focus on our main interest variables in explaining the channels equations, Table 4 indicates the reverse effect that infant mortality and income have. In this sense, as we expected, infant mortality affects *investment* (-0.133 to -0.287) and *school* (-0.209 to -0.351) in a negative way, whereas its influence is positive on fertility rates (0.257 to 0.331). These relationships, between the mortality and the three channels considered, had already been advanced by the graphic analysis made in the data subsection 2.2.

[Insert: Table 4 IV estimates of the channel equations]

3.2 Indirect effects estimation

Table 5 presents the results of the 3SLS estimates. We have just argued that the effect of mortality is likely to work through investment in physical and human capital, as well as fertility. Table 5 then, quantify the relative importance of these channels and also corroborated the direct estimations we have presented above (in Tables 3 and 4).

That is, turning to the channels themselves, we note that consistent with the observations based on the linear panel estimates (specifically, in Table 4), the negative influence of infant mortality on channels *investment* (-0.231) and *school* (-0.318) and the positive one for the *fertility* (0.293), are resubmitted. Ultimately, our system equations estimates (Fig.5) allow us to quantify the effect of infant mortality on growth.

As the effect of the channels of growth has the opposite sign that the effect of infant mortality has on the channel, the indirect effect of health on growth is negative (-0.066). In summary, we found evidence that infant mortality reduces economic growth, but the effect although it is statistically significant is, as expected for a developed economy, modest in size.

[Insert: Table 5 System estimates of the infant mortality effects (3SLS)]

4. CONCLUSIONS

The recent growth literature provides several arguments suggesting that health capital may lead to positive effects on growth. Hence, trying to answer the question of whether health enhances growth, this paper uses several econometric panel data strategies in order to analyze the role of health capital on Spanish regional economic growth, during the period 1980-2007.

Specifically, we have studied the direct and indirect effects through growth, is affected. Appropriate econometric estimators and test procedures were used in the analysis to draw differences. In line with previous papers, we have found evidence about the positive relationship between health and wealth.

In doing so, we have considered three channels whereby infant mortality, as a proxy of health, may affect growth: *investment*, *school* and *fertility* and had found that *investment* is the strongest channel. Particularly the results, as we expected, show that *investment* and *school* affect economic growth in a positive way, while the effect is negative for the *fertility*. Additionally, infant mortality has the reverse effect on the channels. In any case, the effect of mortality on economic growth comes out negative and statistically significant (with a modest size). Thus, it should be noted that the final obtained effect of health on economic growth ranges between -0.014 to -0.066 depending in the (direct or indirect) model we had estimated.

Therefore, from a policy economic perspective the results confirm that more health investments and better health status are essential for economic growth. Subsequently, the main objectives for policy makers when deciding where to allocate the resources for economic development should be clearly directed to improve its citizens' health through a direct way or the indirect channels there appear to be.

These results are on primary importance, for example, in current debates on the cost and benefits of health care programs. Therefore, in designing policies to facilitate economic development and growth, policy makers needs to broaden the concept of human capital stock including health.

Because it is an area in which greater effort must be made to generate relevant empirical information with which policy makers can base informed decisions, and naturally, because there are caveats to our analysis that need to be taken into account when interpreting the results (health capital is proxied by an infant mortality rate, it is considered a full time period,…), this paper could be extended in several directions. In this sense, it would be interesting looking at differences between subgroups of regions and subperiods of time for explaining economic performance and health results. In the same way, it would be valuable to focus on specific causes of death and to test the results using other health proxies. These and other extensions of the analysis of this paper are left for further research when there will be more elaborate data on health indicators.

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TABLES AND FIGURES

Table 1 Variables and data sources

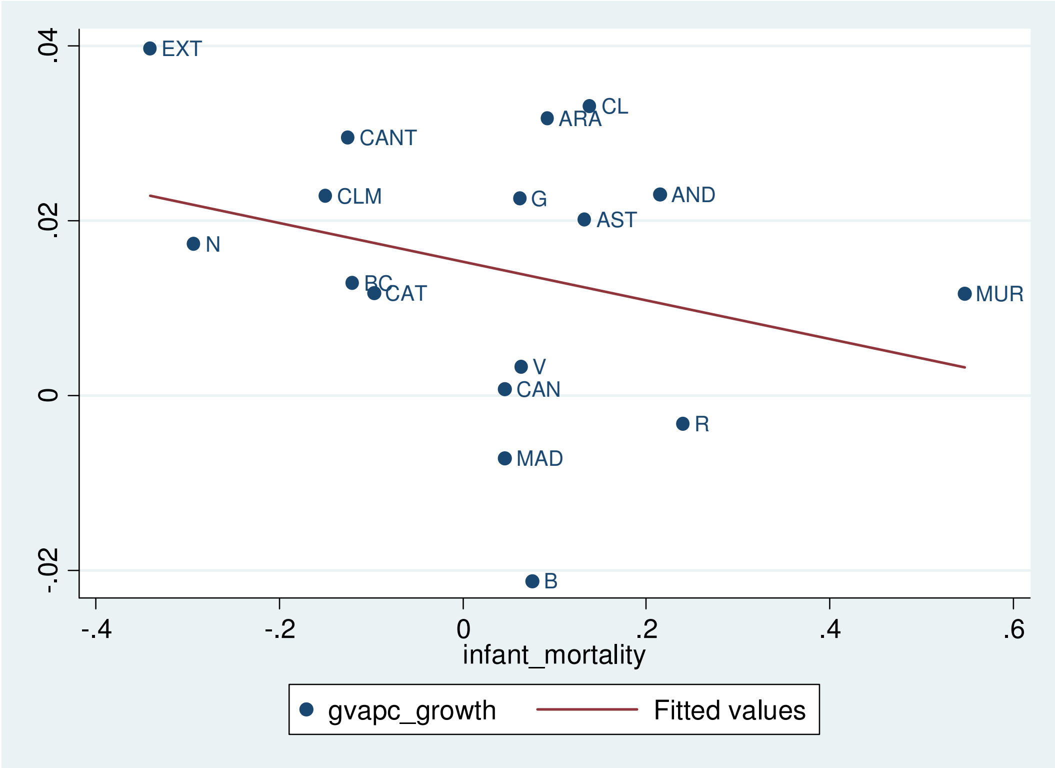
Variable	Definition	Data Source
Y	Per capita gross value added (GVA), thousands of euros (2000 constant prices)	BD.MORES
pob	Total population, units	INE
GFCF	Gross fixed capital formation, thousands of € (2000 constant prices)	BD.MORES
investment	GFCF/GVA	BD.MORES
school	Human Capital, average schooling years based on 1970 General Education Law	Ivie
fertility	Fertility Rate, births per thousand women	INE
government	(Personnel expenses + depreciation + current expenditure) / GVA	Ministry of Finance and Public Administration and Badespe
infant mortality	Infant Mortality Rate, deaths per thousand inhabitants 0-4 years	INE
density	Population density (people per squared kilometer)	INE
urbanization	Proportion of total people in municipalities > 10,000 inhabitants, in percentages	INE
opennes	Openness rate: (exports + imports)/GVA	DATACOMEX

Table 2 Descriptive statistics

Variable	Mean	Std. Dev.	Min.	Max.	Observations
Y	11.21	3.28	4.39	20.20	476
pob	2.34	2.00	0.25	7.91	476
GFCF	5.08	5.05	0.35	25.98	476
investment	0.20	0.04	0.08	0.44	476
school	7.55	1.12	5.12	10.51	476
fertility	42.64	10.43	23.38	82.77	476
government	0.05	0.04	0.00	0.18	408
infant mortality	1.59	0.63	0.54	3.60	476
density	138.29	146.67	20.74	757.56	476
urbanization	71.86	14.89	42.27	94.79	187
opennes	0.43	0.22	0.07	1.00	221

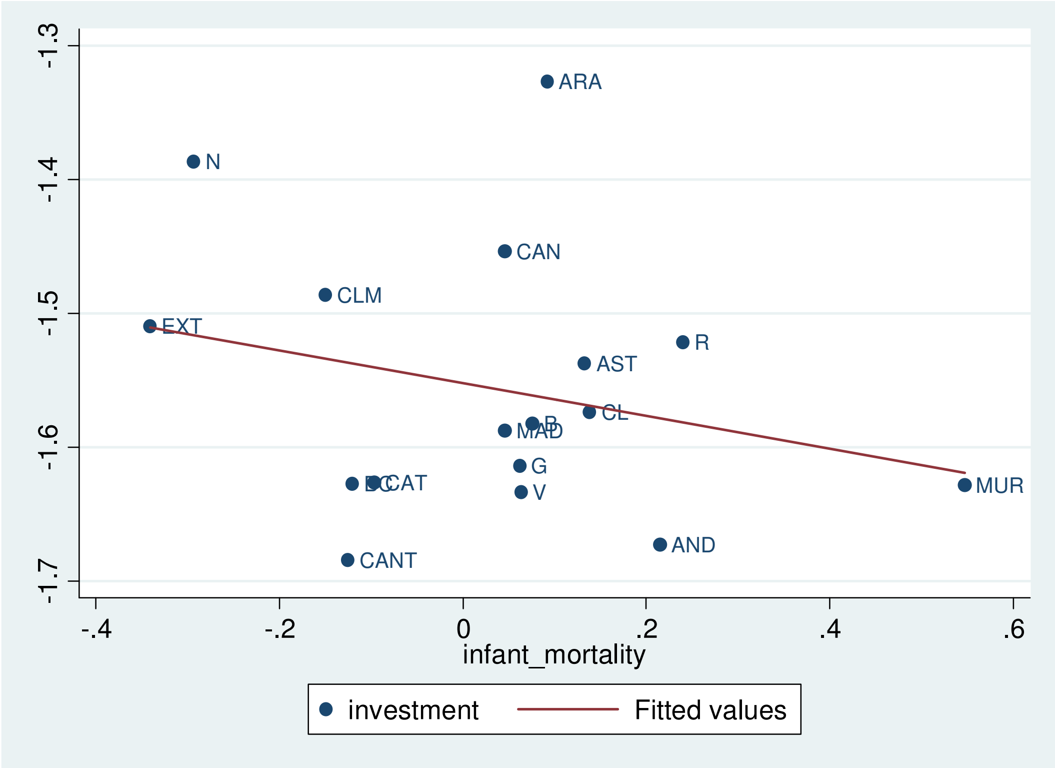
Note: *pob* and *GFCF,* in millions.

Figure 1 Relationship between health capital (infant mortality) and economic growth for the Spanish regions in 2002



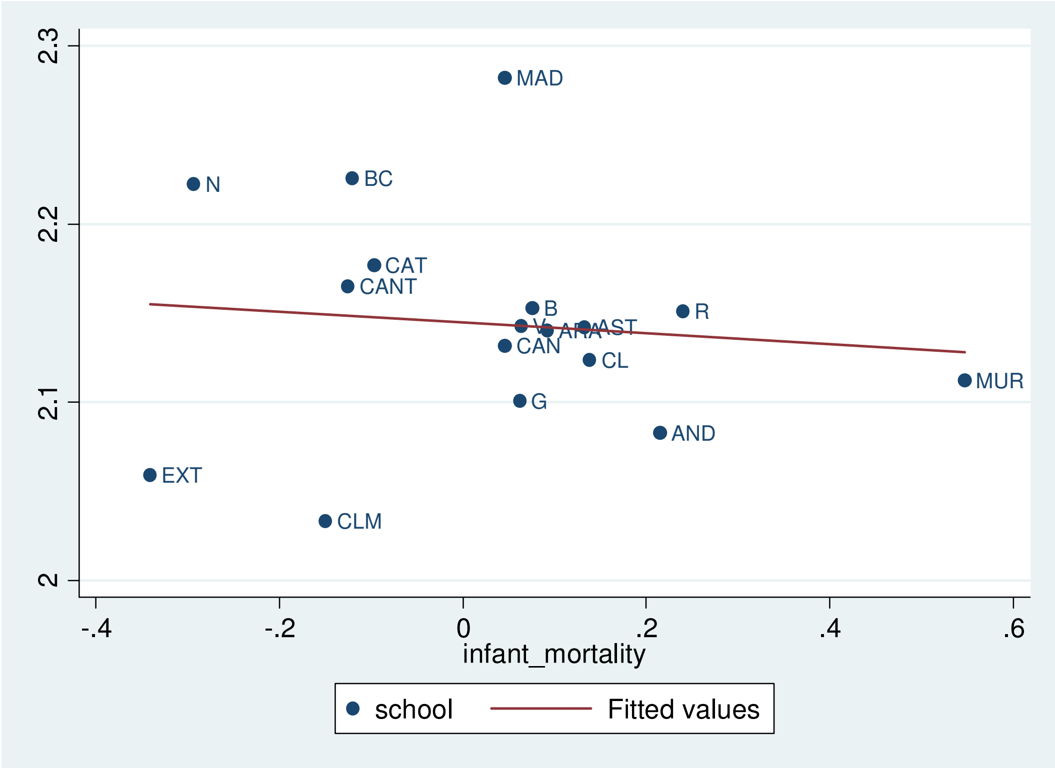
Notes: variables in logarithms. Andalusia (AND), Aragon (ARA), Principality of Asturias (AST), Balearic Islands (B), Basque Country (BC), Canary Islands (CAN), Cantabria (CANT), Castile-La Mancha (CM), Castile and León (CL), Catalonia (CAT), Community of Madrid (M), Extremadura (EXT), Galicia (GAL), La Rioja (R), Region of Murcia (MUR), Navarre (N) and Valencian Community (V).

Figure 2 Relationship between health capital (infant mortality) and *investment* for the Spanish regions in 2002



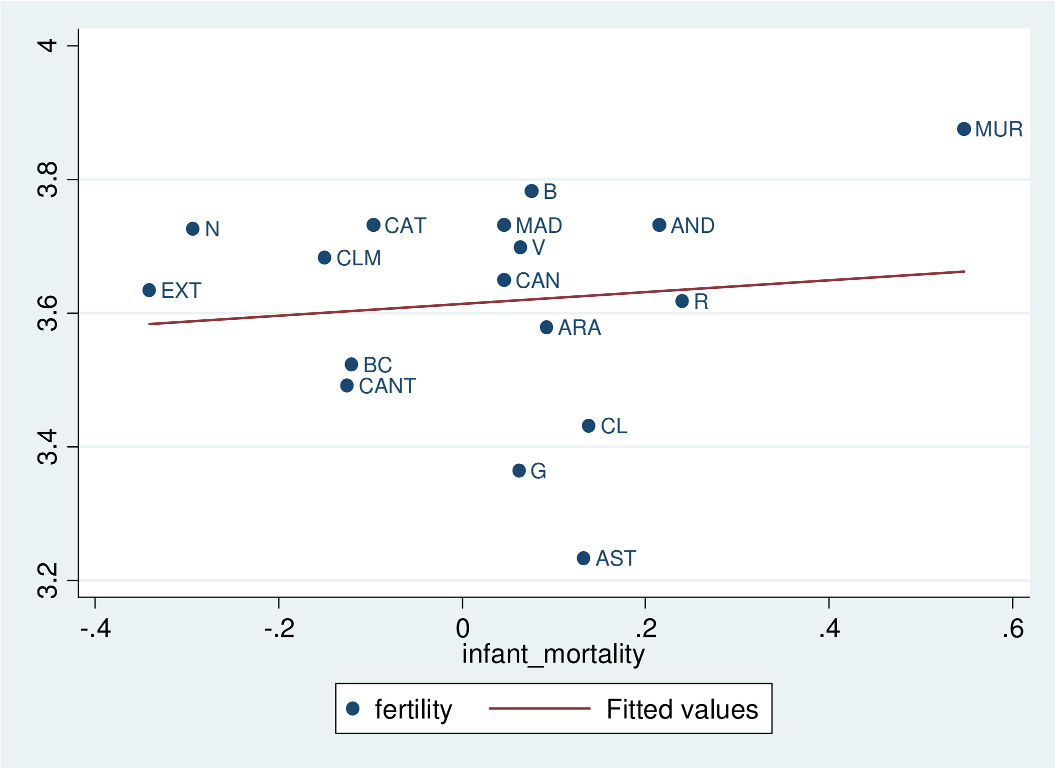
Note: variables in logarithms.

Figure 3 Relationship between health capital (infant mortality) and *school* for the Spanish regions in 2002



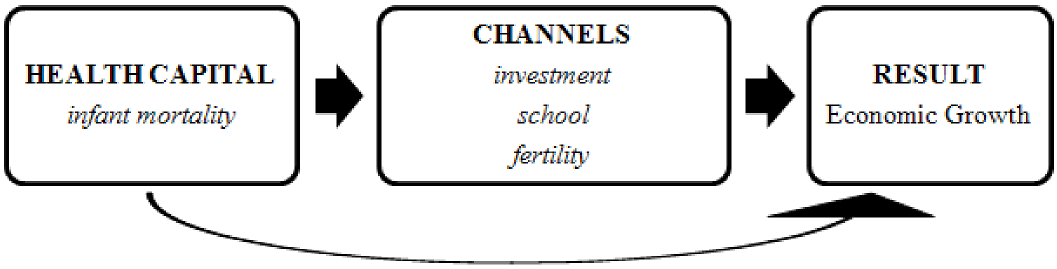
Note: variables in logarithms.

Figure 4 Relationship between health capital (infant mortality) and *fertility* for the Spanish regions in 2002



Note: variables in logarithms.

Figure 5 Structural system



Source: Authors' elaboration based on Lorentzen, McMillan and Wacziarg (2008).

Table 3 Estimates of the growth regression, linear panel Dependent variable: GVApc growth

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
logY-1	-0.020 ** (-2.03)	-0.049 *** (-3.73)	-0.196 *** (-7.47)	-0.052 *** (-3.81)	-0.190 *** (-7.21)	-0.126 *** (-4.42)	-0.129 *** (-4.10)
infant mortality	-0.010 (-1.21)					-0.015 *** (-2.98)	-0.014 *** (-2.56)
investment		0.069 *** (4.49)			0.034 ** (2.16)	0.038 *** (3.61)	0.047 *** (4.20)
school			0.346 *** (7.44)		0.288 *** (5.42)	0.237 *** (4.27)	0.200 *** (3.20)
fertility				-0.077 *** (-4.31)	-0.018 (-0.95)	-0.005 (-0.32)	-0.008 (-0.40)
government						-0.004 (-0.09)	0.034 (0.68)
opennes						0.277 * (1.82)	0.172 (0.93)
logpob						-0.223 *** (-8.05)	-0.198 *** (-4.56)
opennes logpob*						-0.018 * (-1.74)	-0.010 (-0.81)
urbanization							-0.000 (-0.27)
density							-0.000 (-0.71)
Constant	0.074 *** (2.91)	0.253 *** (5.10)	-0.212 *** (-4.70)	0.435 *** (4.84)	0.016 (-0.12)	3.010 *** (9.00)	2.858 *** (5.21)
Hausman	*0.261*	*0.011*	*0.000*	*0.014*	*0.000*	*0.000*	*0.000*
Observations	*459*	*459*	*459*	*459*	*459*	*221*	*197*

Notes: main variables (*infant mortality*, *investment*, *school* and *fertility*) in logarithms. * significant at 10%; ** significant at 5%; *** significant at 1%

Table 4 IV estimates of the channel equations

	investment ***(1)***	***investment*** ***(2)***	***investment*** ***(3)***	***school*** ***(4)***	***school*** ***(5)***	***school*** ***(6)***	***fertility*** ***(7)***	***fertility*** ***(8)***	***fertility*** ***(9)***
infant mortality	-0.287 *** (11.04)	-0.133 *** (3.02)	0.028 (0.10)	-0.351 *** (-33.76)	-0.209 *** (-18.01)	-0.017 (-0.29)	0.331 *** (15.74)	0.257 *** (7.04)	-0.114 (-0.63)
logY$_{-1}$		0.294 *** (4.72)			0.270 *** (16.43)	0.379 *** (6.22)		-0.142 *** (-2.75)	
fertility						0.053 (1.38)			
school			3.941 *** (3.51)						-0.101 (-0.37)
*logY*school*			-0.141 *** (-3.79)						
urbanization			-0.008 * (-1.89)			0.005 *** (4.75)			-0.007 *** (-2.75)
density			0 .001 * (1.84)			0.000 ** (1.94)			0.001 ** (2.77)
Constant	-1.543 *** (-123.78)	-2.292 *** (14.26)	-8.983 *** (-4.42)	2.147 *** (431.29)	1.458 *** (34.37)	0.579 *** (3.49)	2.588 *** (356.08)	3.905 *** (29.68)	2.622 *** (2.96)
Observations	459	459	187	459	459	187	459	459	187

Notes: main variables (*infant mortality*, *investment*, *school* and *fertility*) in logarithms. *t*-statistics in parenthesis; * significant at 10%; ** significant at 5%; *** significant at 1%. Instruments: lagged values of the endogenous variables.

Table 5 System estimates of the infant mortality effects (3SLS)

	Effect of channel on growth	**Effect of infant mortality on channel**	**Effect of infant mortality on growth**
investment effect	0.094 *** (2.51)	-0.228 *** (-4.50)	-0.021 *** (-2.82)
school effect	0.067 *** (2.83)	-0.318 *** (-22.66)	-0.021 *** (-2.82)
fertility effect	-0.073 *** (-2.80)	0.292 *** (10.35)	-0.021 *** (-2.82)
TOTAL EFFECT			-0.063

Notes: main variables (*infant mortality*, *investment*, *school* and *fertility*) in logarithms. *t*-statistics in parenthesis; * significant at 10%; ** significant at 5%; *** significant at 1%. Instruments: lagged values of infant mortality.