The Impact of Investment in Human Capital on Economic Development: An Empirical Exercise Based on Height and Years of Schooling in Spain (1881-1998).

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THE IMPACT OF INVESTMENT IN HUMAN CAPITAL ON ECONOMIC DEVELOPMENT: AN EMPIRICAL EXERCISE BASED ON HEIGHT AND YEARS OF SCHOOLING IN SPAIN (1881-1998).

ABSTRACT

Throughout the 19th century and until the mid-20th century, in terms of long-term investment in human capital and, above all, in education, Spain lagged far behind the international standards and, more specifically, the levels attained by its neighbours in Europe. In 1900, only 55% of the population could read; in 1950, this figure was 93%. This paper provides evidence that these conditions contributed to a pattern of slower economic growth in which the physical strength required for agricultural work, measured here through height, had a larger impact than education on economic growth. It was not until the 1970s, with the arrival of democracy, that the Spanish education system was modernized and the influence of education on economic growth increased.

Keywords: employment structure, human capital, educational offer, economic growth.

JEL Codes: I2, I1, J3, J8, N3

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The Impact Of Investment In Human Capital On Economic Development: An Empirical Exercise Based On Height And Years Of Schooling In Spain (1881-1998)

1. Introduction: The Role Of Human Capital In Economic Growth

Beginning in the 1960s, with the contributions of Becker (1964), Barro (2011), Lucas (2002), and Barro and Sala i Martin (2004), among others, theoretical economics began to grow more sophisticated, incorporating human capital as an endogenous factor of economic growth. Previously, economic theory had only considered exogenous factors (land, labour and physical capital) as factors of production to be used to analyse growth. Human capital's defining feature is its multiplier effect on the productivity of the labour factor. Moreover, when added to physical capital, it removes the restriction of diminishing returns in the absence of technological change and paves the way for sustained long-term growth even when no exogenous technological change has taken place, thereby altering the characteristics of the production function. Therefore, in keeping with recent work by theoretical economists, human capital has emerged as an important factor for explaining economic growth.

Human capital theory became relevant once access first to primary and secondary education and then to universities became widespread and educational institutions became more accessible. As can be seen in Table 1, this did not occur in most European countries until the 20th century. Among the data shown in Table 1, the differences between the literacy rates in northern and southern Europe are especially sharp, with the

countries in the south registering lower ones. This is typical of underdeveloped agricultural economies, in which there is no need to read manuals or instructions to operate machinery. In the absence of educational institutions, people entered the factory production system through the mentoring system and on-the-job training so typical of 19th-century factories, where productivity gains were achieved by dint of daily trial and error.

Table 1: Literacy rates (%) in Europe

	UK	France	Germany	Netherlands	Sweden	Italy	Spain	Russia
1820	53	38	65	67	75	22	20	8
1870	76	69	80	81	80	32	30	15

Source: Pamuk, van Zanden (2011).

Human capital theory, as formulated by Becker (1964), is associated with an investment in present-day training with a view to increasing future income. If the training is general, applicable at any company, the worker pays for the cost. If it is specific, useful only to one company, the training costs are shared by the worker and the employer. According to Becker, the greater the value of the investment and the more specific it is in nature, the greater, in relative terms, the resulting increase in future income will be.

As noted, due to its nature, the importance of human capital theory has changed over time. It was not until, above all, the second and third industrial revolutions that it even made sense to apply it. During the second industrial revolution, characterized by the introduction of electricity and combustion engines, the large size of the companies and the revolution this entailed in their management called for the incorporation of educated middle and senior managers in the pay scale. During the second wave of globalization and the third industrial revolution, the increased efficiency of communications and computing brought world markets closer together. Higher levels of education were required to manage the resulting new business networks, which, in turn, adopted more flexible organization structures. This necessitated the spread of university studies to produce people able to organize and manage industrial production and services in a world in which such things were increasingly complex. In other words, the demand for human capital grew over the course of the 20th century. In contrast, during the first industrial revolution, what mattered most was physical endurance and training to develop manufacturing technologies. Due to the relative abundance of available labour and the few management problems faced by 19th-century factories, they demanded little formal human capital; instead their human capital was mostly informal, the result of on-the-job experience with production.

In what follows, we show that these patterns also hold for the Spanish case. In particular, we provide evidence that the relationship between human capital and economic growth changed from the late XIXth century to recent years, as a result of the transformation of the productive system. While the economy depended primarily on physical conditions in the first years of our sample, in the latest years we observe that education became much more important for explaining economic growth.

1.1. Quality of life and the supply of human capital in 19th-century Spain

To estimate the quality of life in Spain, we used one of the main indicators thereof: height and years of schooling. Height is a good indicator of the satisfactory or unsatisfactory nature of childhood and adolescent nutrition, as well as of whether the work performed by children is harmful to their health. It is likewise a good indicator of workers' physical resilience with regard to performing jobs that, as noted, required considerable stamina. Recently, Martinez-Carrión, Puche-Gil, and Cabañete-Cabezuelos (2013) have shown a negative correlation between child labour and height. By definition, child labour also has a very high opportunity cost in terms of human capital, as children who are working are unable to attend school. Moreover, in the 19th century, children worked in both agricultural and urban industrial contexts from the age of 7 (Reher and Camps, 1991; Camps, 2011; Borrás, 1996). However, the work was undeniably much harder in the "Satanic mills", where the disciplinary standards and material circumstances required people to work non-stop even in the absence of a foreman (Camps, 1995). Such child labour can be considered a health risk affecting physical growth. In fact, together with income, nutrition, and environmental and hygiene conditions, child labour is one of the most decisive factors in determining height. Other related factors are the socioeconomic conditions. Literacy levels are also interrelated with height as well as the ecological and environmental factors (Martínez-Carrión (2012); Martínez Carrión (2012b); Martínez Carrión (1994); Tanner (1994); Moreno-Lázaro and Martínez-Carrión (2010); Martínez-Carrión and Puche-Gil (2009)).

According to the available evidence on the main European and Spanish industrial regions, the average height of workers decreased during the Industrial Revolution (see Martinez-Carrión et al., 2013, p. 7). The Spanish case has been amply addressed by Martinez-Carrión in several papers showing that average heights in the country's industrial regions fell in the 19th century, in contrast with the evolution of GDP per capita. In other words, one could argue, based on height, that over the 19th century, child labour, and the other aforementioned variables affecting height, led to a decline in the quality of life. On the other hand, child labour, which also occurred in agriculture, can explain Spain's high illiteracy rates.

With regard to the educational offer, the enrolment rate was 38.1% in 1860 and 47% in 1900 (Nuñez, 2005), primarily at religious and public schools. It is well known that 19th-century Spain suffered from chronic indebtedness, going so far as to mortgage the

subsoil as collateral for payment of its foreign debts (Nadal, 1975). In fact, the situation was quite similar to that of today's third-world countries, in which foreign debt and the risk premium prevent the public treasury from making productive investments. Consequently, in this period, the education on offer was insufficient and poor quality, as also reflected by the low literacy rates, all of which further contributed to the lag in the Spanish economy. On the other hand the extensive use of child labour both in industrial and agrarian settings had as an opportunity cost the very low levels of education of the population.

1.2. Standards of living and the supply of human capital in the 20th century

The different quality-of-life indicators show a gradual improvement over the course of the 20th century. In fact, mortality and child mortality rates did not begin to fall until the first decade of the 20th century, when a long process of decline began, except for the parenthesis of the Spanish Civil War, and determined the characteristics of the demographic transition in Spain (Nicolau, 2005). This in itself indicates that living conditions, nutrition, environmental factors and hygiene improved over the period. Average heights also began to increase, as seen in the size of military recruits, which rose from 163.8 centimetres in 1900 to 168.6 in 1950 to 175.1 in 1980 (Quiroga Valle, 2002; Nicolau, 2005). Although already visible in the first half of the century, this trend towards increased height grew more pronounced in the second half. Thus, quality of life improved in the 20th century, and the trend was even stronger in the second half. This statement can only be sustained over the long term, as there is abundant proof that real wages and economic growth actually fell during the years of autarky that marked the early Francoist period. However, with that caveat, we can say that the trend towards gains in quality of life is a phenomenon associated with the economic transformations of the 20th century (second and third technological revolutions).

Coupled with the aforementioned increase in quality of life, the educational offer also improved. While the gross stock of years of schooling of the generation born in 1901 was 4.6, it had grown to 7.1 for the generation of 1956, and 13 for the generation of 1980. In comparative terms, the achievements of the second half of the 20th century were not modest, as the ground lost in investment in education to date was regained. However, as seen in the previous sections, Spain began with a considerably smaller endowment of human capital. Even if education levels did not manage to converge, the number of students enrolled at secondary schools and university increased considerably, above all in the 1970s, with the start and consolidation of democracy. Nevertheless, as late as 1979, some 17.7% of the country's population still had no formal education (Nuñez, 2005).

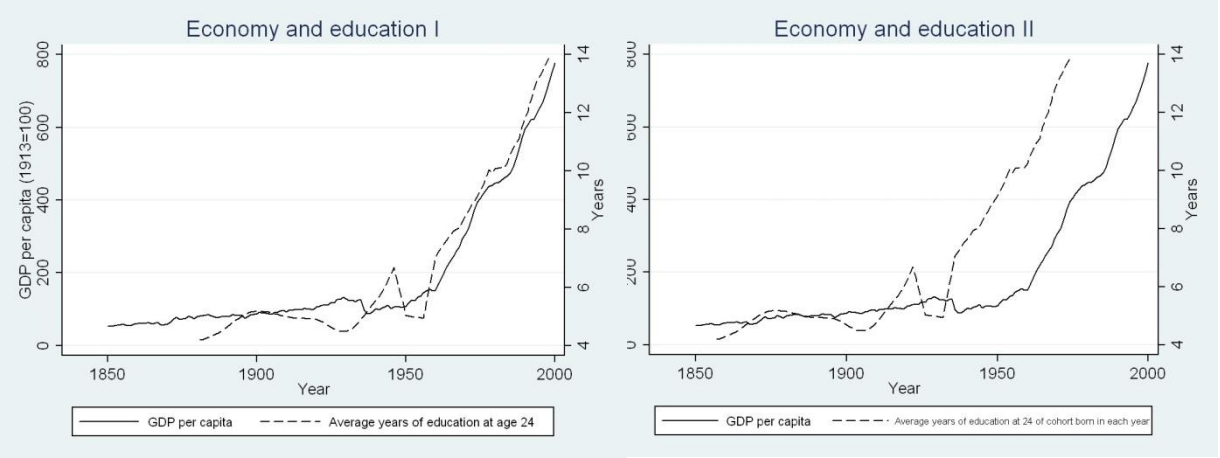
2. Methodology and sources

To study the relationship between the accumulation of human capital and growth in Spain, we used a methodology based on treating these variables as time series. We have used the series of gross stock years of schooling at age 24 by Nuñez (2005) available at Estadísticas Históricas de España edited by Albert Carreras and Xavier Tafunell, the series of GDP per capita at factor costs by Leandro Prados de la Escosura (2003) and the series of height at age 20 by José Miguel Martínez Carrión (2012). The evolution of these series is displayed in Figures 1 and 2.

Conducting econometric exercises with time series to find causal relationships is a notoriously complex task. All of our variables are stationary only in first differences and thus OLS with the variables in levels would lead to misleading and spurious results. However, our results suggest that there is no cointegrating relationship among them either. We have therefore used a regression model in first differences.

On the other hand, and as stated in the introduction education has been treated by the literature as an endogenous variable of economic growth. This could impose limitations to use it as an exogenous variable in our econometric analysis. However, since our education variable refers to the stock of years of schooling at 24 years old, it is unlikely that we encounter reverse causality from GDP growth to change in years of schooling in the same period.

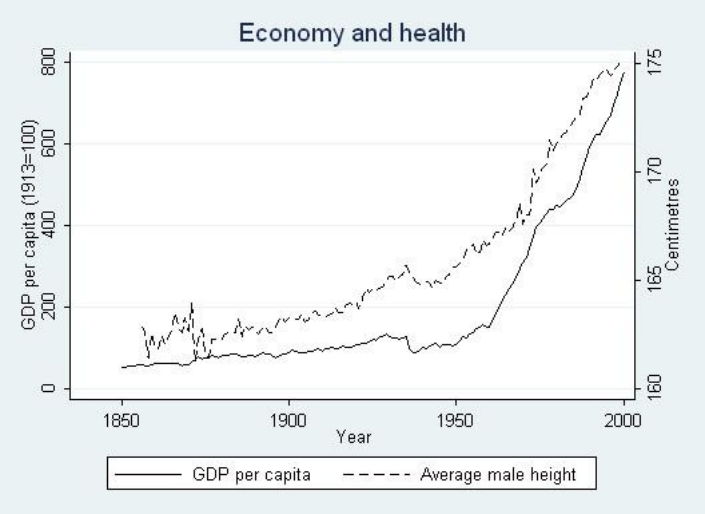
Figure 1: Evolution of GDP per capita and education



(a) GDP p.c. and average stock of years of schooling of the population aged 24 in a given year

(b) GDP p.c. and average stock of years of schooling at age 24 of the cohort born in a given year.

Figure 2: Evolution of GDP per capita and height



To gain a more precise understanding of the evolution of the educational offer and its impact on economic growth, we divided the series into 3 sub-periods: from 1882 to 1929, from 1930 to 1958, and from 1959 to 1998. The first sub-period encompasses the end of the long 19th century, which we extended to 1929, so as not to excessively split up the series. The years between 1930 and 1958 were years of economic crisis, followed by the Civil War and Francoism. They should thus be considered separately due to their distinct defining features, which set them apart, in terms of their evolution, from the other segments in the series. The years from 1959 to 1989 saw the start of strong economic growth in Spain and, from the 1970s onward, the modernization of the education system. Additionally, for the purpose of making international comparisons, we used data from the World Bank and Barro-Lee for the same years, which allowed us to measure the degree of Spain's exceptionality or similarity to other OECD countries.

To further clarify the nature of the data we enclose the summary statistics for the whole sample and the different sub periods we have chosen to develop the analysis in the forthcoming sections (tables 2 to 5).

Table 2 : Summary statistics (1882-1998)

Variable	Mean	Std. Dev.	N
dschooling	0.006	0.042	48
dtalla	0.051	0.262	48

Table 3 : Summary statistics period 1 (1882-1929)

Variable	Mean	Std. Dev.	N
dschooling	0.006	0.042	48
dtalla	0.051	0.262	48

Table 4: Summary statistics period 2 (1930-1958)

Variable	Mean	Std. Dev.	N
dschooling	0.053	0.235	29
dtalla	0.064	0.247	29

Table 5: Summary statistics period 3 (1959-1998)

Variable	Mean	Std. Dev.	N
dschooling	0.196	0.126	40
dtalla	0.201	0.487	40

3. Human capital and economic growth

In order to measure the impact of human capital accumulation on economic growth we first present the results for all the period under study and then we split them in the aforementioned sub periods. Results for the whole sample are presented in table 6.

Table 6: The impact of education and height on GDP per capita growth. Results in first differences (1882-1998)

	Log GDP p.c., FD
Schooling, FD	0.053**
	(0.027)
Height, FD	0.029***
	(0.010)
Observations	117
F	15.418

Newey-West standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The results of table 6 show that changes in both height and schooling have a positive and significant impact on GDP per capita growth. Notice that the value of the coefficient of schooling nearly doubles the value of the coefficient of height. Taking into account the standard deviations we have presented in table 1 of summary statistics and the results of table 6 we can conclude that one standard deviation increase in the year-on-year change in schooling leads to a 0.86% increase in GDP per capita growth in the overall period, and one standard deviation increase in the variation in height leads to a 1.03% increase in GDP per capita growth. Therefore in the study of the long run presented here the result we just mentioned on height is bigger because the value of the standard deviation is also bigger, even if the value of the coefficient of schooling obtained in table 6 nearly doubles that of height. But what we want to stress here on the global results is that according to our data human capital accumulation had a high impact on the long run trend of economic growth even if as we shall see the impact of height was predominant during the early decades and the impact of education was the main component of human capital affecting economic growth in the final period.

3.1. From 1881 to 1929

The regression results on the impact of human capital on GDP per capita growth for the first sub period from 1881 to 1929 are presented in table 7. In the introductory sections of this paper we have already stressed that factors behind growth of schooling and height were poorly developed during this period. Nonetheless we want to stress the results obtained in first differences regression analysis.

Table 7: The impact of education and height on GDP per capita growth. Results in first differences (1882-1929)

	Log GDP p.c., FD
Schooling, FD	-0.133
	(0.121)
Height, FD	0.014
	(0.020)
Observations	48
F	0.880

Newey-West standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

As noted earlier, in Spain's industrial and mining regions, average heights even fell as industrialization became more pronounced. Also as previously noted, in 1900, school enrolment stood at less than 50% (specifically, 47%).

In table 7 we can see that the coefficients for schooling and height are not statistically significant in this period. However, we can stress the negative sign of the coefficient of schooling and the positive sign of the coefficient of height even if it reaches a value of 50% of the value attained for the global period 1881-1998. Taking into account the standard deviations presented in table 3 on the summary statistics we obtain that a standard deviation increase in the variation in schooling leads to -0.56% decrease in GDP per capita growth and a standard deviation increase in the year-on-year change in height leads to 0.37% increase of per capita GDP growth. This negative coefficient can be understandable in the context of the poor quality of the education system of those years. In fact, the negative impact on current education of the educational system in Spain and Spanish former colonies (in contrast with the British) has been recently presented by Horst Feldmann (2016). Before its modernization Spanish education was mainly performed under the principles of the Catholic Church. It had as a main goal the transmission of religious beliefs and little impact on the abilities to read and write of the population. Furthermore girls were excluded from education in catholic schools. As stated by Feldman this kind of education had as a main goal to learn the catechism and excluded other more scientific or historical topics from its contents. This is the main reason why it could even had a negative impact on economic growth.

On the side of height and its positive impact on growth of per capita GDP we must stress that Spain was mainly an agrarian country and that physical strength was needed to work both in the fields and the first factories as presented in the introductory chapters. Nonetheless and during this period the impact of height on economic growth was still very limited.

3.2. From 1930 to 1958

The period from 1930 to 1958 was one of major political upheaval. It began with an international economic crisis, albeit one that had less of an impact on Spain due to the relatively low degree of openness of the Spanish economy. Moreover, although Spain was neutral in both World Wars, it experienced civil war between 1936 and 1939, followed by Francoist autarky and isolation from the competitive forces of the international market. Several authors (Catalan, Sudria, Carreras and Tafunell) have underscored how the lack of competition, the closing off from the international market, the lack of foreign exchange to purchase imports, and administrative pricing distorted the market, leading to a period of economic depression during the 1940s and 1950s. With regard to our model, what is important to note are the distortions in the area of human capital formation and their impact on economic growth. As can be seen in Figure 1, the duration of schooling declined in the years after the Civil War. Democratically minded intellectuals, professors and teachers forged in the

educational institutions of the Spanish Second Republic were forced to emigrate, leading to a considerable loss of human capital. Public resources, including with regard to schools and universities, were allocated to regions that shared the dictator's ideology, which were often also the most depressed. This context of administrative allocation of resources noticeably affected the impact of human capital formation on growth.

Table 8: The impact of education and height on GDP per capita growth. Results in first differences (1930-1958)

	Log GDP p.c., FD
Schooling, FD	-0.001
	(0.053)
Height, FD	0.058
	(0.050)
Observations	29
F	0.674

Newey-West standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Although the coefficients for education and height are again not significant, the sign of the coefficients in Table 8 clearly shows the redistributive effects that took place during the period. The coefficient of the years of schooling variable is negative, while that of the height variable is positive. Taking into account the standard deviations from table 4 on the summary statistics of the period we can conclude that one standard deviation increase in the variation of years of schooling leads to 0.02% decrease in GDP per capita growth and one standard deviation increase in the change in height leads to 1.43% increase in GDP per capita growth.

On the negative sign of the coefficient of years of schooling we want to stress that the human capital resulting from education and formed during the republican years was forced to emigrate or go into exile. The decrease in the duration of the education acquired at the new Francoist schools and the poor quality thereof had a negative effect on the evolution of GDP per capita. The economies of the most prosperous industrial hubs became depressed, and Spain became more rural and less industrialized. Furthermore, teaching became doctrinaire in order to bind the people ideologically with the regime, while liberal content, based on liberal economics and favouring growth, was eliminated from textbooks and school and university teaching. In light of the data shown in Table 8, it seems clear that the transformations in the Francoist education system also help to explain why the period was one of economic

stagnation: education, one of the mainstays of economic growth everywhere, became a force negatively correlated with it.

In contrast, the role of physical strength, measured here through height, was strongly positive, the most positive achieved in the long term throughout the entire period studied, although not statistically different from zero, maybe due to the smaller number of observations for this period. Since the country was deindustrialized, the main economic activities came to focus on the primary sector. In fact, the gains in height over the period were not very noticeable, and that also explains why the final multiplier effect was modest. However, this factor offers a clear glimpse of the new foundations of the Francoist economy. The new planned economy depended on physical strength rather than education for its development. Economic activity shifted to subsistence agriculture and mining, activities for which physical strength is essential. Due to the losses of human capital, export and industrial activities were depressed, all of which helps to explain the sharp decline in economic growth registered during this period.

3.3. From 1959 to 1998

With the beginning of the golden age of capitalism, the Spanish economy rebounded from the strong stagnation of the previous decades. Following the stabilization plans of 1957-1959, the 1960s were marked by growth. Despite the relative lack of export activity, tourism and remittances from emigrants provided the necessary foreign exchange to finance imports. With minor fluctuations, this growth trend lasted throughout the 1970s (which saw the death of the dictator in 1976 and the start of the democratic transition) and 1980s (which saw Spain's entry into the European Economic Community in 1985) even at lower rates of growth than during the 1960s (Prados de la Escosura (2003); Prados de la Escosura, Rosés (2007)). Once the transition to democracy had been made and during the second globalization era, Spain became a more open country, subject to the competitive forces of the global international market.

In this context of economic and political modernization, the impact of the forces that define human capital was also affected. Table 9 shows how the impact of years of schooling on economic growth reached its highest positive value of all the period since 1881 and the result is statistically significant. On the other hand and for the first time the coefficient obtained for education is much higher than that obtained for height. The magnitude of the investment in human capital increased (see Figure 1) and, with it, the income and yields resulting from it. Moreover, in this period, the education system was once more transformed, and new universities were founded. In fact, based on the number of university enrolments (Nuñez, 2005), it was not until these decades that higher education became widespread. Furthermore, although average height also grew as a result of the leaps and bounds made by the healthcare system and improved nutrition, it came to play a secondary role in economic growth.

Table 9: The impact of education and height on GDP per capita growth. Results in first differences (1959-1998)

	Log GDP p.c.,FD
Schooling, FD	0.108***
	(0.038)
Height, FD	0.021*
	(0.011)
Observations	40
F	16.035

Newey-West standard errors in parentheses

* p < 0.10, ** p < 0.05, *** p < 0.01

Taking into account the standard deviations presented in table 5 on the summary statistics of this period we can conclude that a one standard deviation increase in the variation of years of schooling leads to 1.36% increase of GDP per capita growth and a one standard deviation increase in the change in height leads to 1.02% increase in GDP per capita growth. The new economy was no longer associated with primary sector activities requiring physical strength but rather had become oriented towards services and, to a lesser extent, industrial activities. As noted in the introduction, with these activities, education plays a vital role. Therefore, as can be seen in Table 9, during the second era of globalization, education became the engine of growth. In fact, the size of the estimate for education in this period is much larger than that obtained for the whole sample 1882-1998. Education stimulated the creation of new economic activities that enabled Spain's integration in Europe and the world and served as an additional spur to economic growth.

In order to enable a comparative analysis of the impact that education had on growth in Spain with its impact in other OECD countries during the same period, Table 10 shows the international results. In this case, data on height were not available. We thus used the evolution of life expectancy to measure the degree of health.

Table 10: The impact of education and life expectancy on GDP per capita in OECD countries. Panel data (1960-2000)

	Log GDP p.c.
Years of education	0.115***
	(1.268)
Life expectancy	0.054***
	(0.350)
Constant	-457.416***
	(16.550)
Observations	679
R-squared	0.7767

Sources: Barro-Lee and the World Bank

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Although the results are not strictly comparable, a comparison of the dynamics suggested by Tables 9 and 10 shows the high degree of similarity between Spain and the other OECD countries in these recent years. In the period from 1960 to 2000, in OECD countries, each additional year of schooling was associated with an 11.5% increase in GDP per capita and a one-year increase in life expectancy entailed a 5.4% increase in GDP per capita. In Spain, as we have seen, a one year increase in the variation in years of schooling is associated with a 10.8% in GDP per capita growth, and a one centimetre increase in the change of average height is related to a 2.1% increase in GDP per capita growth. Although the data on height and life expectancies are not strictly comparable either, they are both good indicators of the degree of health resulting from childhood and adolescent nutrition and medical care. The quantitative and qualitative changes of the period were quite noticeable and paved the way for economic growth. Growth was also higher because the magnitude of the investment in human capital was quite high from a historical perspective. Furthermore, the considerable similarity between the results seen in Tables 9 and 10 is a good indicator of the high degree of economic integration achieved by Spain in relation to the other OECD countries. Thus, during this period, the Spanish economy came to depend on economic activities involving levels of investment in human capital similar to those registered in other developed economies.

4. Conclusions

In the preceding pages, we have shown that the Spanish economy was not modernized until the decades ranging from 1960 to 2000, when investments in education increased and had a high impact on economic growth. This period

coincides with the second wave of globalization, and the similarity of the results for Spain and those of the other OECD countries is proof of the high degree of economic integration achieved.

However, we also saw that this has not always been the case. In the long term, in the period from 1881 to 1958, we saw how education levels in Spain were always considerably lower than in neighbouring European countries. Because Spain had an agrarian economy, physical strength, measured here through height, had a greater impact on economic growth than education levels did. We even saw how the education provided in the early years of Francoism may have effected growth negatively. All these factors are characteristic of an underdeveloped economy in which the values arising from education and the Enlightenment did not take root in society until well into the 20th century, thereby contributing to Spain's relative lag with regard to other European countries.

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