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Leandro Prados de la Escosura and Joan R. Rosés

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Keywords: Human Capital; Growth; Labor Productivity, Total Factor Productivity; Spain.

JEL Classification: E24, J24, O47, N33, N34

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*Human Capital and Economic Growth in Spain, 1850-2000**

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Human Capital and Economic Growth in Spain, 1850-2000

1. Introduction

The role of human capital in the growth process has been extensively analyzed since Adam Smith and Alfred Marshall, and has interested both theoretical economists and economic historians. However, it was not until the mid-20th century that Becker (1964), Schultz (1958), and Mincer (1963) developed a complete theory of human capital, according to which the individual level of education and experience determines future labor income. The United Nations (1997) defines human capital as “productive wealth embodied in labor, skills and knowledge”. This broad definition does not restrict human capital to education but encompasses all investments in humans which are made to improve their skills, including schooling and parental education, on-the-job training and learning-by-doing (i.e., acquiring skills through work experience) or any other activities that improves the productive use of a person’s skills.

The measurement of human capital is even more elusive than its definition. Many authors have employed formal education measures, such as enrolment rates or the level of educational attainment, while others resorted to more indirect proxies like literacy or numeracy as a way to identifying human capital. However, none of these measures fulfill with the definition of human capital since they ignore informal education, vocational training, workers’ experience, and on-the-job training. Furthermore, these partial measures do not consider the economic value (benefit) of human capital, the potential differences in rates of return between different types of education, and the acquisition of human capital for individual consumption and not for production. The fact is that a “sound” measure of human capital should be not only comprehensive but also consistent with theoretical underpinnings. How to measure human capital will be the first question to be addressed in this paper.

The second question we will consider, the contribution of human capital to economic growth, has attracted a considerable attention from the literature. There is a certain consensus among economists

and economic historians about the important role of human capital in long run growth and its contribution to convergence and catching-up (Abramovitz (1986). Schultz (1963) argued that a large share of economic growth comes from further additions to the initial stock of human capital and that human capital accumulation was largely responsible for the “residual” in early growth accounting exercises. Denison (1962) and Griliches and Jorgenson (1967) examined empirically this hypothesis and concluded that changes in the quality of the workforce did not account for all total factor productivity (TFP) increases. With the emergence of ‘new growth theory’ in the 1980s and 1990s and, in particular, with the important contribution by Lucas (1988), the relationship between human capital and growth became even more central for those interested in the causes of growth. Again, new empirical studies, in this case based on cross-country regressions, have served to qualify initial theoretical arguments. Benhabib and Spiegel (1994) and Krueger and Lindahl (2001) pointed out that it is the level of educational attainment rather than its increase what matters for growth. More recently, Cohen and Soto (2007) have argued, instead, that growth in schooling rates have statistically significant influence (albeit relatively modest) on GDP growth rates. Among economic historians, Sandberg (1979) attributed the successful development of the Swedish economy during the 19th century to its comparatively higher literacy levels.¹ In a similar vein, several studies related successful and unsuccessful development stories during the 19th century to the presence or absence of certain education levels.²

The contribution of this article is twofold. On the one hand, we provide two alternative measures of human capital for Spain from 1850 to 2000: the first, based on the concept of education,

¹ A more recent assessment of the Swedish case is provided by Ljungberg and Nilsson (2009).

² In sharp contrast, another stream of literature stresses the limited contribution of human capital to growth during the Industrial Revolution (see, the review by Mitch 2004). A revisionist view emerged late in the 1990s claimed on the basis of microeconomic evidence that the industrial workforce was skilled despite its low levels of formal education (Rosés 1998; Bessen 2003; Boot 1995). Industrial labor acquired skills in different ways (for example, children and young people got practical know how and experience working in the factories). However, these studies also showed that the level of human capital eased the adoption of new technologies, but its accumulation did not contribute significantly to increasing GDP growth rates.

while the second, on the concept of ‘labor quality’. Then, we will review the advantages and shortcomings of each measure and discuss whether they are compatible. On the other hand, we present new empirical evidence on human capital accumulation and explore its contribution to economic growth using a growth accounting framework.³ Spain’s experience is particularly relevant for the debate because while poor and ignorant during the 19th Century she had joined the club of rich countries by the late 20th century. Over the last century and a half Spain experienced a sustained expansion of GDP per head at an average rate of 1.9 percent per year, while GDP per hour worked did it at 2.1 percent. We conclude that while long-run trends in human capital are similar using any of the two measures, the direct, skill premium approach favored by Jorgenson (1990) fits better the historical experience of Spain as observed over shorter periods. Human capital provided a positive albeit small contribution to labor productivity growth and it could be suggested that human capital accumulation probably had a level effect on GDP facilitating technological innovation. On the whole, broad (physical and human) capital accumulation appears complementary of TFP growth.

[FIGURE 1]

[TABLE 1]

2. The “Mincerian” approach to Human Capital

Human capital is usually approximated through education measures.⁴ For this reason, we have made estimates of human capital on the basis of educational attainment. More specifically, we

³ Thus, we will decompose growth rates into the contribution of production factors in terms of quantity and efficiency. This framework does not include a particular growth theory since it only provides a descriptive procedure and it is, therefore, compatible with the alternative specifications of different growth models (Barro 1999 and Collins and Bosworth 1996). In this paper, we make a historical adaptation of Domar (1961) and Griliches and Jorgenson (1967) approach to measure factor inputs in terms of quality.

⁴ For Spain, see Núñez (2005); Mas et al. (2005); and Doménech and de la Fuente (2006).

have computed up to three different human capital measures using data on age structure (as a measure of experience) and years of education attained.⁵

We have calibrated the first human capital measure (HC_{Mincer}) with the parameters from a Mincer equation for Spain in the early 1990s (Table 2, Col. 1).⁶ Specifically, the equation considered is the following:

$$(1) \text{Ln}(HC)_{\text{Mincer}} = 5.2982 + 0.0823 * \text{schooling} + 0.039 * \text{experience} - 0.0005 * \text{experience}^2$$

In which schooling is the average years of formal education received by the Spanish population aged 15 to 50; and experience is the average age of Spanish population ages 15 to 64.⁷ The exponential of this number generates an index number. Education attainment is based on Núñez (2005) estimates of the years of schooling received for population ages 15 to 50 for the period 1897-1974, projected backwards to 1877 with Núñez's own estimates for years of education of population ages 15-40 (1887-97) and 15-30 (1877-87), and, again, to 1850 with years of primary education acquired at the age of 15.⁸ For the post-1974 period, we have relied on Cohen and Soto's (2007) benchmark estimates of years of education interpolated log-linearly to obtain a yearly series and spliced with Núñez's figures.⁹

⁵ These procedures supersede more simple accounts of education such as literacy or enrolment rates, or the average years of education, given that consider experience.

⁶ Arrazola et al. (2003: 297). The estimate was carried out with data for 1993/4.

⁷ We gratefully acknowledge David Reher who provided us with his unpublished yearly estimates of age composition of Spanish population between 1858 and 1970. We used INI official figures from 1970 onwards, and assumed that 1858 age composition was representative for that of 1850-57.

⁸ Núñez (2005: 167, 239-40).

⁹ The data used from Cohen and Soto (2007) refer to 'years of schooling of population 15-64 who is not studying'. It is worth noting the high coincidence between figures by Núñez (2005) and Cohen and Soto (2007) during the years in which their estimates overlap (1960-74).

We have also carried out additional estimates of human capital following the procedures of Bosworth and Collins (2003). Specifically, we obtained alternative human capital measures by relating educational attainment (HC_{BC}) to average years of schooling (schooling). Thus,

$$(2) (HC)_{BC} = (1+r)^{schooling},$$

with r being the rate of return (Bosworth and Collins, 2003: 119-120). We assumed alternatively 9 and 7.2 percent rates-of-return to each year.¹⁰ The results of these three alternative estimates, presented in Table 2 and Figure 2 below, are highly coincidental.

[FIGURE 2]

[TABLE 2]

The growth rates of education-based measure of human capital are extremely low during the first one-hundred years. If we consider results in more detail (panel B), one could observe that, in comparison with the previous seventy years, human capital accumulation rates even decreased from 1921 to 1952. From these results, it is easy to infer that the ‘high school movement’ arrived relatively later to Spain and investment in education was extremely limited over this period.¹¹ Furthermore, the Civil War, and particularly the initial phases of Franco’s Dictatorship had a negative impact over the levels of primary education (Núñez, 1992). Since the 1960s, however, education accelerated significantly and growth rates were 4.5 times higher than in the precedent century. At this point, the different methods provide a slightly discordant view of human capital performance during the second

¹⁰ The 9 percent return has been obtained by Alba and San Segundo (1995: 162), after controlling for self-selection. The 7.2 percent return is quoted in Psacharopoulos and Patrinos (2004: 127), and derives from Mora (1999).

¹¹ See Goldin (1998) on the importance for the United States of this transformation.

half of the 20th century (differences in overall growth rates are minor): the Bosworth-Collins estimates exhibit growth acceleration while in the Mincerian approach growth rates were stable.¹²

3. The “Labor Quality” approach to Human Capital

Measures of human capital obtained on the basis of education data present important shortcomings as they do not consider the different ways in which people enhance their capabilities.¹³ Therefore, to evaluate the contribution of human capital during the past one-and-a-half century, a measure that captures the effects of both schooling and training is necessary.

An alternative approach suggested by the growth accounting literature provides a solution by computing the quality of the labor force; that is, the set of skills employed during production (hereafter, we will call this method the ‘Jorgenson approach’).¹⁴ There are two basic ideas behind this: (1) the quality of the labor force is enhanced by past investments in human capital, (2) differentials in individuals' earnings are the consequence of these same investments. The rationale is that the income employed in enhancing human capacities raises the worker's earnings because it increases productivity per worker.¹⁵

In the ‘Jorgenson approach’ the appropriate measure of labor input is the flow of services for production emanating from this factor.¹⁶ Algebraically, the equation is:

¹² For this period, our estimates for Mincerian equation are practically identical to those computed directly by Alba and San Segundo (1995).

¹³ In addition, they are not consistent from the production-side of the economy. For this reason they are not valid for productivity analyses.

¹⁴ See, for example, Jorgenson (1990), and Young (1995).

¹⁵ This argument is widely debated. Some authors maintain that earnings differentials are due to institutional constraints. As a result, human capital accumulation could not be measured by computing individual earnings as there would be no persuasive evidence of a direct relationship between age, experience, skill and productivity.

¹⁶ It is usually assumed that such a flow is proportional to the hours of work involved. That is,

$$(3) \quad L_t = \lambda_{L_t} H_t,$$

Where L is labor input, λ_{L_t} is a constant, and H is the measured work hours.

$$(4) \quad \ln L_t - \ln L_{t-1} = \sum_i [\bar{\Theta}_{L_i} (\ln Li_t - \ln Li_{t-1})]$$

where share values are computed as:

$$(5) \quad \bar{\Theta}_{L_i} = 1/2[\theta_{L_i}(t) + \theta_{L_i}(t-1)], \quad (i = 1, \dots, n).$$

L is Labor; i index different labor attributes and Θ the average share of each component in the total outlay for the two periods. Hence, our task is to estimate the labor force cross-classified by as many attributes as possible to capture its heterogeneity.¹⁷ Unfortunately, in the case of Spain, census and survey data for distant periods contain limited information and we can only offer a simplified version of labor input accounts. Thus, we have employed two different procedures. For 1850-1954, Spanish working population has been cross-classified by gender, two different age attributes (adult, child), branch of activity, income, and hours of work but we have been unable to match the income received by each worker with her/his age and level of education.

The first step in the construction of labor input series was to elaborate yearly employment figures for the four main sectors (agriculture, forestry, and fishing, industry construction, and services) on the basis of population censuses. Major shortcomings are posed by Spanish census data: working population is only available at benchmark years and refers to the economically active population [EAP, thereafter], with no regard of involuntary unemployment, while female EAP in agriculture is inconsistent over time. Therefore, we had been forced to make some tough choices. For example, in order to derive consistent figures over time for EAP in agriculture, we excluded the census figures for female population,¹⁸ while assumed that female labor represented a stable proportion of male

¹⁷ Ideally, one should estimate the working population classified by gender, age, education, sector of economic activity, income (wages), hours of work, and type of worker (i.e., employee, self-employed, and so on).

¹⁸ Female labor was not included in agricultural EAP in the 1797 and 1860 population censuses and represented a small and declining proportion of male labor, thereafter. Thus, female/male ratios in agricultural EAP were, according to population censuses around 0.2 over 1877-1900 and ranged between 0.05 and 0.1 during the early 20th century. The exclusion of females working in agriculture from the total working

labor force in agriculture and, thus, we increased the number of days assigned to each male worker (see below).¹⁹ Moreover, as the share of EAP in agriculture is suspiciously stable over 1797-1910, in spite of increasing industrialization and urbanization, we adjusted it by assuming that the share of EAP in agriculture moved along the proportion of rural population (living in villages with less than 5,000 inhabitants) in total population.²⁰ The next step was to obtain yearly EAP figures through log-linear interpolation of benchmark observations. Employment figures for each major sector of economic activity were, then, derived by adjusting yearly EAP series for the economic cycle (obtained as deviations from the Hodrick-Prescott trend in output). Later, employment figures by sector were corrected to preserve additive congruence with the cycle-adjusted figures for total employment.

Employment in these four large sectors was, then, distributed into their branches. Up to 1955 population censuses allowed us to cross classify working population into 19 industries up to 1900, 21 industries for 1900-10, 22 for 1911-50, and 24, thereafter.²¹ Alas, lack of data for 1850-1900 forced us to breakdown manufacturing employment into its branches by assuming that its distribution in 1900 was representative for the entire period.²²

population is usual in Spanish historical literature. See Nicolau (2005); Erdozain and Mikelarena (1999); and Pérez Moreda (1999: 55).

¹⁹ A similar strategy was followed by Carré *et al.* (1975: 89).

²⁰ We follow here Prados de la Escosura (2003: 207-8), and adjusted downwards the percentage of EAP employed in agriculture between 1887 and 1920 redistributing the ‘excess’ agricultural workers proportionally between industry and services.

²¹ Population censuses are available in Spain for 1860, 1877, 1887, 1900, 1910, 1920, 1930, 1940, and 1950.

²² We have been unable to carry out a sensitivity test for the consequences of such an arbitrary assumption. However, since agriculture and services provided most of the employment prior to 1900 (above 80 percent) the bias introduced by our assumption should not be very large. The fact that the number of hours worked across manufacturing industries did not change significantly during the late 19th century also works to reduce the size of the bias. Employment data on mining and construction is drawn from Chastagnaret (2000) and Prados de la Escosura (2003), respectively.

Second, the data on employment (number of workers) was converted into days and, then, hours worked per year, for the period 1850-1954. We assumed that each full-time worker was employed 270 days per annum in industry and services. Such figure results from deducting Sundays and religious holidays plus an allowance for illness.²³ This assumption is consistent with contemporary testimonies and supported by the available evidence.²⁴ In agriculture, however, contemporary and historians' estimates point to a lower figure for the working days per occupied.²⁵ Throughout most of the nineteenth and early twentieth century, full employment among peasants only occurred during the summer period and, consequently, workers were idle for up to four months every year.²⁶ Moreover, as the opportunity cost of allocating agricultural labor to alternative occupations during the slack season was minimal, peasants carried out additional non-agricultural activities, such as producing their own implements, clothing and, especially, providing services such

²³ Interestingly enough a similar number of days is obtained for the 1960s and early 1970s. For example, for 1973, the Conference Board, on the basis of OECD data, estimated 2,005 hours worked per person in Spain, while ILO reckoned that, on average, Spanish workers spent 44.2 hours per week at their place of work. This means that, on average, Spaniards worked 272 days per year.

²⁴ Soto Carmona (1989: 608) pointed out that, on average, the number of days worked per occupied up to 1919 ranged between 240 and 270.

²⁵ Day laborers, according to García Sanz (1979-80: 63) worked an average of 242 days per year in mid-nineteenth century Spain. Gómez Mendoza (1982: 101) emphasized the seasonal nature of late nineteenth century employment and estimated that, on average, a farm laborer worked 210 days out of 275-300 working days per year. Vandellós (1925) reckoned that, in 1914, the average number of days worked per year in agriculture was 250. Simpson (1992) estimated labor requirements in Andalusia's agriculture between 1886 and 1930 and obtained even lower figures, ranging from 108 to 130 days.

²⁶ Using Simpson's (1992) labor requirements per hectare for each type of crop, we have computed, under the astringent assumption of constant technology, the number of full days of work required by Spanish agriculture at different agricultural benchmarks (1891/95, 1897/1901, 1909/13, 1920, 1929/33, 1950, and 1958) and divided the resulting figures by the male EAP in agriculture. They range from 129 (1891/95) to 178 days (1929/33) per male worker. Simpson considers his estimates to be on the low side. In fact, even if we arbitrarily raise them by 25 percent, the number of days worked would range from 172 (1891/95) to 238 days (1929/33).

as transportation and storing.²⁷ However, Spanish population censuses tend to include only information about people's main occupation, and given 'pluriactivity' in agricultural EAP, non-agricultural occupations performed by peasants tend to be underestimated. At the same time, the inconsistency of population census numbers for female labor in agriculture led us to exclude these figures (see above) but, at the same time, required an allowance for female EAP in agricultural activities. Thus, we assumed that female labor represented a stable proportion of male labor force in this sector and, hence, the number of days assigned to each male worker was raised to 270 days per year per occupied in the countryside, distributed between agriculture (240 days) and services (30 days).

As regards the numbers of yearly hours worked per occupied we observed that there was not only a long-run decline over 1850-1954, but also a large variance across sectors. For mid-nineteenth century agriculture, Caballero (1864) pointed to 10 hours per day while a similar average figure, 9.7 hours, was found for the mid 1950s.²⁸ We decided to accept 10 hours per day for 1850-1911 and to interpolate these two figures exponentially over 1912-35, while we maintained 9.7 hours for the period 1936-54. For industry and services, Huberman (2005)'s figures for 1870-1899 were accepted and exponentially interpolated to derive annual hours worked, while the number of hours worked in 1870 was accepted for 1850-69. Domenech (2007)'s estimates for different industries and services in 1910 were adopted for 1900-1910, while Silvestre (2003)'s annual computations for industry were used over 1911-1919. Soto Carmona (1989: 596-613) provides some construction and services figures for the Interwar years. The next period for which we had quantitative evidence on hours worked was the early 1950s. We found that the number of hours per worker was often close to that of 1919, a far from surprising fact as qualitative evidence suggests that the number of hours per worker

²⁷ Pérez Moreda (1999: 57) mentions a contemporary estimate for 1960 that puts disguised unemployment at 1.8 million in a potential agricultural workforce of over 5 million.

²⁸ The figure for the 1950s was obtained dividing yearly hours, which was provided by Teresa Sanchis (private communication), by the amount of yearly working days.

probably declined during the 1920s and early 1930s in a context of trade unions' rising bargaining power, but remained unchanged or even grew during the early General Franco's Dictatorship. So we chose to accept the number of working hours per occupied in 1954 for the years 1936-53, and to interpolate exponentially the figures for 1919 and 1936.

For the post-1954 period, labor force data comes from the MOISSES base for the period 1954-1963,²⁹ from *Encuesta de Población Activa* (thereafter EPA) for 1964-1980,³⁰ and from the official national accounts for 1980-2000.³¹ The distribution of overall labor force across the different industries was based on *Banco de Bilbao's* studies.³² We, then, distributed workers for each industry into four occupational categories (unskilled and skilled operatives, technicians, and managers) with information provided by *Instituto Nacional de Estadística* (INE). Finally, we converted the amount of workers into hours worked for each occupation and branch of economic activity by assuming that, in a given sector, all employees worked the same amount of hours per year.³³

The amount of labor, measured by total hours worked, presents a moderate increase over the long run. Labor force grew moderately up to World War I while accelerated during the 1920s and early 1930s partly as a result of population growth and rural-urban migration. Labor quantity rose again during the Golden Age (1951-74). The 'transition to democracy' decade (1975-86) witnessed a dramatic employment destruction driven by the oil shocks and the exposition of traditionally sheltered industrial sectors to international competition. Labor market deregulation, a marked

²⁹ Antonio Díaz Ballesteros kindly provided us with this data.

³⁰ Reconstructed in Baiges *et al.*(1987).

³¹ The different time segments were spliced using the gap distribution procedure for those years in which the different estimates overlap, as employed in Prados de la Escosura (2003). Official national accounts, CNE80, CNE85, CNE95, and CNE2000 have been used for 1980-85, 1985-95 and 1995-2000, respectively.

³² These are collected in Fundación BBV (1999).

³³ Sanchis (private communication), furnished us with data on hours per economically active population for the 1950s. We used Maluquer de Motes and Llonch (2005), who rely on ILO data, for 1958-63; Ministerio de Trabajo (1964-78) for the period 1964-1978; and OECD (2006) from 1979 onwards.

increase in female participation rate, and the arrival of immigrants -only in the last decade of the 20th century-, are beneath the rise in employment since 1987.

[TABLE 3]

A closer look at the evolution of the labor quantity can be obtained by breaking down the amount of hours worked into its components using the identity in which total hours worked, (H), equals hours per employee, (H/E), times the rate of employment, that is, the employee, E , to EAP, L , ratio (E/L), times the participation rate (that is, the ratio of EAP, L , to the population in working age, that is, 15 to 64 years old, WAN), (L/WAN), times the share of working age population in total population, (WAN/N), times total population (N):

$$(6) \quad H = (H/E) * (E/L) * (L/WAN) * (WAN/N) * N$$

That in rates of change (lower case letters), can be expressed as:

$$(7) \quad h = (h/e) + (e/l) + (l/wan) + (wan/n) + n$$

Population growth and the decline in working hours per employee explain, in a proportion of two-to-one, most of the moderate increase in the labor quantity over the long run (Table 2). Hours per worker and per year shrank from 2,800 at mid-nineteenth century to 1,800 by the end of the 20th century.³⁴

Throughout the hundred and fifty years of modern economic growth considered here, the rise of the quantity of labor measure in the total amount of hours worked was mainly determined by population growth. However, a closer look reveals how other factors at work conditioned its evolution across different long swings. For example, the declining hours per worker/year over 1914-36, a result of the gradual adoption of the eight hours per day standard associated to increasing

³⁴ The decline in the number of daily hours worked per occupied led Denison (1962), to introduce the caveat that the effort per hour was inversely related to the number of hours worked. This reasoning leads to make employment rather than hours worked the relevant indicator of the quantity of labor in growth accounting (Gordon, 1999: 124). However, here we follow the conventional approach and use total hours worked as a measure of the labor quantity.

urbanization and structural change. In the 1920s, falling hours per worker went hand-in-hand with a significant increase in the employment rate, also linked to structural transformation. Between the early 1930s and 1950s, the rising share of the working age population, a gift from the demographic transition, made up for the contraction in participation (L/WAN) and employment (E/L) rates. In the Golden Age, the participation rate fell short of offsetting the rise in the dependency rate and the significant fall in annual hours worked per employed person, with the consequence of a deceleration in the growth of the total hours worked. Later, during the ‘transition to democracy’ years (1975-86), the fall in the participation rate, the dramatic surge in unemployment, and the intensified decline in yearly hours per occupied, that resulted from employment restructuring and the trade unions’ increased bargaining power provoked a dramatic contraction in the quantity of labor. Since Spain’s entry into the European Union (1986), the brisk recovery in the participation and employment rates help explain the increase in the total hours worked.

The third phase in the construction of the labor input was to weight each category of workers by its average nominal earnings.³⁵ The quality and availability of wage data necessary to construct these estimates vary enormously through time and, due to data availability, four periods have been considered, 1850-1908, 1908-1920, 1920-1954, and 1954-2000. We have drawn on a wide variety of sources to obtain wage data for 1850-1908.³⁶ From 1908 to 1920, we employed in our calculations the detailed

³⁵ In the case of self-employed workers, we have assumed, following the principle of opportunity cost, that their labor cost was equal to those of the average worker in their industry (Prados de la Escosura and Rosés, 2003).

³⁶ Agricultural wages were taken from Bringas (2000). Wages in construction (Madrid unskilled wages) and services were obtained from Reher and Ballesteros (1993), although they have been re-scaled to the national levels provided by Rosés and Sánchez-Alonso (2004). Chastagneret (2000) and Escudero (1998), provided wages for mining. Levels of manufacturing wages in all industry and services sectors at different dates (1850, 1880, 1905) were obtained, respectively, from Cerdá (1867) U.S. Department of Labor (1990), and *Anuario Estadístico de Barcelona*. Annual variations between benchmarks were derived by means of Fisher indices with data drawn from Camps (1995); Llonch (2004); and Soler (1997), in the case of consumer industries, and Escudero (1998); and Pérez Castroviejo (1992) in the remaining industries.

wage enquires conducted by the *Instituto de Reformas Sociales*.³⁷ Their reports (*Memorias Generales de la Inspección de Trabajo*) contained information by gender on minimum, maximum and average wages for twenty branches of industry.³⁸ The quality of wage data decreases dramatically over the years 1920-1954.³⁹ In 1920, *Instituto de Reformas Sociales* disappeared, being replaced by the *Ministerio de Trabajo*, and such a change implied that wage data collection was interrupted. Subsequently, wages for only nine occupations and fifty Spanish provinces were published in the *Anuario Estadístico de España* (hereafter *AEE*) that was extended up to fifteen occupations by 1925. Nonetheless, a detailed survey on industry wages for 1914, 1920, 1925 and 1930 was published in 1931 (Ministerio de Trabajo 1931). By combining the wage levels from the *Ministerio de Trabajo*'s survey for 1930 and wage variation rates from *AEE*, we constructed our nominal wage series, classified by industry, for the period 1920-1936. Difficulties to obtain wage data increased since the Civil War. During the early years of General Franco's Dictatorship –the so called Autarchy period–, wages and earnings were severely regulated and included in-kind and extra-payments not comprised in the wage data from earlier publications. Moreover, the only published information was collected at *AEE*.⁴⁰ We, then, spliced wage levels for 1930 and 1955 with a Fisher index of wage yearly variations constructed from the *AEE* data to obtain yearly wage series. From 1954 onwards, we employed labor costs by sectors of economic activity from *Banco de Bilbao*.⁴¹ These do not provide, however, a breakdown by occupational categories that had to be obtained,

³⁷ Javier Silvestre has kindly given us access to his wage database.

³⁸ Unfortunately, the source does not provide information on wages in agriculture and services so we had to rely on data from Bringas (2000); and Reher and Ballesteros (1993), respectively.

³⁹ Vilar (2004), for a review on the wage sources for this period.

⁴⁰ Recently, Vilar (2004) collected new data from unpublished local sources that we have employed in our calculations.

⁴¹ Collected in Fundación BBV (1999) and Alcaide and Alcaide (2001).

then, from the official enquiries on wage, labor costs, and wage structure⁴² and which were later re-scaled to match aggregate figures in *Banco de Bilbao*'s statistics.

[FIGURE 3]

Figure 3 reports the evolution of labor input and labor quantity (unweighted hours worked) from 1850 to 2000. Although the evolution of labor input parallels that of labor quantity, a faster growth is observed in the labor input resulting from shifts in labor composition (“quality”) -derived as the ratio between the labor input and the labor quantity- that, in so far it captures improvements in workers’ skills, provides a measure of human capital. Three acceleration phases stand out in the evolution of the labor input: the 1920s, the Golden Age, and 1986-2000 (Table 4, Col. III). Labor quality improvements contributed significantly to labor input growth in the Interwar and the Golden Age, while represented an offsetting force when labor destruction took place during the ‘transition to democracy’ years (1975-86) (Table 4, Col. II). Interestingly, labor quality hardly seems to have made a contribution to the growth of labor input following Spain’s accession to the European Union in 1986 (Figure 3).

4. Comparing Alternative Approaches

If we now compare our labor quality estimates obtained through Jorgenson and Mincer approaches (Table 4, Cols. II and IV, respectively) their results largely concur, except for the 1920s, when educational attainment figures show no improvement, and the 1987-2000 period, when the labor quality obtained through the Mincer approach shows a gain of 0.9 percent growth, against the 0.2 percent obtained with the Jorgenson approach. In the case of the 1920s, our view is that the Jorgenson labor quality estimates seem to be more consistent with the evidence on growth and

⁴² Ministerio de Trabajo (1964-78), *Salarios, Encuesta de Salarios y de Coste Laboral*, and *Encuesta de Estructura Salarial*.

structural change than those suggesting negligible growth derived from the educational attainment approach.

[TABLE 4]

[FIGURE 4]

We have made an attempt to solve the conundrum for the post-1986 period by carrying out a sensitivity test for the period 1964-2000, when better data are available. Thus, we have computed a new labor quality index in which the occupational categories of our Jorgenson index were replaced by educational categories and workers and, then, weighted by the average remuneration of their education level in their respective industries. Thus, we, firstly, we substituted five educational categories (illiterate, primary schooling, secondary schooling, previous to tertiary, tertiary) from Mas et al. (2005) study on human capital for our occupational categories. Then, we employed the parameters from Alba and San Segundo's (1995: 159) Mincerian regression for 1990 to weight each category by its relative value (wage) while maintaining the congruence with the total remuneration of the industry.⁴³ Hence, the relative remuneration of different educational categories is identical within all industries but average wages differed across industries. The new Mincerian labor quality estimates cast annual growth rates of 1.0 and 0.8 percent for 1975-86 and 1987-2000, respectively. These results match quite well those previously derived with the educational attainment approach to human capital confirming the discrepancy regarding labor quality growth over 1987-2000 between our direct Jorgenson-type estimate and that derived from the Mincerian approach. Such a discrepancy could result from internal changes in the composition of labor categories, as the amount of education per type of worker increased dramatically from 1986 to 2000 with the diffusion of compulsory schooling, secondary and tertiary education. However, it could also be the case that increases in education resulted from a growing consumption demand of a highly income-elastic good, schooling, with no corresponding impact on the quality of the labor force. All in all, over the

⁴³ These parameters represent the average educational premium for each educational category.

period 1964-2000, the Jorgenson and the new Mincer estimates cast similar growth rates (0.8 and 0.9 percent, respectively).

5. Implications for long-run productivity growth

A final step in our investigation is to assess the impact of human capital on labor productivity growth and in order to do it we use a growth accounting framework.⁴⁴ This exercise provides another opportunity to judge which of the two approaches to measure human capital trends offers the most reasonable picture. The sources of labor productivity growth over the long-run are presented in Table 5, with labor quality estimates using the Jorgenson approach and the resulting TFP estimates in Cols. (IV) and (V), while alternative estimates using the Mincer approach and the subsequent TFP estimates in Cols. (VI) and (VII).⁴⁵ Labor productivity trends are determined, thus, by human and physical capital/labor ratios and efficiency gains.

A main finding is that TFP accounts for half the increase in labor productivity over the one and a half centuries considered, with broad capital (mostly physical capital), for the other half. Nonetheless, there is a clear divide between factor input accumulation as the pre-1950 dominant force (contributing from two-thirds –Jorgenson- to three-fourths –Mincer) of labor productivity growth), and TFP as the hegemonic one in the second half of the 20th century (with a contribution of two-third of labor productivity growth in the Golden Age and, later, around one-half).

As regards the contribution of human capital to labor productivity growth, we can observe that, with any measure, human capital contributed less than physical capital and TFP. Moreover, there are little differences between the contributions of alternative measures of human capital to labor productivity growth over the long-run. Hence, using alternative measures does not change the interpretation of the role of broad capital accumulation to productivity advance.

⁴⁴ The growth accounting framework, and its sources, is fully described in Prados de la Escosura and Rosés (2008).

⁴⁵ Estimates are derived with variable factor shares. See for details Prados de la Escosura and Rosés (2008).

[TABLE 5]

In fact, differences between alternative measures of human capital are concentrated in short-run periods. A closer look shows that the contribution of human capital to labor productivity growth varies when is alternatively measured through the Jorgenson or the Mincer approach. For example, noticeable differentials in the labor quality contribution only appear and have, therefore, an impact on TFP growth in the 1920s and, particularly, over the last period considered, 1987-2000. In the 1920s, human capital would have contributed with one-fourth of labor productivity growth according to the Jorgenson approach estimate, while it would have been negligible using the Mincer approach. In turn, during the years 1987-2000, in the Mincer approach, human capital contributed more than 50 percent of labor productivity growth, while using the Jorgenson approach only represented about 10 percent. However, over the period of fast productivity advance, 1953-86, the role of human capital was more relevant in the Jorgenson approach. As regards the implications of human capital alternative measures for TFP growth, it is worth noting that during the 1920s, a lower improvement in Mincer labor quality estimates increases TFP growth up to 1.6 percent, compared to the 1.1 percent obtained with the Jorgenson approach, raising its contribution to GDP growth from one-fourth to two-fifths. Conversely, between 1987 and 2000, the more intense labor quality gains in the Mincer estimates suppress the TFP contribution to GDP growth (from 0.2 to -0.3 percent).

It should be stressed that these results for 1987-2000 cast doubts on the use of the Mincerian approach as a human capital measure. With per capita income growth, population invested more on education, but not all education was employed in the production-side of the economy. Then, any measure of human capital based on education tends to overestimate the contribution of human capital to economic growth and, in consequence, to underestimate TFP growth.

In Spain, although human capital contributed little to the increase in labor productivity growth, it could be the case that human capital accumulation had a “level” effect of facilitating technological innovation. In particular, the increase in human capital during the Golden Age

correlates well with the spectacular rise in TFP growth rates, which was facilitated by the massive adoption of foreign technologies. However, further research will be required to test this proposition.

REFERENCES

- Abramovitz, M., 1986. Catching Up, Falling Behind, and Forging Ahead. *Journal of Economic History* 46 (2), 385-406.
- Alba, A. and San Segundo, M.J., 1995. The Returns to Education in Spain. *Economics of Education Review* 14 (2), 155-66.
- Alcaide, J., and Alcaide, P., 2001. Renta nacional de España y su distribución provincial. Año 1995 y avances 1996-1999. Fundación BBVA, Bilbao.
- Anuario Estadístico de Barcelona, 1905. Ayuntamiento de Barcelona, Barcelona.
- Anuario Estadístico de España (ad annum). Madrid.
- Arrazola, M., J., de Hevia, J., Risueño, M., and Sanz, J.F., 2003. Returns to Education in Spain: Some Evidence on the Endogeneity of Schooling. *Education Economics* 11 (3), 293-304.
- Baiges, J., Molinas, C., and Sebastián, M. 1987. La economía española 1964-1985. Datos, fuentes y análisis. Instituto de Estudios Fiscales, Madrid.
- Barro, R.J., 1999. Notes on Growth Accounting. *Journal of Economic Growth* 4 (2), 119-37.
- Becker, G.S., 1964. Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education. University of Chicago Press, Chicago.
- Benhabib, J., and Spiegel, M.M., 1994. The role of human capital in economic development evidence from aggregate cross-country data. *Journal of Monetary Economics* 34 (2), 143-173.
- Bessen, J., 2003. Technology and Learning by Factory Workers: The Stretch- Out at Lowell, 1842. *Journal of Economic History* 63 (1), 33-64.
- Boot, H.M., 1995. How Skilled were Lancashire Cotton Factory Workers in 1833? *Economic History Review* 48 (2), 283-303.
- Bosworth, B.P., and Collins, S.M., 2003. The Empirics of Growth: An Update. *Brookings Papers in Economic Activity* 34(2), 113-79.
- Bringas Gutiérrez, M.A., 2000. La productividad de los factores en la agricultura española (1752-1935). Banco de España, Madrid.
- Caballero, F., 1864. Memoria sobre el fomento de la población rural. Imprenta del Colegio de Sordomudos y de Ciegos, Madrid.
- Camps, E., 1995. La formación del mercado de trabajo industrial en la Cataluña del siglo XIX. Ministerio de Trabajo y Seguridad Social, Madrid.
- Carré, J.J, Dubois, P., and Malinvaud, E., 1975. French Economic Growth. Stanford University Press, Stanford.
- Cerdá, I., 1867. Teoría General de la Urbanización y aplicación de sus principios y doctrinas a la reforma y ensanche de Barcelona. Barcelona.
- Chastagnaret, G., 2000. L'Espagne, puissance minière dans l'Europe du XIXe siècle. Casa de Velázquez, Madrid.
- Cohen, D., and Soto, M., 2007. Growth and Human Capital: Good Data, Good Results. *Journal of Economic Growth*, 12(1), 51-76.
- Collins, S.M., and Bosworth, B.P., 1996. Economic Growth in East Asia: Accumulation versus Assimilation. *Brookings Papers in Economic Activity* 27 (2), 135-91.
- Dabán Sánchez, T., Díaz Ballesteros, A., Escribá Pérez, F.J., and Murgui García, M.J., 1998. La base de datos BDMORES. Ministerio de Economía y Hacienda. DGAPP D-98001.
- Denison, E.F., 1962. The Sources of Economic Growth in the United States and the Alternatives before Us. Committee for Economic Development, Washington, DC.

- Domar, E., 1961. On the Measurement of Technological Change. *Economic Journal* 71, 709-29.
- Doménech, J., 2007. Working Hours in the European Periphery. The Length of the Working Day in Spain, 1880-1920. *Explorations in Economic History* 44 (3), 469-86.
- Doménech, R. and de la Fuente, A., 2006. Human Capital in Growth Regressions: How Much Difference Does Data Quality Make? *Journal of the European Economic Association* 4 (1), 1-36.
- Encuesta de Estructura Salarial (ad annum), INE, Madrid.
- Encuesta de Salarios y de Coste Laboral (ad annum), INE, Madrid.
- Erdozain, P. and F. Mikelarena, F., 1999. Las cifras de activos agrarios de los censos de población españoles del periodo 1877-1911. Un análisis crítico. *Boletín de la Asociación de Demografía Histórica* 17(1), 89-113.
- Escudero, A., 1998. *Minería e industrialización de Vizcaya*. Crítica, Barcelona.
- Fundación BBV, 1999. Renta nacional de España y su distribución provincial: serie homogénea años 1955 a 1993 y avances 1994 a 1998. Fundación BBV, Bilbao.
- García Sanz, A. 1979-80. Jornales agrícolas y presupuesto familiar campesino en España a mediados del siglo XIX, *Anales del CUNEF*, 49-71
- Goldin, C., 1998. America's Graduation from High School: The Evolution and Spread of Secondary Schooling in the Twentieth Century, *Journal of Economic History* 58 (2), 345-374
- Gómez Mendoza, A. 1982. Ferrocarriles y cambio económico en España (1855-1913). Alianza, Madrid.
- Gordon, R.J., 1999. U.S. Economic Growth Since 1870: One Big Wave? *American Economic Review* 89 (2), 123-28.
- Griliches, Z., and Jorgenson, D. 1967. The Explanation of Productivity Change. *Review of Economic Studies* 34, 249-80.
- Huberman, M., 2005. Working Hours of the World Unite? New International Evidence of Worktime, 1870-1913. *Journal of Economic History* 64 (4), 964-1001.
- Jorgenson, D.J., 1990. Productivity and Economic Growth. In: Berndt, E.R., and Tripplett, J.E., (eds.), *Fifty Years of Economic Measurement. The Jubilee of the Conference on Research in Income and Wealth*. University of Chicago Press, Chicago, 19-118.
- Krueger, A.B., and Lindahl, M., 2001. Education for Growth: Why and for Whom? *Journal of Economic Literature* 39(4), 1101-1136.
- Ljungberg, J. and Nilsson, A. 2009. Human Capital and Economic Growth: Sweden 1870-2000. *Cliometrica* 3 (1), 71-95.
- Llonch, M., 2004. Jornada, salarios y costes laborales en el sector textil catalán. *Revista de Historia Industrial* 26, 101-40.
- Lucas, R. Jr., 1988. On the mechanics of economic development. *Journal of Monetary Economics* 22 (1), 3-42,
- Maluquer de Motes, J. and Llonch, M., 2005. Trabajo y relaciones laborales. In: Carreras, A., and Tafunell, X. (Eds.), *Estadísticas Históricas de España, siglos XIX y XX*, Fundación BBV, Bilbao, 1154-245.
- Mas, M., Pérez, F., Uriel, E., Serrano, L. and Soler, A. 2005. *Capital Humano. Series 1964-2004*. Fundación Bancaja and IVIE, Valencia.
- Mincer, J., 1958. Investment in Human Capital and Personal Income Distribution. *Journal of Political Economy* 66 (4), 281-302.
- Ministerio de Trabajo, 1931. *Estadística de salarios y jornadas de trabajo: 1914-1930. Resultados globales en toda la Nación*. Ministerio de Trabajo, Madrid.
- Ministerio de Trabajo (ad annum). *Salarios*. Ministerio de Trabajo, Madrid.
- Mitch, D. (2004), Education and Skill of the British Labour Force. In: Floud, R., and Johnson, P.A. (Eds.), *Cambridge Economic History of Modern Britain*, Cambridge University Press, Cambridge, vol. I, pp. 332-56.

- Mora, J.G., 1999. Socioeconomic Background, Schooling, and Monetary Rewards in Spain. Universidad de Valencia, Mimeo.
- Nicolau, R., 2005. Población, salud y actividad. In: Carreras, A., and Tafunell, X. (Eds.), *Estadísticas Históricas de España, siglos XIX y XX*, Fundación BBV, Bilbao, 77-154.
- Núñez, C.E., 1992. La fuente de la riqueza. Educación y Desarrollo económico en la España Contemporánea, Alianza Universidad, Madrid.
- Núñez, C.E., 2005. Educación. In: Carreras, A., and Tafunell, X. (Eds.), *Estadísticas Históricas de España, siglos XIX y XX*, Fundación BBV, Bilbao, 155-244.
- OECD, 2006. The Labor Force Statistics Database. OECD, Paris.
- Pérez Castroviejo, P.M., 1992. Clase obrera y niveles de vida en las primeras fases de la industrialización vizcaína. Ministerio de Trabajo y Seguridad Social, Madrid.
- Pérez Moreda, V. 1999. Población y economía en la España de los siglos XIX y XX. In: Anes, G., (Eds.), *Historia Económica de España, Siglos XIX y XX*, Galaxia Gutemberg, Barcelona, 7-62.
- Prados de la Escosura, L., 2003. El progreso económico de España, 1850-2000. Fundación BBVA, Bilbao.
- Prados de la Escosura, L., and Rosés, J.R., 2003. National Income Accounts: Wages and Labor. In: Mokyr, J. (Eds.), *Oxford Encyclopedia of Economic History*, Oxford University Press, London, 48-52.
- Prados de la Escosura, L., and Rosés, J.R. 2008. Proximate Causes of Economic Growth in Spain, 1850–2000. *Universidad Carlos III Working Papers in Economic History* 2008-12.
- Psacharopoulos, G., and Patrinos, H.A., 2004. Returns to Investment in Education: A Further Update. *Education Economics* 12 (2), 111-34.
- Reher, D.S. and Ballesteros, E., 1993. Precios y salarios en Castilla la Nueva: la construcción de un índice de salarios reales, 1509-1991. *Revista de Historia Económica* 11 (1), 101-51.
- Rosés, J.R., 1998. Measuring the contribution of human capital to the development of the Catalan factory system (1830-61). *European Review of Economic History* 2 (1), 25-48.
- Rosés, J.R., and Sánchez-Alonso, B., 2004. Regional Wage Convergence in Spain (1850-1930). *Explorations in Economic History* 41 (3), 404-25.
- Sandberg, L.G., 1979. The Case of the Impoverished Sophisticate: Human Capital and Swedish Economic Growth before World War I. *Journal of Economic History* 39 (1), 225-241.
- Schultz, T.W., 1963. *The Economic Value of Education*. Columbia University Press, New York.
- Silvestre, J., 2003. Migraciones interiores y mercado de trabajo en España, 1877-1936. Unpublished Ph.D. dissertation, Universidad de Zaragoza.
- Simpson, J. 1992. Technical Change, Labor Absorption, and Living Standards in Andalucía 1886-1936. *Agricultural History* 66 (3): 1-24.
- Soler, R., 1997. La evolución del salario en una empresa textil algodonera. La fábrica de La Rambla de Vilanova i la Geltrú (1891-1925). *Revista de Historia Económica* 15 (2), 399-411.
- Soto Carmona, A., 1989. El trabajo industrial en la España contemporánea: (1874-1936). Anthropos, Rubí.
- United Nations, 1997. *Glossary of Environment Statistics*. Studies in Methods, Series F, No. 67, United Nations, New York.
- U.S. Department of Labor, 1990. *Fifteenth Annual Report of the Commissioner of Labor: Wages in Commercial Countries*. GPO, Washington DC.
- Vandellós, J. A. 1925. La richesse et le revenu de la Péninsule Ibérique. *Metron* 4: 151-86.
- Vilar, M., 2004. La ruptura posbélica a través del comportamiento de los salarios industriales: nueva evidencia cuantitativa (1908-1963). *Revista de Historia Industrial* 25, 81-126.
- Young, A., 1995. The Tyranny of Numbers: Confronting the Statistical Realities of the East Asian Growth Experience. *Quarterly Journal of Economics* 90 (2), 641-80.

Table 1
Per Capita GDP Growth and its Components, 1850-2000
(annual average logarithmic rates %)

	(I)	(II)	(III)
	Per Capita GDP	Hours worked /Population	GDP per Hour Worked
1850-2000	1.9	-0.2	2.1
<i>Panel A.</i>			
1850-1950	0.8	-0.1	0.9
1951-1974	5.5	0.0	5.5
1975-2000	2.6	-0.8	3.4
<i>Panel B.</i>			
1850-1883	1.4	0.2	1.2
1884-1920	0.7	-0.3	1.0
1921-1929	2.8	0.8	2.0
1930-1952	0.0	0.0	0.0
1953-1958	3.9	-0.5	4.3
1959-1974	5.8	-0.5	6.3
1975-1986	1.8	-4.4	6.1
1987-2000	3.3	2.2	1.1

Sources: Prados de la Escosura and Rosés (2009).

Table 2
Human Capital Growth, 1850-2000: Education Approach
(annual average logarithmic rates %)

	(I)	(II)	(III)
	Mincer Eq.	Rate of Return	
		9 percent	7.2 percent
	(Arrazola et al)	(Alba and San Segundo)	(Mora)
1850-2000	0.4	0.4	0.3
<i>Panel A</i>			
1850-1950	0.2	0.2	0.2
1951-1974	0.9	0.8	0.6
1975-2000	0.9	0.9	0.7
<i>Panel B</i>			
1850-1883	0.3	0.2	0.2
1884-1920	0.3	0.3	0.2
1921-1929	-0.1	-0.1	-0.1
1930-1952	0.2	0.2	0.1
1953-1958	0.9	0.7	0.6
1959-1974	0.9	0.8	0.6
1975-1986	0.8	0.9	0.7
1987-2000	0.9	1.0	0.8

Sources: Arrazola et al. (2003); Alba and San Segundo (1995); Mora (1999), and see the text.

Table 3
Labor Quantity Growth Decomposition, 1850-2000
(annual average logarithmic rates %)

	(I) Hours worked (H)	(II) Hours per occupied (H/E)	(III) Occupied per EAP (E/L)	(IV) EAP per Pop 15-64 (L/WAN)	(V) Pop 15-64 /Population (WAN/N)	(VI) Population (N)
1850-2000	0.4	-0.3	-0.1	0.1	0.1	0.6
<i>Panel A.</i>						
1850-1950	0.5	-0.1	0.0	0.0	0.1	0.6
1951-1974	1.0	-0.4	0.3	0.4	-0.3	1.0
1975-2000	-0.4	-0.8	-0.6	0.2	0.4	0.4
<i>Panel B.</i>						
1850-1883	0.6	-0.1	0.1	0.1	0.0	0.4
1884-1920	0.2	-0.2	-0.1	0.0	0.0	0.6
1921-1929	1.8	-0.3	1.0	0.0	0.1	1.0
1930-1952	0.8	-0.1	-0.1	-0.1	0.3	0.9
1953-1958	0.4	-0.6	-0.4	0.8	-0.3	0.8
1959-1974	0.6	-0.5	0.0	0.2	-0.2	1.1
1975-1986	-3.6	-1.5	-2.4	-0.8	0.4	0.7
1987-2000	2.4	-0.1	1.0	1.0	0.3	0.2

Sources: See the text.

Table 4
Labour Quantity, Quality, and Input Growth: alternative Estimates
(annual average logarithmic rates %)

	Jorgenson Approach			Mincer Approach	
	(I) Labor Quantity	(II) Labor Quality	(III) Labor Input [(I)+(II)]	(IV) Labor Quality	(V) Labor Input [(I)+(IV)]
1850-2000	0.4	0.4	0.8	0.4	0.9
<i>Panel A.</i>					
1850-1950	0.5	0.2	0.7	0.2	0.7
1951-1974	1.0	1.0	2.0	0.9	1.9
1975-2000	-0.4	0.7	0.3	0.9	0.5
<i>Panel B.</i>					
1850-1883	0.6	0.1	0.7	0.3	0.9
1884-1920	0.2	0.1	0.4	0.3	0.5
1921-1929	1.8	0.8	2.6	-0.1	1.7
1930-1952	0.8	0.0	0.8	0.2	1.0
1953-1958	0.4	1.2	1.6	0.9	1.2
1959-1974	0.6	1.1	1.7	0.9	1.5
1975-1986	-3.6	1.2	-2.4	0.8	-2.8
1987-2000	2.4	0.2	2.6	0.9	3.3

Sources: See the text

Table 5
Sources of Labor Productivity Growth (1850-2000): Alternative Labor Quality Estimates
(annual average logarithmic rates %)

	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)
	GDP per hour worked	Land	Capital Input	Jorgenson Approach		Mincer Approach	
				Labor Quality	TFP	Labor Quality	TFP
1850-2000	2.1	0.0	0.8	0.2	1.1	0.3	1.0
<i>Panel A.</i>							
1850-1950	0.9	0.0	0.5	0.1	0.3	0.1	0.2
1951-1974	5.5	0.0	1.2	0.6	3.7	0.6	3.8
1975-2000	3.4	0.0	1.4	0.4	1.7	0.6	1.4
<i>Panel B.</i>							
1850-1883	1.2	-0.1	0.6	0.0	0.6	0.2	0.5
1884-1920	1.0	0.1	0.6	0.1	0.2	0.2	0.2
1921-1929	2.0	-0.1	0.6	0.5	1.1	-0.1	1.6
1930-1952	0.0	0.0	0.2	0.0	-0.1	0.2	-0.4
1953-1958	4.3	-0.2	1.3	0.8	2.4	0.6	2.7
1959-1974	6.3	0.0	1.2	0.9	4.2	0.7	4.4
1975-1986	6.1	0.0	1.9	0.9	3.4	0.6	3.7
1987-2000	1.1	0.0	0.8	0.1	0.2	0.6	-0.3

Sources: Col (I), Table, col. III; Table 4; Prados de la Escosura and Rosés, (2009), variable factor shares), and see the text.

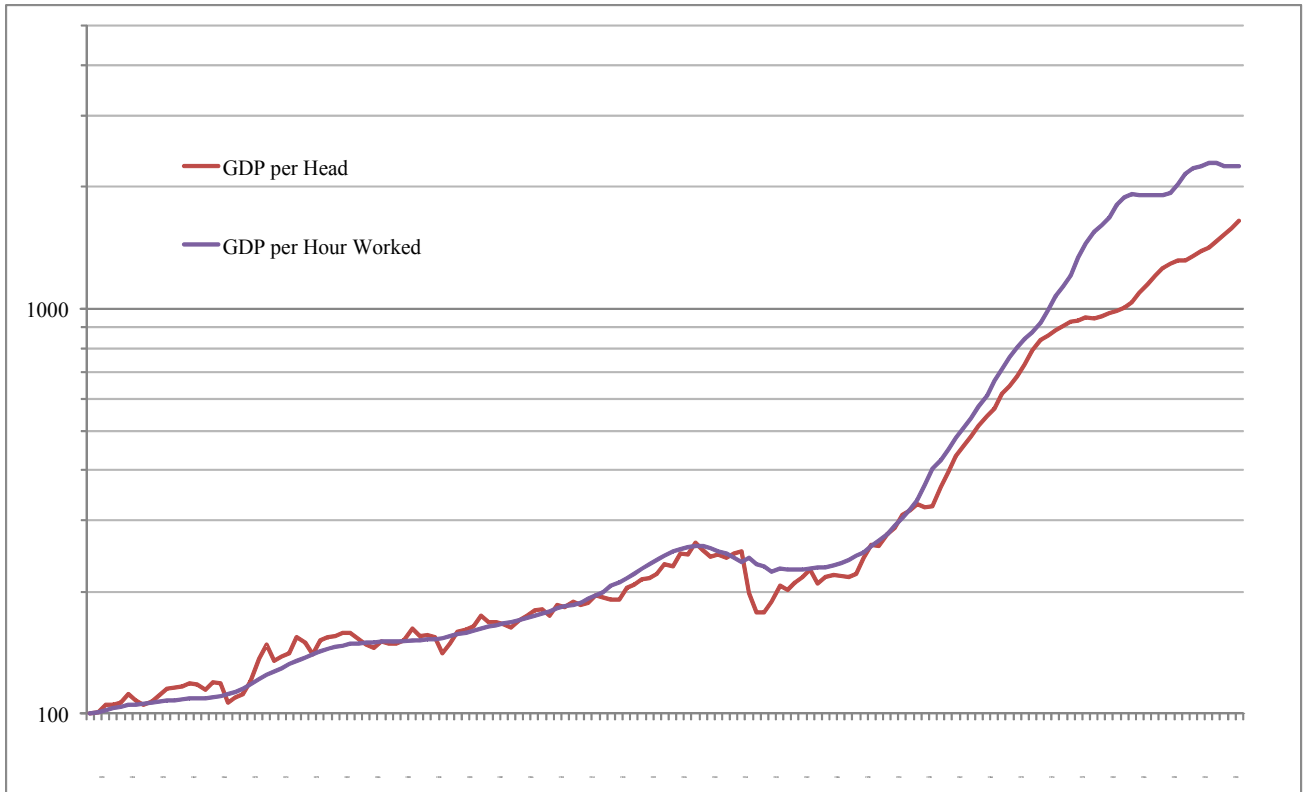


Figure 1. Real GDP per Head and per Hour Worked
Sources: Prados de la Escosura (2003, updated)

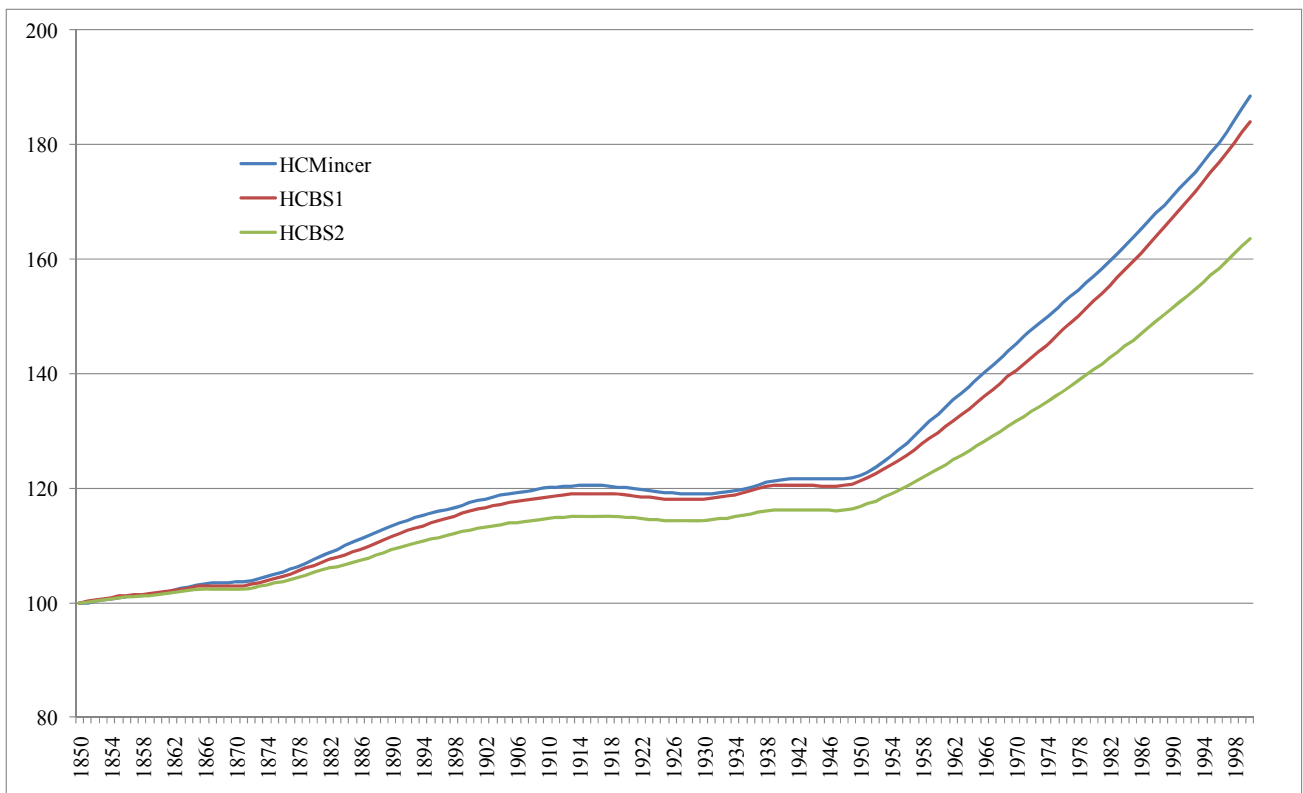


Figure 2. Human Capital through the Education Approach: Alternative Estimates
Sources: See text

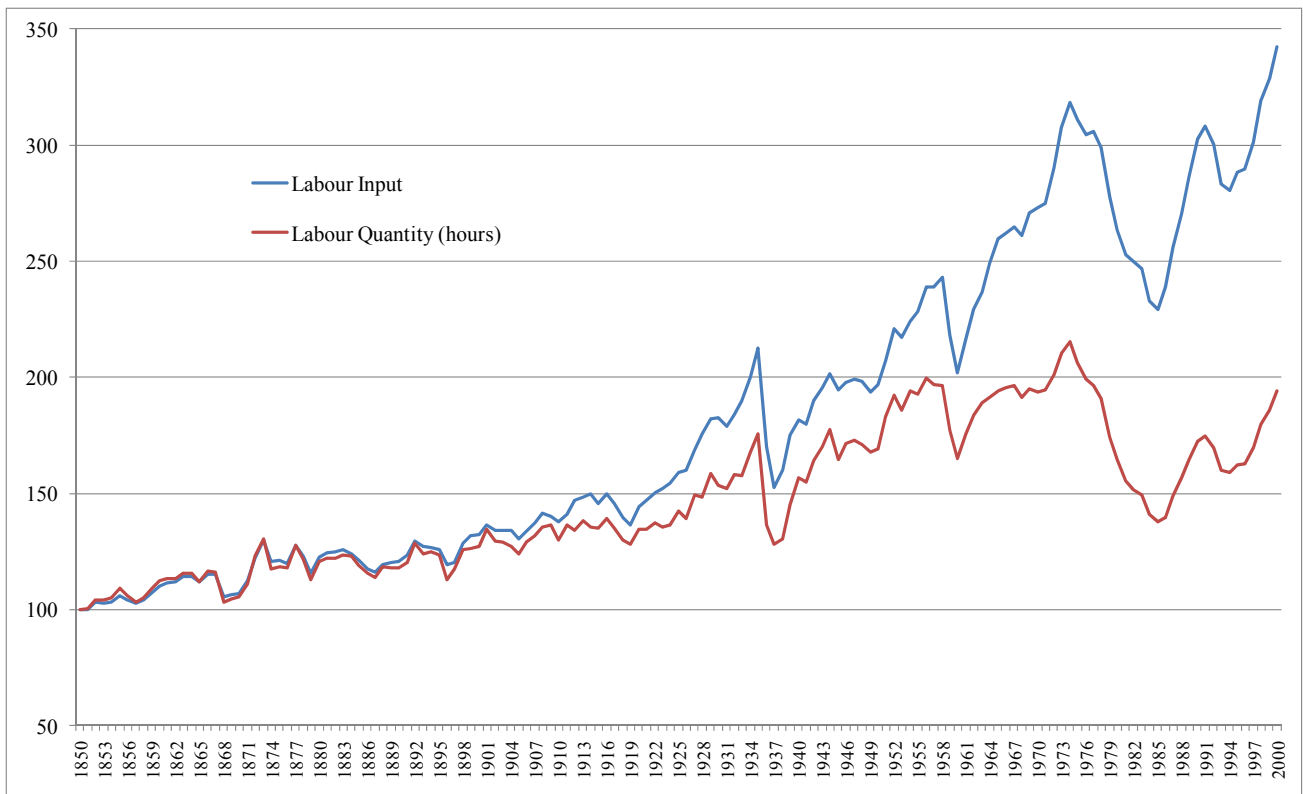


Figure 3. Labor Input and Quantity: Jorgenson Approach
 Sources: See text

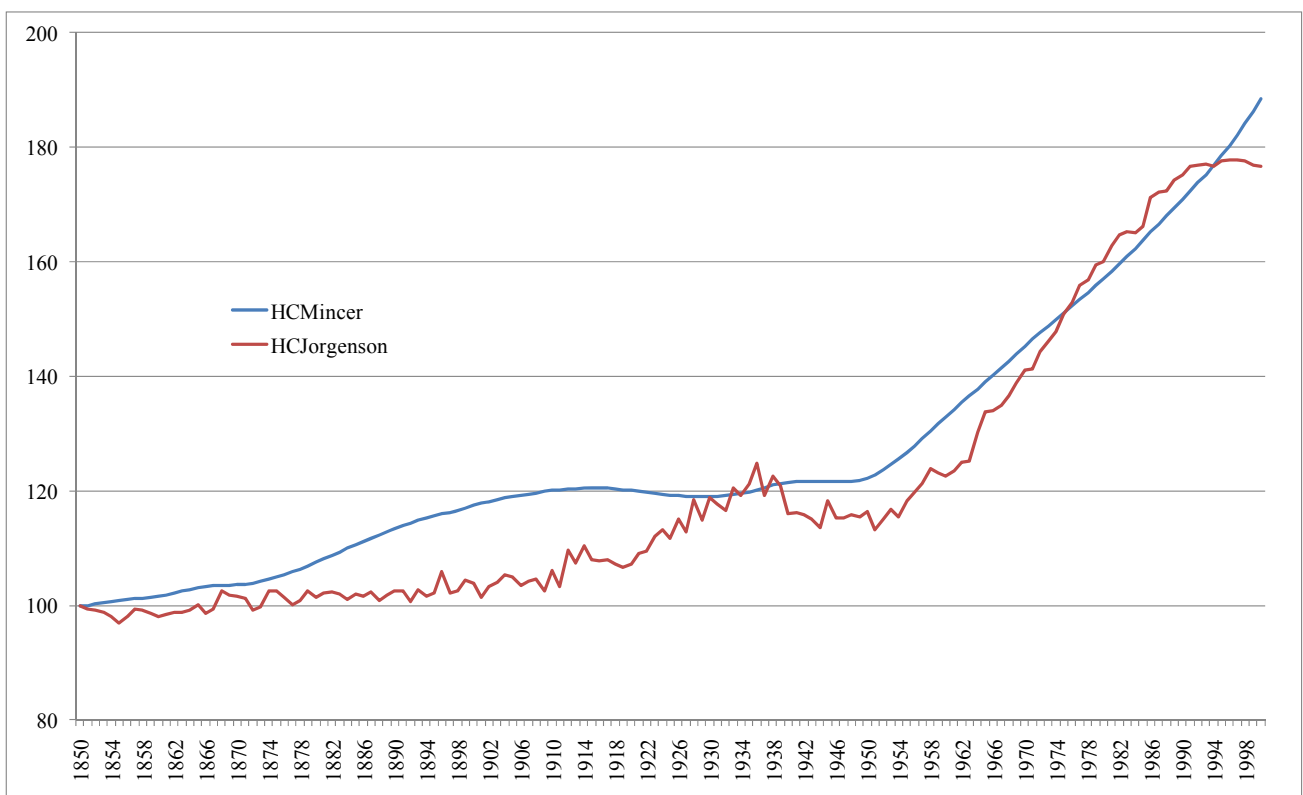


Figure 4. Human Capital Estimates: Mincer and Jorgenson Approaches
 Sources: See text