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Proximate Causes of Economic Growth in Spain, 1850-2000

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Abstract

Between 1850 and 2000, Spain's real output and labor productivity grew at average rates of 2.5 and 2.1 percent. The sources of this long-run growth are investigated here for the first time. Broad capital accumulation and efficiency gains appear as complementary in Spain's long-term growth. Factor accumulation dominated long-run growth up to 1950, while total factor productivity led thereafter and, especially, during periods of growth acceleration. The main spurts in TFP and capital coincide with the impact of the railroads (1850s-80), the electrification (the 1920s and 1950s) and to the adoption of new vintage technology during the Golden Age.

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Proximate Causes of Economic Growth in Spain, 1850-2000[*]

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Over the last century and a half aggregate economic activity in Spain experienced a 43-fold increase, growing at 2.5 percent per year, and per capita GDP was 16 times larger than in 1850 implying an annual rate of 1.9 percent.[1] GDP per hour worked expanded at a faster rate (2.1 percent) as hours of work per person declined. This economic growth, however, did not take place at a steady rate. During the Golden Age (1950-74) per capita GDP rose seven times faster than in the previous hundred years, and twice as fast as during the last quarter of the twentieth century. Does factor accumulation or productivity improvement -"abstention" or "ingenuity" to use D.N. McCloskey words- account for it?[2] In fact, no consensus has emerged about the relative importance of the contributions of factor accumulation and total factor productivity (TFP) to GDP growth, nor do we know whether a temporal sequence can be established for their relative contributions to growth.[3] Susan Collins and Barry Bosworth have suggested that, in its early stages, growth is primarily associated with capital accumulation, while TFP only emerges above a certain

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[1] In order to make the comparison between GDP and factor inputs consistent (see expression (4) below), a new Translog index has been constructed for real GDP on the basis of current values and quantity indices for the four main sectors of economic activity (agriculture, industry, construction, and service) provided in Prados de la Escosura, *Progreso*. The new Translog index exhibits a slightly faster growth than the chain Laspeyres index used in Prados de la Escosura, *Progreso*.

[2] McCloskey, "Industrial Revolution".

[3] Cf. Crafts, *British Economic Growth*, and Mokyr, "New Economic History", on the case of Britain and Denison, *Why Growth Rates Differ*, pioneering study on Western Europe (but not including Spain) and the U.S. in the post-World War II era. On developing countries, including and some comparisons with post-World War II Europe, see Krugman, "Myth"; Young, "Tyranny"; Collins and Bosworth, "Economic Growth"; Crafts, "East Asian Trend Growth", and Bosworth and Collins, "Empirics of Growth".

development threshold.[4] Studying the sources of Spain's growth over one hundred and fifty years provides an unusual opportunity to explore these issues.[5]

Spain's long-run economic growth can be depicted as trend stationary with structural breaks in 1936 - a shift to a lower level as a consequence of the Civil War (1936-39)- and, in trend, in 1951 and 1975 (Figure 1), establishing three long periods: 1850-1950, 1951-74, and 1975-2000 (Table 1, Panel A).[6] Long swings in which rates of variation differ from its long-run trend as a result of shifts in economic policies, access to international markets and technological change are also exhibited in Spanish economic performance (Panel B).[7]

FIGURE 1]

[TABLE 1]

[4] Collins and Bosworth, "Economic Growth", p. 186.

[5] Unfortunately, detailed growth-accounting exercises with long-run evidence are rare. See, for example, Maddison, "Growth and Slowdown"; Matthews et al., *British Economic Growth*; Carré et al., *French Economic Growth*; and Kendrick, *Productivity*, and Abramovitz and David, *Two Centuries*, for the United States.

[6] Prados de la Escosura, "Growth". A change of trend indicates a break in the long-term rate of growth while a change in level represents an increase or, as in the case of the Civil War years, a drop in economic activity that does not alter the trend growth rate. A distinction should be made between the *trend* growth rate and the GDP *level*, the former being the relevant one to establish a periodization. Thus, the pertinent fact for accepting a structural break in 1951 is that the trend growth rate changed after this year and not that the GDP level was lower in 1951 than in 1929.

[7] The phases or long swings defined in Table 1 correspond with the time division arising from econometrically estimated deviations from the established trend (Prados de la Escosura, "Growth"). Growth rates are measured as average annual logarithmic rates of change over periods delimited by peak years.

We use a growth accounting approach allows to decompose this long-run growth into the contribution of production factors in terms of quantity and efficiency.[8] The sources of Spain's growth have changed dramatically since 1850. Broad capital accumulation and TFP growth appear complementary in Spain's long-term growth and our results for Spain confirm Collins and Bosworth's finding of low TFP growth for countries in their early stages of development.[9] Factor accumulation dominated long-run growth up to 1950, while efficiency gains led thereafter and, especially, during periods of growth acceleration. The main spurts in TFP and capital correspond to the impact of the railroad (1850s-80s), the electrification (the 1920s and 1950s) and the adoption of new vintage technology during the Golden Age.

The rest of the paper is divided into three parts. Section II describes the reduced form of Jorgenson's growth accounting adopted in this paper and presents our new database, which comprises new estimates of GDP, and the stock and input of capital and labor, over one-and-a-half centuries. Then, in Section III, we discuss with alternative growth-accounting measures, the role of TFP and factor accumulation in GDP and labor productivity growth. We conclude with some remarks and a research suggestion.

THE 'PROXIMATE' SOURCES OF GROWTH: METHODS AND SOURCES

Growth accounting is "a means of allocating observed output growth between the contributions of changes in factor inputs and a residual, total factor productivity, which measures a combination of

[8] 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, "Growth Accounting"; Collins and Bosworth, "Economic Growth", p. 139). In this paper, we make a historical adaptation of Domar's, "Measurement of Technological Change", and Griliches and Jorgenson's, "Explanation of Productivity Change", approach to measure factor inputs in terms of quality.

[9] As Collins and Bosworth, "Economic Growth", p. 164, point out, technical advances might be embodied in new capital while increasing TFP might induce greater capital accumulation by raising the returns to capital.

changes in efficiency in the use of those inputs and changes in technology."[10] In the growth accounting approach favored by Jorgenson, superlative indices are used, as well as heterogeneous measures of factor inputs that make it possible to separate their contribution to growth into quantity and composition changes.[11]

a) The Translog Index of Total Factor Productivity

The point of departure for our estimate of the sources of long-run growth in Spain is the production function given by:

$$Q = F(X, K, L) \tag{1}$$

In which output (Q) is as function of land (X), capital (K), and labor (L) inputs.

Specifically:

$$\begin{aligned} \ln Q = a_0 + a_x lnX + a_k lnK + a_l lnL + \tfrac{1}{2} b_{xx} (lnX)^2 + \tfrac{1}{2} b_{kk} (lnK)^2 \\ + \tfrac{1}{2} b_{ll} (lnL)^2 \, b_{xk} lnX \, lnK + b_{xl} lnX \, lnL + b_{kl} lnK \, lnL \end{aligned} \tag{2}$$

In two discrete periods of time, and after differentiating and taking logarithms:

$$\begin{aligned} \ln Q(t) - \ln Q(t-1) = \Theta_X [\ln X(t) - \ln X(t-1)] + \Theta_K [\ln K(t) - \ln K(t-1)] \\ + \Theta_L [\ln L(t) - \ln L(t-1)] + TFP_{t-1,t,} \end{aligned} \tag{3}$$

Θ_i denotes the elasticity of output with respect to each input.[12] Under the assumptions of perfect competition and constant returns to scale these elasticities are equivalent to the share of inputs in total

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[10] Bosworth and Collins, "Empirics of Growth", p. 114.

[11] As a consequence, a reduction in the 'unexplained residual' or total factor productivity can occur as the 'residual' no longer includes composition ("quality") changes in inputs. See Jorgenson, "Productivity". It is worth noting that Jorgenson's approach resembles but has striking differences with that of Denison, *Sources*. More specifically, Denison also cross-classified hours worked by workers' attributes and weighted them by wage rates. However, ignoring the heterogeneity among components of capital input, he did not cross-classified capital by type of asset and weighted it by rental rates like Jorgenson did. As Jorgenson, "Productivity", points out, this violated the equilibrium conditions for growth accounting analysis.

[12] See Christensen *et al.* "Transcendental Logarithmic".

factor payments. Weights are, then, given by the average share of each component in the total outlay for the two periods.[13] Under constant returns to scale, the values of factor shares sum to unity.[14] The Translog index of TFP ($TFP_{t-1,t}$) is the difference between the growth rate of output and a weighted average of the growth rates of factor inputs.

The rate of growth of output and of each input *i* between two periods is a weighted average of the growth rates of its *n* components.[15] The respective equations for output, land, capital, and labor are:

(4) $$lnQ_t - lnQ_{t-1} = \sum_i [\overline{\Theta}_{Q_i} (lnQi_t - lnQi_{t-1})]$$

(5) $$lnX_t - lnX_{t-1} = \sum_i [\overline{\Theta}_{L_i} (lnXi_t - lnX i_{t-1})]$$

(6) $$lnK_t - lnK_{t-1} = \sum_i [\overline{\Theta}_{K_i} (lnCi_t - lnCi_{t-1})]$$

(7) $$lnL_t - lnL_{t-1} = \sum_i [\overline{\Theta}_{L_i} (lnLi_t - lnLi_{t-1})]$$

Where share values are computed as:

(8) $$\overline{\Theta}_{n_i} = 1/2[\theta_{ni}(t) + \theta_{ni}(t-1)], \qquad (i = 1,..i,..n).$$

b) Capital input

We develop our measure of capital input, which is an index number of the flow of services provided by the stock of capital in three successive phases.[16] First, we construct the stock of capital.[17]

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[13] Total outlay is practically equivalent to the total payments received for outputs. However, in some cases, these payments can be adjusted for direct taxation and monopoly gains to obtain the total outlay (that would reduce the share of capital in total payments and, hence, increase the rate of TFP growth). We make no adjustments here and assume that total outlay is equivalent to total payments.

[14] The Translog Index offers a justification for using variable shares and for adjusting production factors according their social product. See Jorgenson, "Productivity".

[15] Weights are given by the share of each component in the corresponding payments for each input.

[16] As it is usually assumed, capital *input* (K) in year t is proportional to the *stock* of capital C at the beginning of the period t. Thus, $K_t = \lambda \cdot C_{t-1}$, where the constant ($\lambda$) transforms the capital *stock* into its services, and

Second, we estimate the rental price of capital (or price of capital services) and the total returns to capital (the value of capital services). Finally, we weight the quantity of each asset by its share in the total returns to capital to derive a single capital input index.

Since the amount of new additions to the stock of capital (investment, I_t) is directly observable while the stock, C_t, is not, we need to infer the stock of capital (C) for the year t from the accumulation of investment (I) in past years, taking into account that a part of the stock is retired when obsolete. Using the Perpetual Inventory Method (PIM), the stock of capital in the year t (C_t) is equal to the weighted sum of the investment realized during this same year and the previous ones where each generation of capital is weighted by its depreciation rate in period t,[18]

(9) $$C_t = (1 - \delta t)\ C_{t-1} + I_t$$

Thus, the capital stock C in year t is equal to the amount of capital in year $t\text{-}1$ multiplied by 1 minus the depreciation rate (δ) of the year t, plus the gross fixed capital formation, I, during the year t.[19] The depreciation rate is $\delta = X / T$, where X is a parameter[20] (*declining balance*) and T is the

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where the capital *stock* C_t moves according to the new investments, at constant prices, during the year, and to the depreciation and replacement rates. Cf. Jorgenson, "Productivity".

[17] We define the *stock* of capital as all tangible goods that can be used during more than one period to produce other goods and services. More specifically, the capital *stock* comprises residential and non-residential structures, transport equipment, and producer durable equipment (machinery and equipment).

[18] This is the case under the following assumptions: (1) all durable goods bought in a certain period t form a vintage of capital; (2) the services produced for different vintages of capital in period t are perfect substitutes; and (3) their services are proportional to the initial investment. See Hulten, "Measurement of Capital".

[19] The use of the PIM method requires, thus, (1) an initial benchmark for the stock of capital; (2) historical series of Gross Fixed Capital Formation by types of assets, at constant prices; and (3) the efficiency of each vintage of capital.

[20] The parameter X is, according to Hulten and F. Wykoff, "Economic Depreciation", 1.65 for machinery and equipment, and 0.91 for buildings and structures. The values of the parameter were derived from a careful

life of each type of asset.[21] This method generates a measure of capital that takes into account the productive capacity of each component and, hence, measures capital stock in *efficiency units*.[22]

The second step in developing measures of capital *input* is to construct rental prices for each category. In competitive equilibrium, the cost of producing a unit of capital is equal to its price and the expected rent during its life. Assuming that old and new vintages of capital are perfect substitutes[23], the rental price of capital, p_k, in year *(t)*, can be estimated as[24]:

$$p_k(t) = p_i(t-1)r(t) + \delta\, p_i(t) - [\,p_i(t) - p_i(t-1)] \qquad (10)$$

Where p_i is the investment price of the capital good i, r is the nominal rate of return, and δ_i is the depreciation rate for the capital good i. The rental price of capital is, thus, the sum of return per unit of capital, $p_i(t-1)r(t)$, depreciation, $\delta\, p_i(t)$, and the negative of revaluation, $[\,p_i(t) - p_i(t-1)]$.[25]

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econometric exercise in which a large data base was used. Accepting the *X* parameter's values from Hulten and Wykoff , "Economic Depreciation", for historical purposes is arbitrary. Nonetheless, it is worth noting that these parameters have been widely employed in empirical studies as they correspond to the technological frontier to which countries tend to converge.

[21] This 'modified' geometric depreciation pattern is somewhere in between the arithmetic and geometric depreciation patterns (that is, it moves between one and two times the inverse of asset lives). Cf. Jorgenson, "Productivity". For Spain, the alternative assumptions of $X = 1$ (arithmetic depreciation) and $X = 2$ (geometric depreciation) do not cast significantly different results for the stock of capital (Appendix, Table A-1).

[22] Hulten, "Measurement of Capital". Alas, in our historical exercise we do not fully succeed in measuring the capital stock in efficiency units, as we cannot carry out a deeper de-aggregation by type of asset, thus, fail to capture all the composition -or 'quality'- changes.

[23] Jorgenson, "Productivity".

[24] Hall and Jorgenson, "Tax Policy"

[25] Jorgenson, "Capital", p. 10. It should be noted that we have already established the depreciation rates and the prices of acquisition of capital for Spain but we do not know the rates of return. There are two methods for estimating rates of return (r). The first uses the long-run interest rate as equivalent to the competitive

Total returns to capital are, then, obtained, as the product of the rental price of capital by the quantity of capital stock, and it is equal to capital property compensation. This way we can derive the share of each type of asset in the total returns to capital that will be used as weights in the computation of the capital input index. It can be observed that a capital good with a higher amortization rate receives a larger weight in the index of capital input (machinery is, for example, allocated a higher weight than dwellings). The implication is that changes in the stock composition from long duration (and low rate of return) to short duration (and high rate of return) capital goods represent an increase in the quality of capital. The final step is to construct a capital input index by combining the quantity of each asset with its share in the total returns to capital as in expression (6).

The ratio between the capital input and the capital stock provides a measure of the capital's composition changes or 'quality' of capital. However, the idea that technological change embodied in capital is captured by increases in the 'quality' of capital lacks consensus and has been rejected by Alwyn Young and Moses Abramovitz and Paul David who consider that technological progress embodied in capital will appear in the 'residual'.[26]

Data on yearly investment (quantities and prices) by type of asset are taken from Prados de la Escosura.[27] Three different epochs (1850-1913, 1914-1958, and 1959-2000), with their particular

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benefit rate. The second derives the rate of return from the share of national income received by the owners of capital assets as a compensation for their property that can be obtained by solving equation (9). The difference between the two estimations represents monopolistic competition rents.

[26] For example, Young, "Tyranny of Numbers", p. 649, claimed that as each type of input *i* is assumed to be identical over time, any increases in the efficiency of such input will appear in the 'residual'. Abramovitz and David, *Two Centuries*, p. 23, warned us that "when we speak of the growth of Capital Quality, we do not refer to the important changes in the characteristics of capital goods which raise their productivity but are the result of technological progress. That effect, for which there are no direct measures, remains embedded in the TFP residual." For a less skeptic view, see Hulten, "Measurement of Capital", p. 134; and "Growth Accounting". Our historical estimates fit in the case exposed by Young.

[27] Prados de la Escosura, *Progreso*.

asset lives, are considered for 'productive' capital (that is, for all capital assets except residential dwellings). [28] This is due to the fact that assets lives tend to shorten as one gets closer to the present.

An additional difficulty was to establish the initial level of capital stock (C_0) for each type of asset j in our PIM estimate. We derived this initial stock by assuming that the growth rate of investment during the first decade of the time span considered, that is, the 1850s, was representative of the growth rate of investment prior to 1850.[29] Algebraically:

$$C_{0j} = I_{0j} / (\delta + g), \quad (11)$$

Where C is the capital stock, I the investment rate, δ the depreciation rate, and g the rate of variation between 1850/54 and 1855/59 for each type of asset j. However, it seems plausible that the growth of investment was significantly slower before the 1850s (the decade in which the railroad was introduced in Spain) and we have consequently assumed that the initial capital stock would have been twice as high the figure derived from this computation.[30]

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[28] For each type of capital assets its life was established from available information. The assumed lives for different types of assets are in line with those used in major historical works (Feinstein, "Sources and Methods", for the U.K., and Jorgenson, "Capital", for the U.S.) and tend to be on the conservative (high) side when compared with available studies for late 20th century Spain. Further details on the construction of capital measures are provided in Prados de la Escosura and Rosés, "Physical Capital", where capital estimates were derived assuming alternatively longer (shorter) assets lives. Also alternative estimates of (gross and net) capital stock constructed using arithmetic depreciation rates are provided. The main trends in capital stock and input offered here are robust to these alternative estimates.

[29] Baigés *et al. Economía española* and Young, "Tyranny of Numbers".

[30] This correction in the initial assumption (11) reduces the contribution of capital to GDP growth and, hence, increases that of TFP. Nonetheless, the effect of the assumption about the initial capital stock fades away over time. Actually alternative capital stock series constructed by assuming the one resulting from expression (11), double such level (our preferred estimate), and zero initial capital, converge by 1890 (Prados de la Escosura and Rosés, "Physical Capital").

Finally, we have chosen to approximate the competitive benefit rate with the long-run interest rate. The internal return of private liabilities, used as a proxy for the long-term interest rate since 1964, comes from the MOISSES and BDMORES databases[31], while the corporate rates of return[32] were employed for 1880-1954 and the net rate of return on public debt for 1850-1880.[33] Figure 2 and Table 2 present the evolution of capital stock and input from 1850 to 2000.

[FIGURE 2]

Capital input and stock do not follow a steady path as Figure 2 and Table 2, Panel A, show. Expansion was more intense during the Golden Age but no returning to the pre-1950 path of growth thereafter. Different phases of growth can be distinguished that, with the exception of the decade of transition to democracy (1975-85), match GDP performance (Table 2, Panel B).[34] An initial period of intense growth up to the early 1880s, slowed down until World War I, resumed in the 1920s, and was interrupted during from the 1930s to the early 1950s. Since the early 1950s capital accumulation grew at a faster and steadier pace, with a big spurt in the years 1959-74.

[TABLE 2]

Changes in the composition of capital by type of asset from residential construction toward productive capital (machinery and equipment) (Figure 3) increased the services provided by the capital stock to production and reflected in the growing gap between the growth rates of capital input and stock (the so-called *quality* of capital) that rose in phases of fast capital growth (Table 2, col. 3 and

[31] Dabán et al., "base de datos".

[32] Tafunell, "Rentabilidad financiera".

[33] Tafunell, "Empresa y bolsa".

[34] Table A-1 in the Appendix offers the growth rates corresponding to gross and net capital stock obtained with arithmetic depreciation rates (1/*T*) but accepting the same assets lives used in the capital stock series obtained with modified depreciation rates (Table 2). These alternative estimates share the main trends described here.

Figure 4).[35] Three periods stand out in which capital quality grew above the long run trend: from the mid-1850s to the early 1880s, a period of opening up in which foreign capital was invested in the railroads construction and in mining; the 1920s, that witnessed another episode of foreign capital inflow and the electrification of Spanish industry; and the Golden Age (1953-74), in which Spain completed electrification and replaced the old vintage capital after two decades of international isolation due to the Great Depression, the Civil War (1936-39) and the inward looking policies of the Franco regime. It is worth noting that in spite of receiving a large influx of foreign capital since its accession to the European Union (1986), the 'quality' of capital did not rise in Spain above the historical trend rate over 1986-2000, suggesting a weak and delayed impact of ICT technologies.[36]

[FIGURE 3]

[FIGURE 4]

c) Land input

The usual practice in historical research is to include land as an independent factor of production.[37] However, in most growth accounting exercises land is considered together with the

[35] Alas, our historical exercise fails to capture <u>all</u> the composition -or 'quality'- changes, as we cannot carry out a deeper de-aggregation by type of asset, but hints the direction in which composition changes take place. Our attempt represents a step ahead with regards to the conventional estimates that do not adjust for the service provided by each type of asset but simply rely on the stock of capital –in which one dollar of dwellings amounts to the same as a dollar in machinery in terms of the service provided to production.

[36] See Mas and Quesada, "ICT and Economic Growth"; and Timmer and van Ark, "Information and Communication Technology".

[37] See, for example, Crafts, *British Economic Growth*; Antrás and Voth, "Factor Prices". Bosworth and Collins, "China and India", also include land as an independent factor for present-day developing countries.

capital stock due to the difficulty to ascertain the actual amount of land in use.[38] Moreover, to establish the price of unimproved land, which is the relevant one, represents a major obstacle as its market price includes improvements to land, that actually correspond to capital input. We have opted here for providing estimates of the sources of growth in which land is considered as a separate factor of production.[39]

Alas since we found impossible to distinguish the part that corresponded to capital incorporated into the improved land, we settled for a crude estimate of the land stock. The first step was to elaborate yearly land figures. Unfortunately, estimates for total agricultural land only exist at some benchmarks before the late 1950s[40] that we have interpolated to derive annual figures and, then, adjusted for the economic cycle with the deviations from the Hodrick-Prescott trend in agricultural output.[41] Next, we converted hectares of land into a stock by weighting each type of land by its price at two different benchmark years (1931 and 1985) and, then, spliced the resulting

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[38] Cf. Matthews et al. *British Economic Growth*, p. 205, and A. Maddison, "Growth and Slowdown", p. 660. In Spain, San Juan, *Eficacia y rentabilidad*, does not distinguish between land and capital and includes land in the capital stock.

[39] In the Appendix we provide growth accounting estimates in which land is considered as part of capital.

[40] The benchmarks correspond to the following years, 1834, 1860, 1891/95, 1897/1901, 1909/13, 1920/22, 1929/33, 1950, and 1958. The sources from which our estimates have been constructed are Garrabou and Sanz, *Historia Agraria*, for 1834 and 1860; Simpson, *Spanish Agriculture*, for 1891/95-1929/33; Banco Urquijo, *La riqueza*, for 1920; and O'Brien and Prados de la Escosura, "Agricultural Productivity", background computations, for 1891-1980; Hayami and Ruttan, *Agricultural Development* and Prasada Rao *Inter-Country Comparisons* provide international comparable aggregate land estimates for 1960 and at five year benchmarks for 1970-90, respectively. Fortunately for main crops (major cereals, roots, fruit trees, vine and olive) annual figures are available (Barciela *et al.*, "Sector agrario").

[41] Agricultural output from Prados de la Escosura, *Progreso*.

quantity indices into a single Laspeyres index for the entire period considered.[42] Since the land stock grew little over the long run (Table 3 and Figure 5), and certainly much less than capital and labor, its inclusion in the growth accounting exercise pushes TFP growth upwards.[43]

[TABLE 3]

[FIGURE 5]

d) Labor input

The appropriate measure of labor input is the flow of services for production emanating from this factor.[44] Hence, our task is to estimate the labor force cross-classified by as many attributes as possible to capture its heterogeneity.[45] 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

[42] Indices with fixed weights (land prices) for 1931 and 1985 were respectively constructed for 1850-1958 and 1958-2000 and, then, spliced into a single quantity index of the stock of agricultural land. Land prices for 1931 and 1985 come from Bringas, *Productividad de los Factores* and Ministerio de Agricultura, *Estadística Agroalimentaria*, respectively. There are minor differences between the stock estimates (Laspeyres index) and the number of hectares index at least until the 1960s, which suggests that only minor composition changes took place over the first hundred years considered.

[43] Contrary to Matthews et al.'s (*British Economic Growth*:, p. 206) suggestion, adding land reduces factor input growth and, hence, increases that of TFP.

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

$$Li_t = \lambda_{Li} Hi_t, \qquad (12)$$

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

[45] 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).

received by each worker with her/his age and level of education. However, as a sensitivity test, we provide below alternative estimates for the labor input on the basis of educational attainment data.

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,[46] while assumed that female labor represented a stable proportion of male labor force in agriculture and, thus, we have increased the number of days assigned to each male worker (see below).[47] 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.[48] 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

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[46] 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 population is usual in Spanish historical literature. Cf. Nicolau, "Población"; Erdozáin and Mikelarena, "Cifras de activos agrarios"; and Pérez Moreda "Población y economía", p. 55.

[47] A similar strategy was followed by Carré et al., *French Economic Growth*, p. 89.

[48] We follow here Prados de la Escosura, *Progreso*, pp. 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.

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.[49] 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.[50]

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.[51] This assumption is consistent with contemporary testimonies and supported by the available evidence.[52] In agriculture, however,

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

[50] Unfortunately we cannot 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 *L'Espagne* and Prados de la Escosura *Progreso,* respectively.

[51] 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.

[52] Soto Carmona (*Trabajo industrial*, p. 608) pointed out that, on average, the number of days worked per occupied up to 1919 ranged between 240 and 270.

contemporary and historians' estimates point to a lower figure for the working days per occupied.[53] 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.[54] 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 as transportation and storing.[55] 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

[53] Day laborers, according to García Sanz, "Jornales agrícolas", p. 63, worked an average of 242 days per year in mid-nineteenth century Spain. Gómez Mendoza, *Ferrocarriles*, p. 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, "Richesse et Revenue", reckoned that, in 1914, the average number of days worked per year in agriculture was 250. Simpson, "Technical change", estimated labor requirements in Andalusia's agriculture between 1886 and 1930 and obtained even lower figures, ranging from 108 to 130 days.

[54] Using Simpson's, "Technical change", 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).

[55] Pérez Moreda, "Población y economía", p. 57, mentions a contemporary estimate for 1960 that puts disguised unemployment at 1.8 million in a potential agricultural workforce of over 5 million.

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, Fermín Caballero pointed to 10 hours per day while a similar average figure, 9.7 hours, was found for the mid 1950s.[56] 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, Michael Huberman'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.[57] Jordi Domenech's estimates for different industries and services in 1910 were adopted for 1900-1910, while Javier Silvestre's annual computations for industry were used over 1911-1919.[58] Álvaro Soto Carmona provides some construction and services figures for the Interwar years.[59] 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 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.

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[56] Caballero, *Memoria*. 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.

[57] Huberman, "Working Hours".

[58] Doménech, "Working Hours"; Silvestre, *Migraciones interiors*, p. 190.

[59] Soto Carmona, *Trabajo industrial*, pp. 596-613.

For the post-1954 period, labor force data comes from the MOISSES base for the period 1954-1963,[60] from *Encuesta de Población Activa* (thereafter EPA) for 1964-1980,[61] and from the official national accounts for 1980-2000.[62] The distribution of overall labor force across the different industries was based on *Banco de Bilbao*'s studies.[63] 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.[64]

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

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[60] Antonio Díaz Ballesteros kindly provided us with this data.

[61] Reconstructed in Baiges *et al., Economía española*.

[62] 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, *Progreso*. Official national accounts, CNE80, CNE85, CNE95, and CNE2000 have been used for 1980-85, 1985-95 and 1995-2000, respectively.

[63] These are collected in Fundación BBV, *Renta nacional*.

[64] Sanchis (private communication), furnished us with data on hours per economically active population for the 1950s. We used Maluquer de Motes and Llonch, "Trabajo y relaciones laborales", who rely on ILO data, for 1958-63; Ministerio de Trabajo's *Salarios* for 1964-78; and OECD, *Labor Force Statistics* from 1979 onwards.

[TABLE 4]

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*):

(13) $$H = (H/E) * (E/L)* (L/WAN) * (WAN/N)* N$$

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

(14) $$h = (h/e) + (e/l) + (l/wan) + (wan/n) + n$$

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 4). Hours per worker and per year shrank from 2,800 at mid-nineteenth century to 1,800 by the end of the twentieth century (Figure 6).[65]

[FIGURE 6]

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 urbanization and structural change. In the 1920s, falling hours per worker went hand-in-

[65] The decline in the number of daily hours worked per occupied led Denison, *Sources*, 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, “U.S. Economic Growth”, p. 124). However, here we follow the conventional approach and use total hours worked as a measure of the labor quantity.

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 is to weight each category of workers by its average nominal earnings.[66] 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.[67] From 1908 to 1920, we employed in our calculations

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[66] 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 (Cf. Prados de la Escosura and Rosés, "Wages").

[67] Agricultural wages were taken from Bringas, *Productividad de los factores*. Wages in construction (Madrid unskilled wages) and services were obtained from Reher and Ballesteros, "Precios y salarios", although they have been re-scaled to the national levels provided by Rosés and Sánchez-Alonso, "Regional Wage Convergence". Chastagneret, *L'Espagne*, and Escudero, *Minería*, 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, *Teoría General*, U.S. Department of Labor, *Fifteenth Annual Report*, and *Anuario Estadístico de Barcelona*. Annual variations between benchmarks were derived by means of Fisher

the detailed wage enquires conducted by the *Instituto de Reformas Sociales*.[68] Their reports (*Memorias Generales de la Inspección de Trabajo*) contained information by gender on minimum, maximum and average wages for twenty branches of industry.[69] The quality of wage data decreases dramatically over the years 1920-1954.[70] 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.[71] 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*.[72] 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

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indices with data drawn from Camps, *Formación del Mercado de trabajo*; Llonch, "Jornada, salarios"; and Soler, "Evolución del salario", in the case of consumer industries, and Escudero, *Minería*; and Pérez Castroviejo, *Clase obrera*, in the remaining industries.

[68] Javier Silvestre has kindly given us access to his wages database.

[69] Unfortunately, the source does not provide information on wages in agriculture and services so we had to rely on data from Bringas, *Productividad de los factores*; and Reher and Ballesteros, "Precios y salarios", respectively.

[70] Vilar, "Ruptura posbélica" for a review on the wage sources for this period.

[71] Ministerio de Trabajo, *Estadística de salarios*.

[72] Recently, Vilar "Ruptura posbélica" collected new data from unpublished local sources that we have employed in our calculations.

employed labor costs by sectors of economic activity from *Banco de Bilbao*.[73] These do not provide, however, a breakdown by occupational categories that had to be obtained, then, from the official enquiries on wage, labor costs, and wage structure,[74] and which were later re-scaled to match aggregate figures in *Banco de Bilbao*'s statistics.

[FIGURE 7]

Figure 7 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 5, 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 5, 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 8).

[TABLE 5]

[FIGURE 8]

This counterintuitive result for the post-1986 period raises the question of whether our labor input measure using the Jorgenson approach actually captures improvements in human capital affecting the labor force. Since human capital is usually approximated through education measures,[75] we made alternative estimates of the quality of labor on the basis of educational attainment for a sensitivity test. Thus, we computed a human capital measure using data on age

[73] Collected in Fundación BBV, *Renta nacional*; and Alcaide and Alcaide, *Renta nacional*.

[74] *Salarios*, *Encuesta de Salarios y de Coste Laboral* and *Encuesta de Estructura Salarial*.

[75] For Spain, see Mas et al., *Capital Humano*; and Doménech and de la Fuente, "Human Capital".

structure (as a measure of experience) and years of education attained, calibrated with the parameters from a Mincer equation for Spain in the early 1990s (Table 5, Col. IV).[76]. The average age of Spanish population ages 15 to 64 comes from data supplied by David Reher and are assumed representative for the labor force.[77] Education attainment is based on Núñez 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.[78] For the post-1974 period, we have relied on Daniel Cohen and Marcelo Soto's benchmark estimates of years of education interpolated log-linearly to obtain a yearly series and spliced with Nuñez's figures.[79] We carried out additional estimates and, following Bosworth and Collins, we obtained alternative human capital measures by relating educational attainment (*EDU*) to average years of schooling (s). Thus, $EDU = (1+r)^s$, with r being the rate of return.[80] We assumed alternatively 9 and 7.2 percent rates of return to each year.[81] The results of these alternative estimates, presented in Table A-2 of the Appendix, are highly coincidental.

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[76] Arrazola et al., "Returns to Education", p. 297. The estimate was carried out with data for 1993/4.

[77] 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 of that of 1850-57.

[78] Núñez, "Educación", pp. 167, 239-40 (Tables 3.1 and 3.13).

[79] Cohen and Soto, "Growth and Human Capital". The data used refer to "years of schooling of population 15-64 who is not studying". It is worth noting the high coincidence between figures by Núñez and Cohen and Soto during the years in which their estimates overlap (1960-74).

[80] Bosworth and Collins, "Empirics of Growth", pp. 119-20.

[81] The 9 percent return has been obtained by Alba and San Segundo, "Returns to Education", p. 162, after controlling for self-selection. The 7.2 percent return is quoted in Psacharopoulos and Patrinos, "Returns to Investment in Education": 127, and derives from Mora, Socioeconomic Background.

If we now compare our labor quality estimates obtained through the Jorgenson and the Mincer approaches (Table 5, 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 structural change than those suggesting negligible growth derived from the educational attainment approach.

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. study on human capital for our occupational categories.[82] Then, we employed the parameters from Alfonso Alba and María-Jesús San Segundo's Mincerian regression[83] for 1990 to weight each category by its relative value (wage) while maintaining the congruence with the total remuneration of the industry. 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

[82] Mas et al. *Capital Humano*

[83] Alba and San Segundo, "Returns to Education", p. 159. These parameters represent the average educational premium for each educational category.

approach. It could be that such a discrepancy resulted 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. We can, then, conclude that our Jorgenson labor input measure is biased against human capital since 1986 but captures reasonably well the impact of human capital on labor quality over the long-run. Actually, over the period 1964-2000, the Jorgenson and the new Mincer estimates cast similar growth rates (0.8 and 0.9 percent, respectively). Therefore, we will take both estimates into account in our analysis of the sources of growth in Spain.

e) Factor shares

In addition to the real factor inputs described above, we need to know the elasticity of output with respect to each input (Θi) in order to compute the sources of growth. Under the restrictive assumption of perfect competition and constant returns to scale, these elasticities can be proxied by the share of each factor's returns in national income. Such an assumption might be objectionable as restrictions on competition and monopolistic practices are common in Spanish history.[84] If the existence of competitive monopolistic rents were proved, our 'naïve' results, obtained under the assumption of perfect competition, would bias total factor productivity growth downwards, as the capital share in GDP –by including competitive monopoly profits- would overstate the elasticity of output with respect to capital, and the result would be a lower bound estimate for TFP growth.[85]

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[84] Cf. Fraile Balbín, *Industrialización* and *Retórica*.

[85] Young, "Tyranny of Numbers", p. 648. Relaxing the assumption of constant returns to scale would also impinge on our TFP estimates. If Spanish aggregate production function featured increasing returns to scale, our 'residual' would over-exaggerate TFP growth (Young, "Tyranny of Numbers", p. 648). Nonetheless, Suárez, "Economías de escala" rejected the increasing returns hypothesis for the case of Spain between 1965 and 1990.

Nonetheless, even if this were the case, as we can see below, the main stylized facts resulting would not be significantly altered.

Up to 1954, labor returns were directly estimated. From 1954 onwards, we derived factor shares from labor and property compensation provided by the different sets of national accounts that we have previously spliced together.[86] To measure labor income correctly it is crucial to establish which proportion of the income of proprietors, unpaid family workers, self-employed, and retired workers represent returns to labor.[87] We have attributed to entrepreneurs and self-employed workers a labor income per head equal to the average compensation of employees in their corresponding industry.[88] Dividing total labor (including self-employed) compensation by GDP at factor costs, we obtained the share of labor. The well-known difficulties to separate land rent from returns to capital in agriculture suggested us to include land rent in the returns of property, together with those of capital.[89] Nonetheless, we have made an attempt to decompose the share of property in national income into the returns to capital and land. The lack of information on land rents forced us to derive the land share as the residual after deducting labor outlays from agricultural gross value added. This method implies no

[86] We followed the same procedure employed for linking GDP and its components, and labor force in Prados de la Escosura (*Progreso*: chapter 4), in which instead of just simply re-scaling earlier national accounts by their differential ratio for the overlapping year, an alternative linkage procedure was used in which the gap was distributed over time at a constant annual rate.

[87] See Prados de la Escosura and Rosés, "Wages".

[88] Kuznets, *Modern Economic Growth*. This is a common procedure in growth accounting (Jorgenson, "Productivity").

[89] The returns to land remunerate its original productive capability that results from natural factors. In practice, however, it is practically impossible to quantify the 'original' productive capability of any kind of land since other factors (cap ital, in particular) are involved in it. (Ministerio de Agricultura, *Cuentas del sector agrario*, pp. 46-50). In his major work on the efficiency of Spanish agriculture since 1964, San Juan, *Eficacia y rentabilidad*, does only consider labor and capital (that includes land) as production factors in the estimate of the sources of agricultural growth.

returns to capital from agriculture and, hence, tends to overstate the share of land in GDP.[90] The share of capital was obtained as a residual after deducting labor and land returns from GDP at factor cost.[91]

[TABLE 6]

[FIGURE 9]

Figure 9 shows the evolution of the shares of land, capital and labor in GDP. On average, for the one and a half centuries considered, our factor shares are 0.08 for land, 0.24 for capital –that is, 0.32 for property-, and 0.68 for labor, that roughly match the 1/3 and 2/3 weights conventionally employed in the growth literature. Average shares vary across long swings with labor fluctuating around two-thirds of GDP, except in the phase of accelerating growth, 1959-74, and during the critical years of the 'transition to democracy' (1975-86) in which it reached above three-fourths of GDP (Table 6). Interestingly the peak of labor share corresponds to years in which skilled workers represented a larger proportion of the labor force and income inequality was lower.[92]

The relative instability of productive factors' shares in GDP stands out against the conventional assumption of stability. This is largely a consequence of data limitations, but their fluctuations can be explained.[93] In Spain, the functional distribution of income appears to be a good

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[90] Nonetheless, given that the relative size of agriculture shrank during the second half of the twentieth century, the resulting (upwards) bias in our TFP growth estimates should not be large.

[91] Although we will estimate the sources of growth using three independent factors of production land, capital, and labor, we will also replicate the exercise using only capital and labor (See Appendix, Table A-3).

[92] Prados de la Escosura, "Inequality, Poverty". A rise in income inequality took place in the late 1990s partly resulting from an improvement in the returns to property income (Alvaredo and Saez, Income and Wealth).

[93] It could be argue that the common assumption of fixed factor shares in the literature makes virtue out of necessity. See Collins and Bosworth, "Economic Growth", pp. 154-5, and Bosworth and Collins, "Empirics of Growth", p. 115. Maddison, "Growth and Slowdown", pp. 659-61, provides an interesting discussion in which he argues in favor of fixed factor shares and suggests 0.3 for capital and 0.7 for labor. See the discussion of the relevant literature in Prados de la Escosura and Rosés, "Wages".

proxy for income distribution up to 1960, as the dispersion within labor and property compensation was relatively unaltered.[94] Only later, as skilled labor increased, did the functional distribution become non-representative of personal income distribution. Distinct phases can be observed. Between mid-nineteenth century and World War I a relative increase in the property share occurred while the labor share tended to decrease. The growing importance of capital can be attributed, among other causes, to rising investment rates and technological change favoring capital.[95] The rise in inequality (from the late 1890s to the end of World War I) coincided with a return to strict protectionism. Stolper-Samuelson forces would have been reinforced by the fact that tariff protection did not push out workers as the depreciation of the peseta increased the cost of migration.[96] In the interwar years, the labor share grew significantly. Institutional labor market reforms favoring workers, especially the reduction in the number of working hours per day, and the increasing voice of trade unions, contributed to a rise in wages relative to property incomes. Also the increase in the human capital endowment of the workforce influenced the expansion of labor.[97] The early years of the Franco's regime witnessed a sharp decrease in the labor share, an outcome of dictatorship's economic policy that implied a re-distribution of income towards property owners.[98] Since the mid-1950s a rapid increase in labor share took place that peaked by the late 1960s when

[94] See Prados de la Escosura, "Inequality, Poverty", on which this paragraph draws on.

[95] It is worth considering the evolution of the land share. After the 1855 peak, usually associated to the Crimean War boom, the land share fell until 1866. From the late 1860s to the mid-1880s, the land share recovered as agricultural exports expanded and the economy grew rapidly. The so called 'agricultural depression' appears to have had an impact on returns to land in the late eighties with a trough in 1892, just at the time Cánovas protectionist tariff was introduced.

[96] Sánchez-Alonso, "European Migration"

[97] As regards land rents, its recovery peaked during First World War to decline in its aftermath, and more severely in the years of the Great Depression and the Civil War.

[98] The autarchy years in early Franco's Regime witnessed a recovery of land rents that was reverted since the early 1950s once Spain started a sustained process of accelerated growth.

pre-Civil War levels were recovered. These labor share gains can be attributed to an expansion of human capital and to the more liberal economic policies that accompanied growth and structural change in the late Francoist regime. Since the early 1970s, however, the capital share in GDP has tended to grow at expenses of labor.

The crudeness of annual factor shares has often led authors to prefer the use of fixed factor shares over time, so we present here growth accounts derived with variable factor shares and, as a sensitivity test, also with fixed factor shares that correspond to their average over the hundred and fifty years considered.

MAIN TRENDS IN TOTAL FACTOR PRODUCTIVITY

The sources of long-run growth in Spain are offered in Table 7, with labor quality estimates using the Jorgenson approach and the resulting TFP estimates in Cols. (VI) and (VII), and alternative estimates using the Mincer approach and the subsequent TFP estimates in Cols. (VIII) and (IX). Estimates derived with variable factor shares are presented in the upper panel and those with fixed factor shares (namely, their average for 1850-2000) in the lower panel. Over the one-and-a-half century considered, TFP and broad capital (physical and, to less extent, human capital) appear to be equally responsible for GDP growth. A glance at long periods shows that the early 1950s represent a divide between hundred years of moderate growth dominated by factor accumulation, and half a century of fast growth led by total factor productivity. Actually, 70 percent of the acceleration in GDP growth over 1951-2000 compared with 1850-1950, is due to efficiency gains.

[TABLE 7]

A closer look at long swing intervals reveals that prior to 1950 total factor productivity played a far from negligible role in phases of faster GDP growth: 1850-83 and the 1920s. Thus, TFP contributed between one-third and one-half (depending on whether Jorgenson or Mincer labor quality estimates are chosen) to acceleration of GDP growth in the 1920s over 1884-1920. Furthermore, the importance of TFP as a source of growth tends to be underestimated as it does not include the additional capital accumulation that results from a productivity increase.[99] Thus, in the absence of the innovation represented by the introduction of the railroads and the modern exploitation of Spanish mining ore deposits during 1850-83 and by electrification in the 1920s, we could speculate that the Spanish economy would have experienced not only lower efficiency gains but also lower capital intensity resulting from the lack of new capital goods.[100]

Total factor productivity led GDP growth during 1953-1986, a period that included both the Golden Age and, unexpectedly, the decade of sluggish growth when the transition from dictatorship to democracy was undertaken. TFP contributed with more than half of GDP growth during the Golden Age, and two-thirds to its acceleration over the previous hundred years. In fact, about two-thirds and four-fifths of the acceleration in GDP growth in 1953-58 and 1959-74 over the previous long swings (1930-52 and 1953-58, respectively) were due to TFP. Then, in the ‘transition to democracy’ years (1975-86) efficiency gains prevented a GDP contraction, as the increase in broad capital fell short to compensate the dramatic decline in employment. Conversely, since Spain’s entry into the European Union (1986) employment creation and the recovery of physical capital accumulation offset the slowdown in total factor productivity.[101] The alternative use of variable and fixed factor shares across long swings does not cast conflicting results.[102]

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[99] Cf. Hulten and Srinivasan, “Indian Manufacturing”.

[100] Cf. Crafts, “Productivity Growth”, pp. 522-4. As regards the impact of railroads on Spain’s growth, see Herranz-Loncán, “Railroad Impact”. This author (p. 873) estimates the railroad TFP contribution to GDP growth (through a social saving approach) in 0.045 percent. This would represent between 7 and 12 percent of Spain’s TFP growth over 1850-1883 (using variable and fixed factor shares, respectively) that would rise to 9-20 percent with Mincer labor quality estimates. This back-of-the-envelope exercise suggests a far from negligible contribution of the railroad to aggregate TFP growth. On electrification in 1920s Spain Cf. Betrán, Natural Resources, and Sanchis, “Economic ‘Miracle’”.

[101] Spain is not the only case in Europe. For example, van Ark “European Union” claims that a slow adjustment towards a new industrial structure is behind the productivity slowdown. In particular, he blames the slow ICT diffusion in market services.

If, alternatively, labor quality is measured through a Mincer approach (Table 7, Cols. (VIII) and (IX)), noticeable differentials in the labor quality contribution only appear and have, therefore, an impact on TFP growth in the 1920s and since 1987. During the 1920s, a lower improvement in Mincer labor quality estimates increases TFP growth from the 1.1 percent obtained with the Jorgenson approach (1.0 with fixed factor shares) to 1.6 percent, rising its contribution to GDP growth from one-fourth to two-fifths, while, conversely, between 1987 and 2000, the more intense labor quality gains in the Mincer estimates suppresses the TFP contribution to GDP growth (from 0.2 to -0.3 percent using variable factor shares, and from 0.6 to 0.1 percent with fixed factor shares).[103]

How do our results compare to those obtained by empirical economists for the post-1964 era? A glance at Table 8 suggests that our growth rates are in line with those available for 1965-74 and for 1987-2000, in which a productivity slowdown has followed Spain's admission into the European Union, but are far higher for the 'transition to democracy' years (1975-86).[104]

[TABLE 9]

[102] Only a minor discrepancy comes out for 1987-2000 due to the lower weight capital receives in this period with fixed factor shares that results in higher TFP growth (0.6 versus 0.2 percent).

[103] An alternative set of estimates in which land is not taken as a separate factor of production but included as a part of capital, is provided in Table A-3 of the Appendix. The main difference with our previous estimates that incorporate land as an independent factor is to cut down the rate of TFP growth, as land grows less than capital. The exclusion of land as an independent factor of production provides, thus, a lower bound for TFP growth. This is noticeable for 1850-83, the 1920s, and, especially, for 1953-58, with variable factor shares (and for the second half of the twentieth century, with fixed factor shares). Thus, TFP growth is suppressed for 1850-1950, as a whole using the Jorgenson approach to labor quality, while becomes negative for 1987-2000 with the Mincer approach.

[104] The reader should bear in mind that the methods employed in the computation of the sources of growth differ widely across authors lending, perhaps, more validity to the coincidence of results during the years 1965-74 and 1987-2000.

Modern economic growth is associated with improvements in GDP per head but, so far, the discussion has been focused on absolute GDP trends. We need, therefore, to establish the connection between increases in per capita GDP and efficiency gains. Table 9 provides an intermediate stage, namely, the decomposition of output per head into hours per person and output per hour. Although hours worked per person declined in the long run trend, the 1920s and the post-1986 years show a marked increase in the labor quantity per head. Labor productivity, in turn, grew at a modest pace before 1920 and, again, since Spain's entry into the EU, while stagnated in the thirties and forties, and experienced impressive gains between 1953 and 1986. Sluggish labor productivity lies beneath weak improvements in GDP per head, with the exception of the last quarter of the twentieth century when labor quantity and productivity evolve inversely. Employment disappeared during the 'transition to democracy' years but was more than offset by the productivity surge associated to industrial re-structuring and shifts of resources away from agriculture and traditional industrial sectors. Since 1987 the productivity slowdown has been compensated by a strong increase in hours worked. As Riccardo Faini put it for the Euro zone, Spain seems to have been unable to combine employment and productivity growth since the mid-1970s.[105]

[TABLE 10]

Labor productivity trends are determined, in turn, by human and physical capital/labor ratios and efficiency gains. Table 10 provides the decomposition of labor productivity growth using alternative sets of estimates (with variable and fixed factor shares in the upper and lower panels, respectively) using Jorgenson (Cols. (IV)-(V)) and Mincer (Cols. (VI)-(VII)) labor quality measures. A main finding is that TFP accounts for half the increase in labor productivity over the one and a half centuries considered. Nonetheless, the divide between factor input accumulation as the dominant force (contributing from two-thirds –Jorgenson- to three-fourths –Mincer- of labor productivity growth) prior to 1950 and TFP as the hegemonic role of thereafter (with a contribution

[105] Faini, "Europe", p. 80.

of two-third of labor productivity growth in the Golden Age and around one-half thereafter), already observed for the sources of GDP growth, remains. If we look now at long swing intervals we find that TFP largely contributed to the rise in output per hour in each of them but for the *Restauración* (1884-1920), the 1930s and 1940s, and the post-1987 years. Furthermore, changes in the pace at which labor productivity advanced are closely associated to those in TFP. For example, TFP accounted for most, if not all, of labor productivity acceleration over the previous long swing in the 1920s and, in the Golden Age, TFP made the largest contribution to the increase in output per hour worked (about three-quarters). Even more important was its role in phases of labor productivity decline when TFP accounts for nearly all of it.

CONCLUDING REMARKS

The main arguments of the paper can now be re-stated. First, factor accumulation, especially capital, and TFP growth seem to have been complementary for GDP and labor productivity growth over the long-run [106] Spanish experience suggests a two-stage process in which improving efficiency appears as a complex learning process that takes place once growth has been initiated on the basis of allocating additional capital and labor to production. Abstention, rather than ingenuity dominated long-run growth in Spain up to 1950. Thereafter, TFP growth, a 'free lunch' to use Joel Mokyr's words, drove economic progress and our results do not confirm Krugman's intuition that growth on the basis of capital accumulation leads to a growth slowdown in the future.[107]

[106] New investment opportunities that increase capital accumulation as a result of technological change and exogenous increases in investment that rise TFP growth as new capital vintages appear offer ways for their interaction (Crafts, "Productivity Growth", pp. 522-3). As Collins and Bosworth, "Economic Growth", p. 164, point out, technical advances might be embodied in new capital while increasing TFP might induce greater capital accumulation by raising the returns to capital.

[107] Mokyr, *Level of Riches*, p. 3. According to Krugman, "Myth", pp. 77-8, this happens as a result of the law of diminishing returns The fact that TFP has slowed down since 1986 opens, nonetheless, this possibility in the early twentieth-first century.

Second, we accept that our growth accounting yields only a range of best guesstimates and that our coverage of factor accumulation is far from perfect. However, it is important not to exaggerate the skepticism. After computing the sources of growth with alternative measures of factor accumulation and factor shares the resulting rates of TFP growth generally exhibit fairly small differences.

Third, our results do not appear unusual in international perspective where there is growing evidence suggesting that factor accumulation prevailed over efficiency gains in the early stages of development. Factor accumulation seems to play a role during the transitional phase to long-run growth.[108] Once modern economic growth is under way, TFP tends to perform a more significant part. Indeed, TFP provided at least one-quarter of British GDP growth between 1780 and 1860, a proportion that increases to three-eights when embodied technological change is taken into account.[109] Slow TFP growth has also been confirmed for the nineteenth century in the United States.[110] Long run assessments for countries in the European Periphery such as Portugal and Turkey show similar results.[111] During the last four decades of the twentieth century developing countries exhibited growth rates dominated by factor accumulation.[112] In modern Spain, as in Britain during the Industrial Revolution, TFP accounted for most of labor productivity acceleration.[113] Does the ability to absorb and to adapt productively foreign ideas and technology depend on a country's development level?[114] Comparative historical research will be needed to widen our analysis of the sources of long-run growth to countries at different levels of development before this hypothesis can be put to the test.

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[108] Grossman and Helpman, *Innovation and Growth*, p. 26.

[109] Crafts, "Productivity Growth", p. 533.

[110] Kendrick, *Productivity Trends*; Abramovitz and David, "Two centuries", p. 35.

[111] Lains, "Catching Up"; Altug et al., "Sources".

[112] Collins and Bosworth, "Economic Growth", p. 159. Young, "Tyranny of Numbers", pp. 657-61; and Young, "Razor's Edge".

[113] Crafts, "Productivity Growth".

[114] Abramovitz, "Catching Up"; Collins and Bosworth, "Economic Growth"

REFERENCES

Abramovitz, M. "Catching Up, Falling Behind, and Forging Ahead." This *Journal* 46, no.2 (1986): 385-406.

Abramovitz, M. and P. David. *Two Centuries of American Macroeconomic Growth from Exploitation of Resource Abundance to Knowledge-Driven Development*. SIEPR Discussion Paper No. 01-05, 2001.

Alba, A. and M.J. San Segundo (1995). "The Returns to Education in Spain." *Economics of Education Review* 14, no. 2 (1995): 155-66.

Alcaide, J and P. Alcaide. *Renta nacional de España y su distribución provincial. Año 1995 y avances 1996-1999*. Bilbao: Fundación BBVA, 2001.

Altug, S., A. Filiztekin, and S. Pamuk. "Sources of Long-Term Economic Growth for Turkey, 1880-2005." CEPR Discussion Paper 6463, September 2007.

Alvaredo, F. and E. Saez. "Income and Wealth Concentration in Spain in a Historical and Fiscal Perspective." Paris School of Economics Working Paper 2007-39, 2007.

Antràs, P. H.J. Voth. "Factor Prices and Productivity Growth during the British Industrial Revolution." *Explorations in Economic History* 40, no.1 (2003): 52-77.

Anuario Estadístico de Barcelona. Barcelona: Ayuntamiento de Barcelona, 1905.

Anuario Estadístico de España, several issues.

Ark, B. van. "Does the European Union Need to Revive Productivity Growth?." In *Competitiveness and Growth In Europe. Lessons and Policy Implications for the Lisbon Strategy*, edited by S. Mundschenk, M.H. Stierle, U. Stierle-von Schütz, and I. Traistaru. Aldershot: Edward Elgar Publishers, 2006.

Arrazola, M., J. de Hevia, M. Risueño, and J.F. Sanz. "Returns to Education in Spain: Some Evidence on the Endogeneity of Schooling." *Education Economics* 11, no. 3 (2003): 293-304.

Baiges, J., C. Molinas, and M. Sebastián. *La economía española 1964-1985. Datos, fuentes y análisis.* Madrid: Instituto de Estudios Fiscales, 1987.

Banco Urquijo, *La Riqueza y el progreso de España*. Madrid: Banco Urquijo, 1924.

Barciela, C., J. Giráldez, GHER and I. López. "Sector agrario y pesca." In *Estadísticas Históricas de España, siglos XIX y XX,* edited by A. Carreras and X. Tafunell, 245-356, Bilbao: Fundación BBBV, 2005.

Barro, R.J. "Notes on Growth Accounting." *Journal of Economic Growth* 4 no. 2 (1999): 119-37.

Betrán Pérez, C. "Natural Resources, Electrification and Economic Growth from the End of the XIXth Century unitl World War II." Universidad de Valencia Documento de Trabajo 00-03, 2000.

Bosworth, B.P. and S. M. Collins. "Accounting for Growth: Comparing China and India", NBER Working Paper No. 12943, Cambridge, MA, February 2007.

_______. "The Empirics of Growth: An Update." *Brookings Papers in Economic Activity* 2 (2003): 113-79.

Bringas Gutiérrez, M.A. *La productividad de los factores en la agricultura española (1752-1935)*. Madrid: Banco de España, 2000.

Broadberry, S. N. *The Productivity Race: British Manufacturing in International Perspective, 1850-1990*. Cambridge: Cambridge University Press, 1997.

Caballero, F. *Memoria sobre el fomento de la población rural*. Madrid: Imp. del Colegio de Sordo-mudos y de Ciegos, 1864.

Camps, E. *La formación del mercado de trabajo industrial en la Cataluña del siglo XIX*. Madrid: Ministerio de Trabajo y Seguridad Social, 1995.

Carré, J.J, P. Dubois, and E. Malinvaud. *French Economic Growth*. Stanford: Stanford University Press, 1975.

Cebrián, M. "Las fuentes del crecimiento económico español, 1964-1973." *Revista de Historia Económica* 19, special issue (2001): 277-99.

Cerdá, I. *Teoría General de la Urbanización y aplicación de sus principios y doctrinas a la reforma y ensanche de Barcelona*. Barcelona: 1867.

Chastagnaret, G. *L'Espagne, puissance minière dans l'Europe du XIXe siècle*. Madrid: Casa de Velázquez, 2000.
Christensen, L. Jorgenson, D. and L. Lau. "Transcendental Logarithmic Production Frontiers." *Review of Economics and Statistics* 55, no. 1 (1973): 8-45.
Cohen, D. and M. Soto. "Growth and Human Capital: Good Data, Good Results." OECD Development Centre Technical Papers no. 179, September 2001.
Collins, S.M., and B.P. Bosworth. "Economic Growth in East Asia: Accumulation versus Assimilation."*Brookings Papers in Economic Activity* 2 (1996): 135-91.
Crafts, N.F.R. *British Economic Growth during the Industrial Revolution.* Oxford: Oxford University Press, 1985.
_______. "Implications of Financial Crisis for East Asian Trend Growth." *Oxford Review of Economic Policy* 15 (1999): 110-31.
_______. "Productivity Growth in the Industrial Revolution: A New Growth Accounting Perspective." This *Journal* 64, no. 2 (2004): 521-35.
Dabán Sánchez, T., A. Díaz Ballesteros, F.J. Escribá Pérez, and M.J. Murgui García. "La base de datos BDMORES". Mº de Economía y Hacienda. Dirección General de Análisis y Programación Presupuestaria. Documento de Trabajo D-98001, 1998.
Denison, E.F. *The Sources of Economic Growth in the United States and the Alternatives before Us*. Washington, DC: Committee for Economic Development, 1962.
Denison, E.F. (with J.-P. Poullier). *Why Growth Rates Differ Postwar Experience in Nine Western Countries*. Washington, D.C.: The Brookings Institution, 1967.
Domar, E. "On the Measurement of Technological Change." *Economic Journal* 71, no. 284 (1961): 709-29.
Doménech, J. "Working Hours in the European Periphery. The Length of the Working Day in Spain, 1880-1920." *Explorations in Economic History* 44 (2007): 469-86.
Doménech, R. and A. de la Fuente. "Human Capital in Growth Regressions: How Much Difference Does Data Quality Make?." *Journal of the European Economic Association* 4, no. 1 (2006): 1-36.
Encuesta de Estructura Salarial, Madrid: INE, several issues.
Encuesta de Salarios y de Coste Laboral, Madrid: INE, several issues.
Erdozáin, P. and F. Mikelarena. "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* XVII, no. 1 (1999): 89-113.
Escudero, A. *Minería e industrialización de Vizcaya*. Barcelona: Crítica, 1998.
Faini, R. "Europe: A Continent in Decline." In *The Global Economy in the 1990s. A Long-run Perspective*, edited by Paul W. Rhode and Gianni Toniolo, 69-88. Cambridge: Cambridge University Press, 2006.
Feinstein, C.H. "Sources and Methods of Estimation for Domestic Reproducible Fixed Assets, Stocks and Works in Progress, Overseas Assets, and Land." In *Studies in Capital Formation in the United Kingdom 1750-1920*, edited by C.H. Feinstein and S. Pollard, 257-471. Oxford: Clarendon Press.
Fraile, P. *Industrialización y grupos de presión. La economía política de la protección en España 1900-1950*. Madrid: Alianza, 1991.
_______. *La retórica contra la competencia en España (1875-1975)*. Madrid: Fundación Argentaria/Visor, 1988.
Fundación BBV. *Renta nacional de España y su distribución provincial: serie homogénea años 1955 a 1993 y avances 1994 a 1998*. Bilbao: Fundación BBV, 1999.
García Sanz, A. "Jornales agrícolas y presupuesto familiar campesino en España a mediados del siglo XIX." *Anales del CUNEF* (1979-1980): 49-71.
Garrabou, R. and R. Sanz. *Historia Agraria de la España contemporánea*. Barcelona: Crítica, 1985.

Gómez Mendoza, A. *Ferrocarriles y cambio económico en España (1855-1913)*. Madrid: Alianza, 1982.
Gordon, R.J. "U.S. Economic Growth Since 1870: One Big Wave?." *American Economic Review Papers and Proceedings* 89, no. 2 (1999): 123:28.
Griliches, Z and D. Jorgenson. "The Explanation of Productivity Change." *Review of Economic Studies* 34, no. 99 (1967): 249-80.
Grossman, G.M. and E. Helpman. *Innovation and Growth in the Global Economy.* Cambridge: MIT Press, 1991.
Hall, R.J and D. Jorgenson. "Tax Policy and Investment Behavior." *American Economic Review* 57, no. 3 (1967): 391-414.
Hayami, Y. and V.W. Ruttan. *Agricultural Development. An International Perspective*. Baltimore and London: The Johns Hopkins University Press, 1985.
Herranz-Loncán, A. "Railroad Impact in Backward Economies: Spain, 1850-1913." This JOURNAL 66, no. 4 (2006): 853-81.
Hofman, A. "Economic Development in Latin America in the 20th Century. A Comparative Perspective." In *Explaining Economic Growth* edited by A. Szirmai, B. van Ark, and D. Pilat, 241-66. Amsterdam: North-Holland, 1993.
Huberman, M. "Working Hours of the World Unite? New International Evidence of Worktime, 1870-1913." This JOURNAL 64, no. 4 (2005): 964-1001.
Hulten, Ch.R. "The Measurement of Capital." In *Fifty Years of Economic Measurement. The Jubilee of the Conference on Research in Income and Wealth*, edited by E.R. Berndt and J.E. Tripplett, 119-52. Chicago: NBER Studies in Income and Wealth, vol. 54. Chicago: University of Chicago Press, 1990.
_______. "Growth Accounting when Technical Change is Embodied in Capital." A*merican Economic Review* 82, no. 4 (1992): 964-80.
_______. and S. Srinivasan. "Indian Manufacturing Industry: Elephant or Tiger?." NBER Working Paper No. 7441, Cambridge, MA, December 1999.
_______. and F. Wykoff. "The Estimation of Economic Depreciation Using Vintage Asset Prices." *Journal of Econometrics* 15 (1981): 367-96.
Jorgenson, D.J. (1989), "Capital as a Factor of Production." In Technology and Capital Formation, edited by D.J. Jorgenson and R. Landau, 1-35, Cambridge, MA: MIT Press, 1989.
_______. "Productivity and Economic Growth." In *Fifty Years of Economic Measurement. The Jubilee of the Conference on Research in Income and Wealth*, edited by E.R. Berndt and J.E. Tripplett, 19-118. Chicago: NBER Studies in Income and Wealth, vol. 54. Chicago: University of Chicago Press, 1990.
Kendrick, J.W. *Productivity Trends in the United States*. Princeton: Princeton University Press, 1961.
Krugman, P. "The Myth of Asia's Miracle." *Foreign Affairs* 73, no.6 (1994): 62-78.
Kuznets, S. *Modern Economic Growth*. New Haven: Yale Univ. Press, 1966.
Lains, P. "Catching Up to the European Core: Portuguese Economic Growth, 1910-1990." *Explorations in Economic History* 40 (2003): 369-86.
Llonch, M. "Jornada, salarios y costes laborales en el sector textil catalán." *Revista de Historia Industrial* 26 (2004): 101-40.
Maddison, A. "Growth and Slowdown in Advanced Capitalist Economies: Techniques of Quantitative Assessment." *Journal of Economic Literature* 25, no. 2 (1987): 649-68.
Maluquer de Motes, J. and M. Llonch. "Trabajo y relaciones laborales." In *Estadísticas Históricas de España, siglos XIX y XX*, edited by A. Carreras and X. Tafunell, 1154-245, Bilbao: Fundación BBBV, 2005.
Matthews, R.C.O, C.H. Feinstein, and J. Odling-Smee. *British Economic Growth, 1856-1973*. Oxford: Oxford University Press, 1982.
Mas, M. and J. Quesada, *Las nuevas tecnologías y el crecimiento económico en España*. Bilbao: Fundación BBVA, 2005

_______., F. Pérez, E. Uriel, L. Serrano and A. Soler. *Capital Humano. Series 1964-2004*. Valencia: Fundación Bancaja and Ivie, 2005.
McCloskey, D.N. "The Industrial Revolution in Britain 1780-1860: A Survey." In *The Economic History of Britain since 1700*, edited by R. Floud and D. McCloskey, 103-27. Cambridge: Cambridge University Press, 1981.
Ministerio de Agricultura. *Cuentas del sector agrario*. Madrid: Secretaría General Técnica del Ministerio de Agricultura, 1979.
Ministerio de Agricultura, Pesca y Alimentación. *Anuario de Estadística Agroalimentaria*. Madrid: Ministerio de Agricultura, Pesca y Alimentación, 2005.
Ministerio de Trabajo. *Estadística de salarios y jornadas de trabajo: 1914-1930. Resultados globales en toda la Nación*. Madrid: Ministerio de Trabajo, 1931.
Ministerio de Trabajo. *Salarios*. Madrid: Ministerio de Trabajo, 1964-1978.
Mokyr, J. *The Lever of Riches: Technological Creativity and Economic Progress*. New York: Oxford University Press, 1990.
_______. "Editor's Introduction: The New Economic History and the Industrial Revolution". In *The British Industrial Revolution: An Economic Perspective*, edited by J. Mokyr, 1-127. Oxford: Westview Press, 1999.
Mora, J.G.. "Socioeconomic Background, Schooling, and Monetary Rewards in Spain." Universidad de Valencia, Mimeo.
Myro, R. "La evolución de la productividad global de la economía española en el período 1965-1981." *Información Comercial Española* 594 (1983): 115-27.
Nicolau, R. "Población, salud y actividad." In *Estadísticas Históricas de España, siglos XIX y XX*, edited by A. Carreras and X. Tafunell, 77-154, Bilbao: Fundación BBBV, 2005.
Núñez, C.E. "Educación." In *Estadísticas Históricas de España, siglos XIX y XX*, edited by A. Carreras and X. Tafunell, 155-244, Bilbao: Fundación BBBV, 2005.
O'Brien, P. and L. Prados de la Escosura. "Agricultural Productivity and European Industrialization, 1890-1980." *Economic History Review* 45, no. 3 (1992): 514-36.
OECD. *The Labour Force Statistics Database.* Paris: OECD, 2006.
Pérez Castroviejo, P.M. *Clase obrera y niveles de vida en las primeras fases de la industrialización vizcaina.* Madrid: Ministerio de Trabajo y Seguridad Social, 1992.
Pérez Moreda, V. "Población y economía en la España de los siglos XIX y XX." In *Historia Económica de España, Siglos XIX y XX*, edited by G. Anes, 7-62, Barcelona: Galaxia Gutemberg, 1999.
Prados de la Escosura, L. *El progreso económico de España, 1850-2000*. Bilbao: Fundación BBVA, 2003.
_______. "Growth and Structural Change in Spain, 1850-2000: A European Perspective." *Revista de Historia Económica / Journal of Iberian and Latin American Economic History* 25, no. 1 (2007): 147-81.
_______. "Inequality, Poverty, and the Kuznets Curve in Spain, 1850-2000." *European Review of Economic History* 12, no.2.
_______. and J.R. Rosés. "'National Income Accounts: Wages and Labour" in *Oxford Encyclopedia of Economic History*, edited by Joel Mokyr, London: Oxford University Press, 2003, pp. 48-52.
_______. and J.R. Rosés. "Physical Capital in Spain, 1850-2000." Universidad Carlos III Working Papers in Economic History 2008-07, April 2008.
Prasada Rao, D. S. *Inter-Country Comparisons of Agricultural Output and Productivity*. Rome: FAO, 1993.
Psacharopoulos, G. and H.A. Patrinos. "Returns to Investment in Education: A Further Update." *Education Economics* 12, no. 2 (2004): 111-34.
Reher, D.S. and E. Ballesteros. "Precios y salarios en Castilla la Nueva: la construcción de un índice de salarios reales, 1509-1991." *Revista de Historia Económica* 11, no. 1 (1993): 101-51.

Rosés, J.R. and B. Sánchez-Alonso. “Regional Wage Convergence in Spain (1850-1930).” *Explorations in Economic History* 41, no. 3 (2004): 404-25.
San Juan, C., *Eficacia y rentabilidad de la agricultura española*. Madrid: Ministerio de Agricultura, Pesca y Alimentación, 1987.
Sánchez-Alonso, B. “European Emigration in the Late Nineteenth Century: the Paradoxical Case of Spain.” *Economic History Review* 53, no. 2 (2000): 309-30.
Sanchis, T. “Spanish Economic ‘Miracle’: A Disaggregated Approach to Productivity Growth, 1958-1975.” *Revista de Historia Económica / Journal of Iberian and Latin American Economic History* 24, no. 2 (2006): 383-417.
Silvestre, J. *Migraciones interiores y mercado de trabajo en España, 1877-1936*. Ph.D. diss., Universidad de Zaragoza, 2003.
Simpson, J. “Technical Change, Labor Absorption, and Living Standards in Andalucia 1886-1936.” *Agricultural History* 66, no. 3 (1992): 1-24.
_______, *Spanish Agriculture: the Long Siesta, 1765-1965*. Cambridge: Cambridge University Press, 1995.
Soler, R. “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, no. 2 (1997): 399-411.
Soto Carmona, A. *El trabajo industrial en la España contemporánea: (1874-1936)*. Rubí: Anthropos, 1989.
Suárez, F.J. “Economías de escala, poder de mercado y externalidades: Medición de las fuentes del crecimiento español.” *Investigaciones Económicas* 16, no. 3 (1992): 411-41.
Sudrià, C. “Los beneficios de España durante la gran guerra. Una aproximación a la balanza de pagos española, 1914-1920.” *Revista de Historia Económica* 8, no. 1 (1990): 363-96.
Tafunell, X. “Empresa y bolsa.” In *Estadísticas Históricas de España, siglos XIX y XX*, edited by A. Carreras and X. Tafunell, 707-833, Bilbao: Fundación BBBV, 2005.
_______. “La rentabilidad financiera de la empresa española, 1880-1981: una estimación en perspectiva sectorial.” *Revista de Historia Industrial* 18 (2001): 71-111.
Timmer, M.P., and B. van Ark. “Does Information and Communication Technology Drive EU-US productivity Growth Differentials?.” *Oxford Economic Papers* 57, no. 4 (2005): 693-716.
U.S. Department of Labor. *Fifteenth Annual Report of the Commissioner of Labor: Wages in Commercial Countries*. Washington DC: GPO, 1900.
Vandellós, J.A. “La richesse et le revenu de la Péninsule Ibérique.” *Metron* 4 (1925): 151-86.
Velarde, J. *Política Económica de la Dictadura*. Madrid: Guadiana, 1969.
Vilar, M. “La ruptura posbélica a través del comportamiento de los salarios industriales: nueva evidencia cuantitativa (1908-1963).” *Revista de Historia Industrial* 25 (2004): 81-126.
Young, A. “The Tyranny of Numbers: Confronting the Statistical Realities of the East Asian Growth Experience.” *Quarterly Journal of Economics* 90, no. 2 (1995): 641-80.
_______. “The Razor's Edge: Distortions and Incremental Reform in the People's Republic of China.” *Quarterly Journal of Economics* 115, no 4 (2000): 109-35.

TABLE 1
GDP AND PER CAPITA GDP GROWTH, 1850-2000
(Annual average logarithmic rates %)

	(I) GDP	(II) Per Capita GDP
1850-2000	2.5	1.9
Panel A.		
1850-1950	1.4	0.8
1951-1974	6.5	5.5
1975-2000	3.0	2.6
Panel B.		
1850-1883	1.8	1.4
1884-1920	1.3	0.7
1921-1929	3.8	2.8
1930-1952	0.8	0.0
1953-1958	4.7	3.9
1959-1974	6.9	5.8
1975-1986	2.5	1.8
1987-2000	3.5	3.3

Sources: Prados de la Escosura, *Progreso*, and see text, fn. 1

TABLE 2
CAPITAL STOCK AND INPUT GROWTH, 1850-2000
(Annual average logarithmic rates %)

	(I) Capital Stock	(II) Capital Input	(III) Capital Quality
1850-2000	3.5	3.7	0.2
Panel A.			
1850-1950	2.7	2.8	0.2
1951-1974	6.0	6.4	0.4
1975-2000	4.5	4.7	0.1
Panel B.			
1850-1883	3.6	4.0	0.3
1884-1920	2.3	2.4	0.1
1921-1929	3.5	3.9	0.4
1930-1952	1.6	1.5	-0.1
1953-1958	4.5	4.9	0.5
1959-1974	7.0	7.4	0.4
1975-1986	4.5	4.5	0.0
1987-2000	4.6	4.8	0.2

Sources: See text and Prados de la Escosura and Rosés, “Physical Capital”.

TABLE 3
CHANGE IN THE STOCK OF LAND, 1850-2000
(Annual average logarithmic rates %)

1850-2000	0.2
Panel A.	
1850-1950	0.2
1951-1974	1.0
1975-2000	-0.4
Panel B.	
1850-1883	0.1
1884-1920	0.8
1921-1929	1.0
1930-1952	0.2
1953-1958	-2.2
1959-1974	1.0
1975-1986	-1.0
1987-2000	0.1

Sources: See text

TABLE 4
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
Panel A.						
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
Panel B.						
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 text

TABLE 5
LABOR QUANTITY, QUALITY, AND INPUT GROWTH, 1850-2000: 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
Panel A.					
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
Panel B.					
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 text

TABLE 6
AVERAGE FACTOR SHARES, 1850-2000 (%)

	(I) Capital	**(III) Land**	**(II) Labor**
1850-2000	24.0	7.5	68.4
Panel A.			
1850-1950	23.4	9.7	66.9
1951-1974	22.2	5.7	72.1
1975-2000	28.1	0.8	71.1
Panel B.			
1850-1883	17.7	9.9	72.4
1884-1920	28.3	10.6	61.1
1921-1929	27.5	10.9	61.6
1930-1952	23.9	7.8	68.4
1953-1958	28.4	9.2	62.3
1959-1974	17.6	3.5	78.9
1975-1986	23.1	1.1	75.8
1987-2000	32.4	0.6	67.1

Sources: See text

TABLE 7
SOURCES OF GROWTH (1850-2000): VARIABLE AND FIXED FACTOR SHARES AND ALTERNATIVE LABOR QUALITY ESTIMATES
(Annual average logarithmic rates %)

	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)	(IX)
	I. Variable Factor Shares					**Jorgenson Approach**		**Mincer Approach**	
	GDP	**Land**	**Capital Stock**	**Capital Quality**	**Labor Quantity**	**Labor Quality**	**TFP**	**Labor Quality**	**TFP**
1850-2000	2.5	0.0	0.8	0.1	0.3	0.3	1.1	0.3	1.0
Panel A.									
1850-1950	1.4	0.0	0.6	0.0	0.3	0.1	0.3	0.1	0.2
1951-1974	6.5	0.1	1.2	0.1	0.7	0.8	3.7	0.7	3.8
1975-2000	3.0	0.0	1.2	0.0	-0.4	0.5	1.7	0.8	1.4
Panel B.									
1850-1883	1.8	0.0	0.6	0.1	0.5	0.0	0.6	0.2	0.5
1884-1920	1.3	0.1	0.6	0.0	0.1	0.1	0.2	0.1	0.2
1921-1929	3.8	0.1	1.0	0.1	1.1	0.5	1.1	-0.1	1.6
1930-1952	0.8	0.1	0.5	0.0	0.4	0.0	-0.1	0.3	-0.4
1953-1958	4.7	-0.2	1.3	0.1	0.2	0.8	2.4	0.5	2.7
1959-1974	6.9	0.1	1.2	0.1	0.5	0.9	4.2	0.6	4.4
1975-1986	2.5	0.0	1.0	0.0	-2.8	0.9	3.4	0.7	3.7
1987-2000	3.5	0.0	1.5	0.1	1.6	0.2	0.2	0.6	-0.3
	II. Fixed Factor Shares								
						Jorgenson Approach		**Mincer Approach**	
	GDP	**Land**	**Capital Stock**	**Capital Quality**	**Labor Quantity**	**Labor Quality**	**TFP**	**Labor Quality**	**TFP**
1850-2000	2.5	0.0	0.8	0.0	0.3	0.3	1.0	0.3	1.0
Panel A.									
1850-1950	1.4	0.0	0.6	0.0	0.4	0.1	0.3	0.1	0.2
1951-1974	6.5	0.1	1.4	0.1	0.7	0.7	3.5	0.6	3.6
1975-2000	3.0	0.0	1.1	0.0	-0.3	0.5	1.7	0.6	1.6
Panel B.									
1850-1883	1.8	0.0	0.9	0.1	0.4	0.0	0.4	0.2	0.2
1884-1920	1.3	0.1	0.6	0.0	0.2	0.1	0.4	0.2	0.3
1921-1929	3.8	0.1	0.8	0.1	1.3	0.5	1.0	-0.1	1.6
1930-1952	0.8	0.0	0.4	0.0	0.6	0.0	-0.1	0.1	-0.2
1953-1958	4.7	-0.2	1.1	0.1	0.2	0.9	2.6	0.6	2.8
1959-1974	6.9	0.1	1.7	0.1	0.4	0.7	3.9	0.6	4.0
1975-1986	2.5	-0.1	1.1	0.0	-2.5	0.8	3.1	0.6	3.4
1987-2000	3.5	0.0	1.1	0.0	1.6	0.2	0.6	0.6	0.1

Sources: Tables 1-6 and see text

TABLE 8
TFP GROWTH, 1965-2000: ALTERNATIVE ESTIMATES
(Annual average logarithmic rates %)

	1965-1974	1975-1986	1987-2000
Myro	4.1	2.6	
Suárez	3.8	1.6	
Hofman (raw)		1.6	
Hofman (adjusted)		0.4	
Cebrián	4.2		
Mas and Quesada*			-0.6
Timmer, Ypma, and van Ark*			0.4
Our Estimates (variable factor shares)	3.7	3.4	0.2
Our Estimates (variable factor shares) (Mincer)	4.0	3.7	-0.3
Our Estimates (fixed factor shares)	3.3	3.1	0.6
Our Estimates (fixed factor shares) (Mincer)	3.6	3.4	0.1

Notes: * Excluding residential structures from capital input
Sources: Suárez, "Economías de escala"; Hofman, "Economic Development": 256, 1973-89; Myro, "Evolución de la productividad": 1966-74; 1975-81; Cebrián, "Fuentes del crecimiento": 1964-73; Timmer and Van Ark, "Information and Communications Technology"; Mas and Quesada, *nuevas tecnologías*: 283, 1985-2002; for our estimates, see Table 7 and text.

TABLE 9
PER CAPITA GDP GROWTH AND ITS COMPONENTS, 1850-2000
(Annual average logarithmic rates %)

	(I) Per Capita GDP	(II) Hours worked /Population	(III) GDP per Hour Worked
1850-2000	1.9	-0.2	2.1
Panel A.			
1850-1950	0.8	-0.1	0.9
1951-1974	5.5	0.0	5.5
1975-2000	2.6	-0.8	3.4
Panel B.			
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: Col. (I), Table 1; rest, see text

TABLE 10
SOURCES OF LABOR PRODUCTIVITY GROWTH (1850-2000): WITH VARIABLE AND FIXED FACTOR SHARES AND ALTERNATIVE LABOR QUALITY ESTIMATES
(Annual average logarithmic rates %)

Variable Factor Shares	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)
				Jorgenson Approach		Mincer Approach	
	GDP per hour worked	Land	Capital Input	Labor Quality	TFP	Labor Quality	TFP
1850-2000	2.1	0.0	0.8	0.2	1.1	0.3	1.0
Panel A.							
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
Panel B.							
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
Fixed Factor Shares							
				Jorgenson Approach		Mincer Approach	
	GDP per hour worked	Land	Capital Input	Labor Quality	TFP	Labor Quality	TFP
1850-2000	2.1	0.0	0.8	0.3	1.0	0.3	1.0
Panel A.							
1850-1950	0.9	0.0	0.5	0.1	0.3	0.1	0.2
1951-1974	5.5	0.0	1.3	0.7	3.5	0.6	3.6
1975-2000	3.4	0.0	1.2	0.5	1.7	0.6	1.6
Panel B.							
1850-1883	1.2	0.0	0.8	0.0	0.4	0.2	0.2
1884-1920	1.0	0.0	0.5	0.1	0.4	0.2	0.3
1921-1929	2.0	-0.1	0.5	0.5	1.0	-0.1	1.6
1930-1952	0.0	0.0	0.2	0.0	-0.1	0.1	-0.2
1953-1958	4.3	-0.2	1.1	0.9	2.6	0.6	2.8
1959-1974	6.3	0.0	1.6	0.8	3.9	0.6	4.0
1975-1986	6.1	0.2	2.0	0.8	3.1	0.6	3.4
1987-2000	1.1	-0.2	0.6	0.2	0.6	0.6	0.1

Sources: Col. (I), Table 9; rest, Table 7 and see text

TABLE A-1
ALTERNATIVE CAPITAL STOCK GROWTH, 1850-2000
(Annual average logarithmic rates %)

	(I) Modified Geometric Depreciation (0.91/*T*;1.65/*T*)	(II) Linear Depreciation Gross (1/*T*)	(III) Linear Depreciation Net (1/*T*)
1850-2000	3.5	3.6	3.5
Panel A.			
1850-1950	2.7	2.8	2.8
1951-1974	6.0	5.4	5.4
1975-2000	4.5	4.6	4.6
Panel B.			
1850-1883	3.6	4.3	4.3
1884-1920	2.3	2.4	2.4
1921-1929	3.5	2.7	2.7
1930-1952	1.6	1.3	1.3
1953-1958	4.5	3.7	3.7
1959-1974	7.0	6.5	6.4
1975-1986	4.5	5.0	4.9
1987-2000	4.6	4.3	4.3

Sources: Prados de la Escosura and Rosés, "Physical Capital"
Note: **T** is the life of each type of asset

TABLE A-2
LABOR QUALITY GROWTH, 1850-2000: ALTERNATIVE ESTIMATES
(Annual average logarithmic rates %)

	(I)	(II)	(III)	(IV)
	Mincer Equation		Rate of Return	
			9 percent	7.2 percent
	(Arrazola et al)	(Alba and San Segundo)	(Alba and San Segundo)	(Mora)
1850-2000	0.4		0.4	0.3
Panel A.				
1850-1950	0.2		0.2	0.2
1951-1974	0.9		0.8	0.6
1975-2000	0.9	0.9	0.9	0.7
Panel B.				
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	1.0	0.9	0.7
1987-2000	0.9	0.8	1.0	0.8

Sources: Arrazola et al., “Returns to Education”; Alba and San Segundo, “Returns to Education”; Mora, “Socioeconomic Background”. See text

TABLE A-3
SOURCES OF GROWTH (WITH LAND INCLUDED AS PART OF CAPITAL) (1850-2000):
VARIABLE AND FIXED FACTOR SHARES AND ALTERNATIVE LABOR QUALITY ESTIMATES
(Annual average logarithmic rates %)

	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
	I. Variable Factor Shares				**Jorgenson Approach**		**Mincer Approach**	
	GDP	**Capital Stock**	**Capital Quality**	**Labor Quantity**	**Labor Quality**	**TFP**	**Labor Quality**	**TFP**
1850-2000	2.5	1.0	0.1	0.3	0.3	0.9	0.3	0.8
Panel A.								
1850-1950	1.4	0.9	0.1	0.3	0.1	0.0	0.1	0.0
1951-1974	6.5	1.5	0.1	0.7	0.8	3.5	0.7	3.6
1975-2000	3.0	1.3	0.0	-0.4	0.5	1.6	0.8	1.4
Panel B.								
1850-1883	1.8	1.0	0.1	0.5	0.0	0.2	0.2	0.1
1884-1920	1.3	0.9	0.1	0.1	0.1	0.1	0.1	0.0
1921-1929	3.8	1.4	0.1	1.1	0.5	0.7	-0.1	1.3
1930-1952	0.8	0.6	0.0	0.4	0.0	-0.2	0.3	-0.5
1953-1958	4.7	1.7	0.2	0.2	0.8	1.7	0.5	2.0
1959-1974	6.9	1.4	0.1	0.5	0.9	4.0	0.6	4.2
1975-1986	2.5	1.0	0.0	-2.8	0.9	3.3	0.7	3.6
1987-2000	3.5	1.5	0.1	1.6	0.2	0.2	0.6	-0.3
	I. Fixed Factor Shares				**Jorgenson Approach**		**Mincer Approach**	
	GDP	**Capital Stock**	**Capital Quality**	**Labor Quantity**	**Labor Quality**	**TFP**	**Labor Quality**	**TFP**
1850-2000	2.5	1.1	0.1	0.3	0.3	0.8	0.3	0.8
Panel A.								
1850-1950	1.4	0.9	0.0	0.4	0.1	0.1	0.1	0.0
1951-1974	6.5	1.9	0.1	0.7	0.7	3.1	0.6	3.2
1975-2000	3.0	1.4	0.1	-0.3	0.5	1.4	0.6	1.2
Panel B.								
1850-1883	1.8	1.1	0.1	0.4	0.0	0.1	0.2	-0.1
1884-1920	1.3	0.7	0.0	0.2	0.1	0.3	0.2	0.2
1921-1929	3.8	1.1	0.1	1.3	0.5	0.8	-0.1	1.4
1930-1952	0.8	0.5	0.0	0.6	0.0	-0.2	0.1	-0.3
1953-1958	4.7	1.4	0.1	0.2	0.9	2.1	0.6	2.3
1959-1974	6.9	2.2	0.1	0.4	0.7	3.4	0.6	3.5
1975-1986	2.5	1.4	0.0	-2.5	0.8	2.7	0.6	3.0
1987-2000	3.5	1.5	0.1	1.6	0.2	0.2	0.6	-0.3

Sources: See text

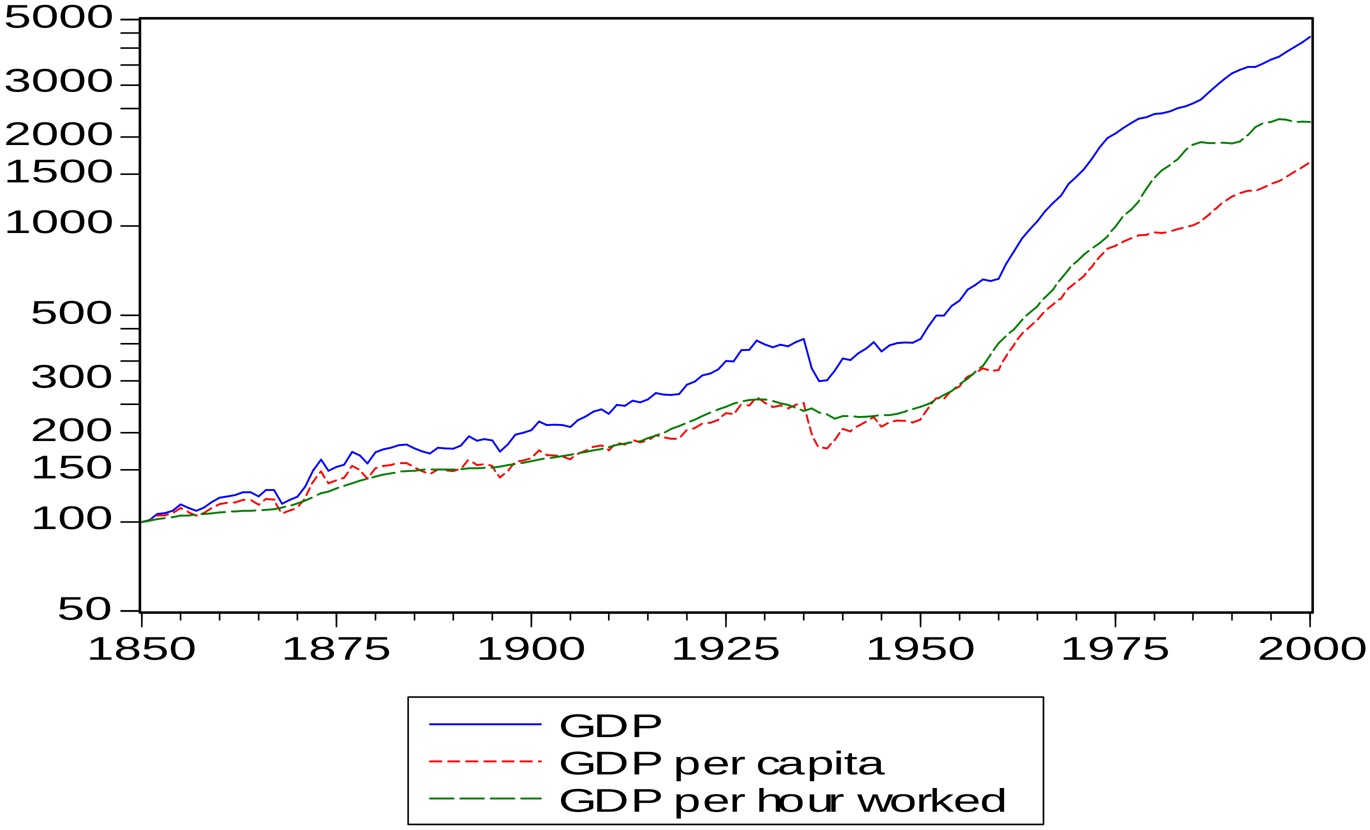

FIGURE 1

GDP, GDP PER CAPITA AND PER HOUR WORKED, 1850-2000 (1850 = 100) (semilog scale)

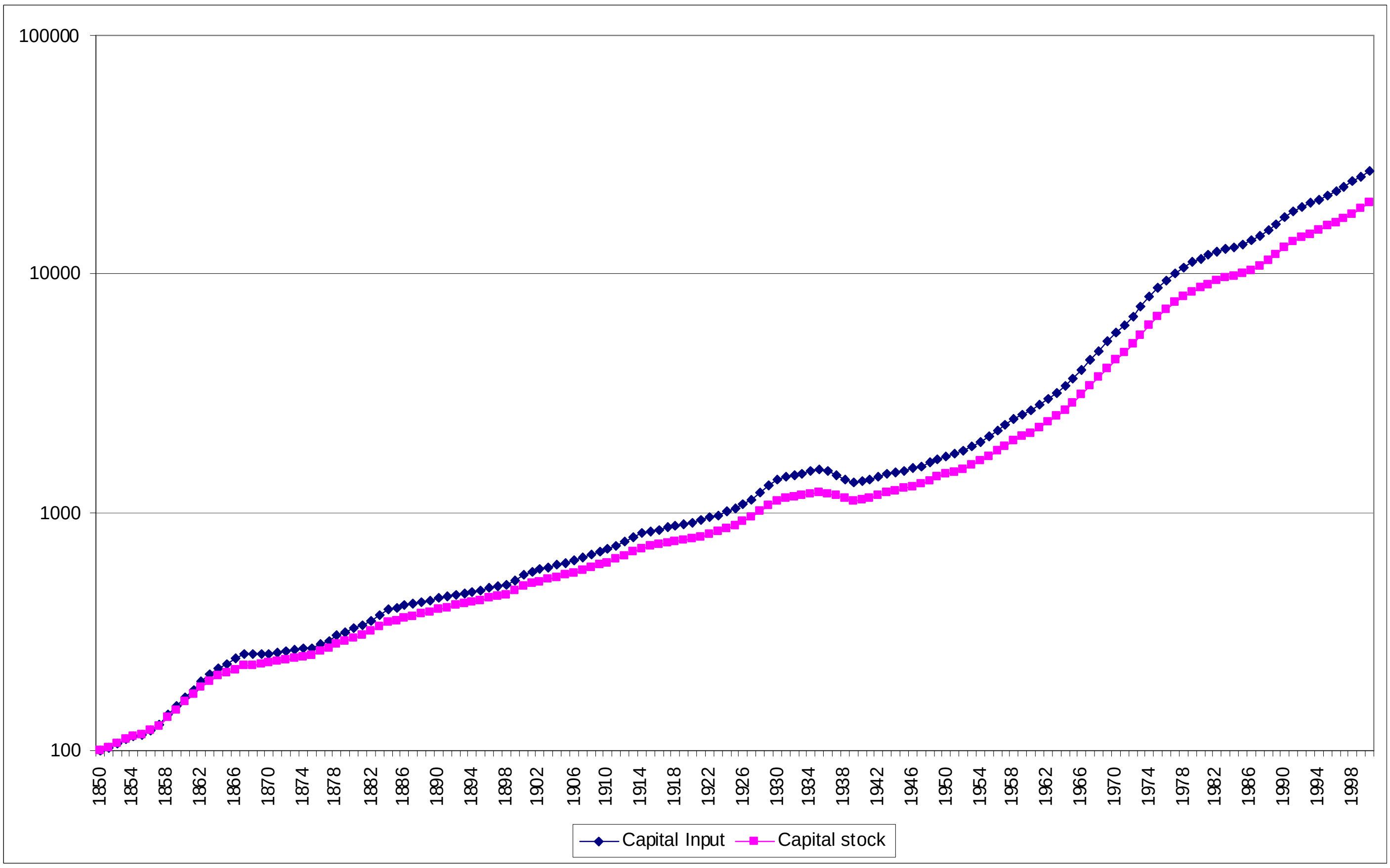

FIGURE 2

CAPITAL STOCK AND INPUT, 1850-2000 (1850 = 100) (semilog scale)

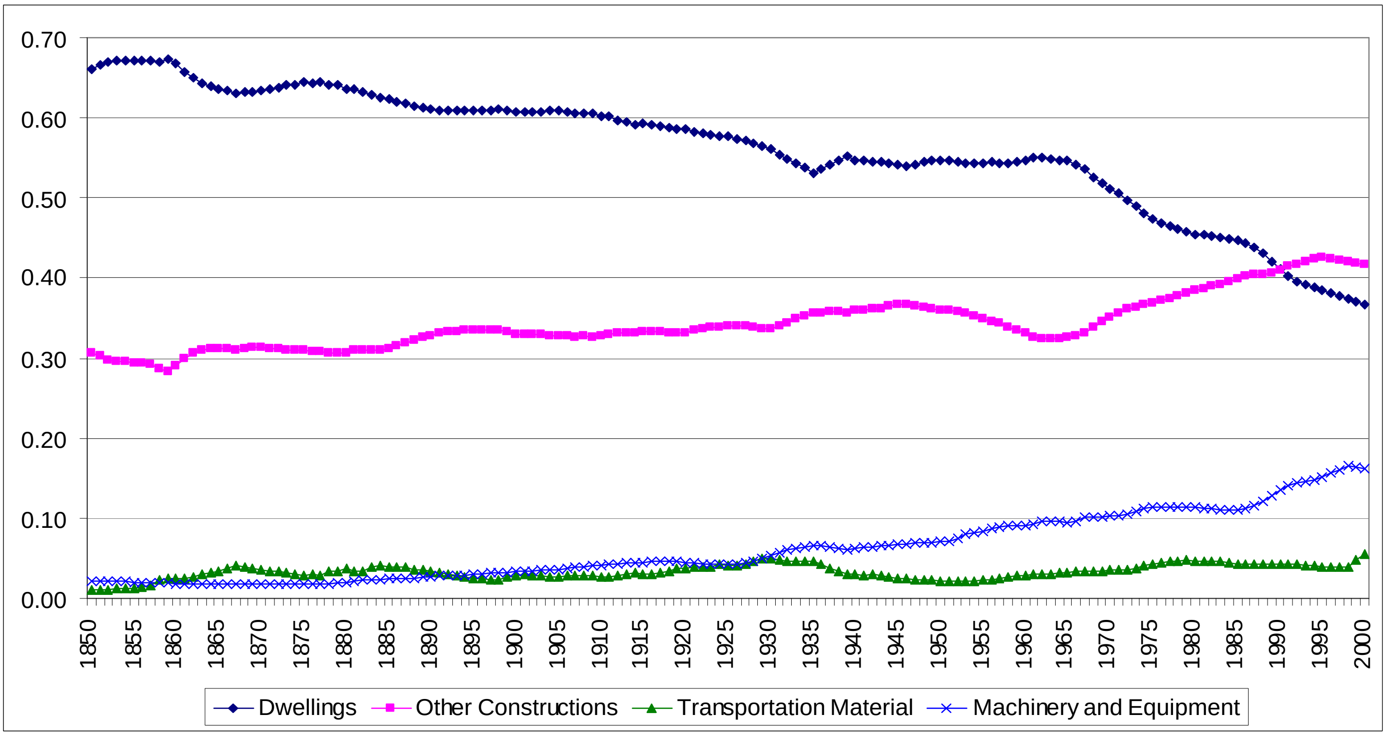

FIGURE 3
THE COMPOSITION OF CAPITAL STOCK, 1850-2000 (1995 Pesetas) (%)

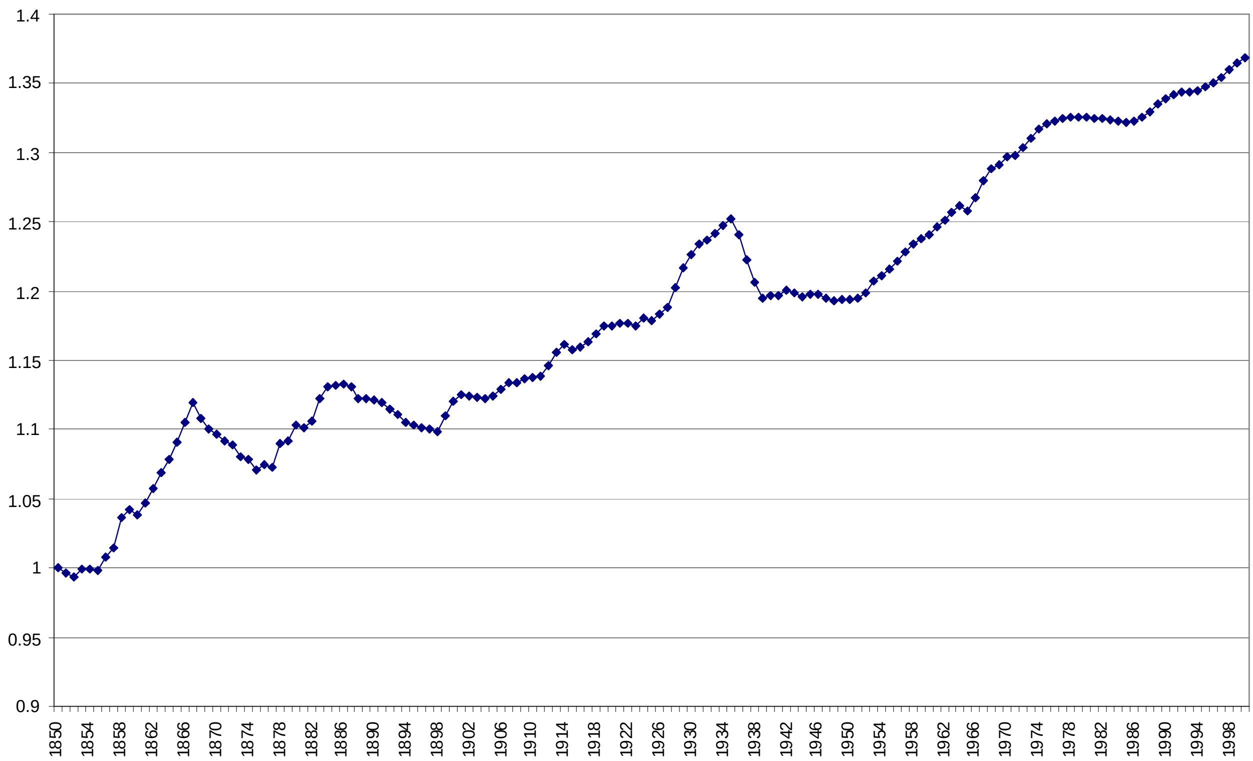

FIGURE 4
QUALITY OF CAPITAL, 1850-2000 (1850 = 1)

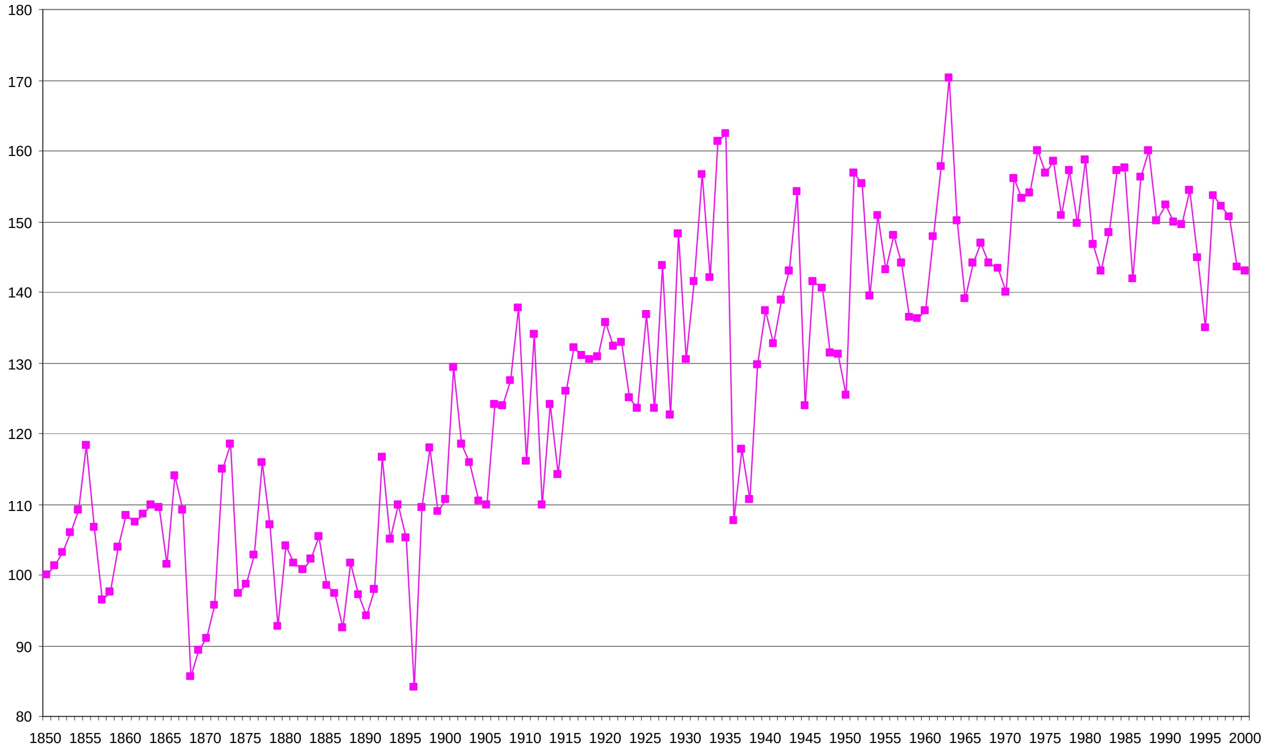

FIGURE 5
LAND STOCK, 1850-2000 (1850 = 1)

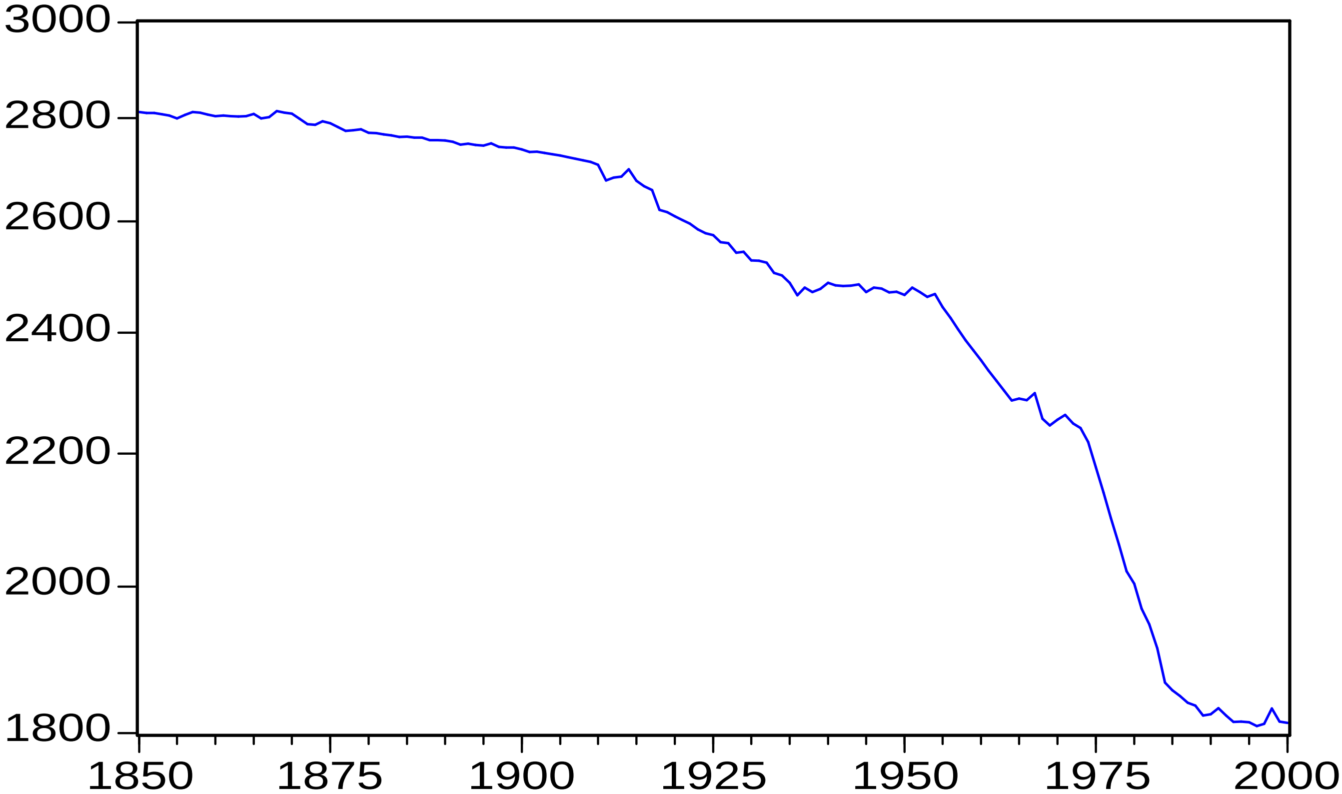

FIGURE 6
HOURS PER WORKER-YEAR, 1850-2000 (semilog scale)

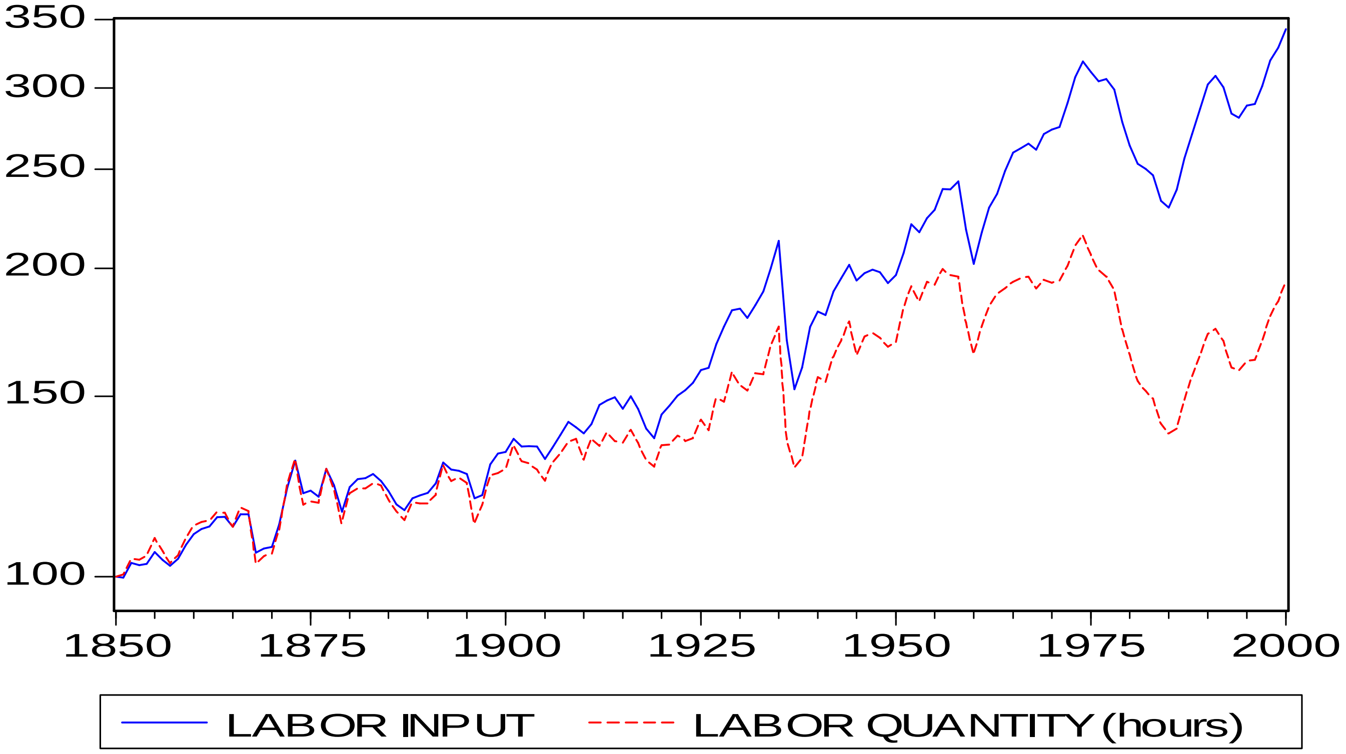

FIGURE 7
LABOR INPUT AND QUANTITY, 1850-2000 (1850=100) (semilog scale)

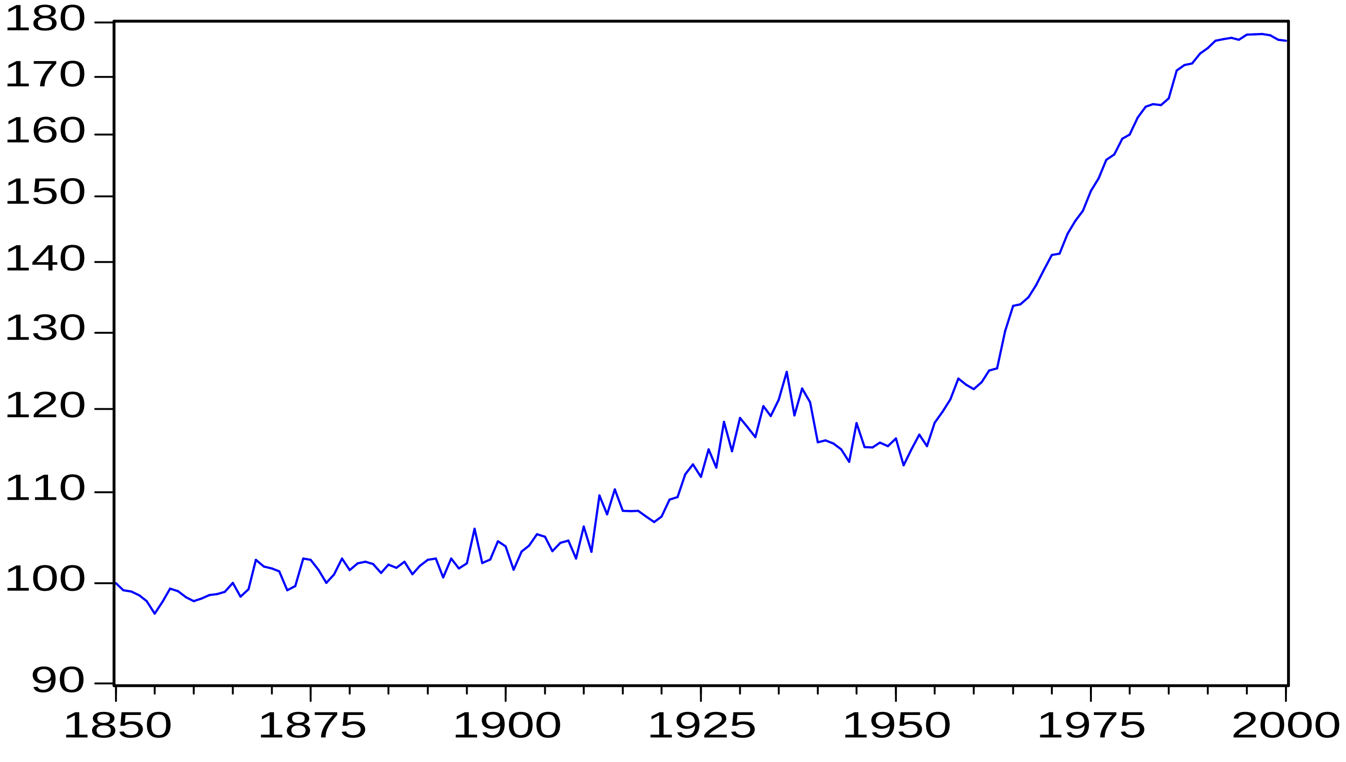

FIGURE 8
LABOR QUALITY, 1850-2000 (1850=100) (semilog scale)

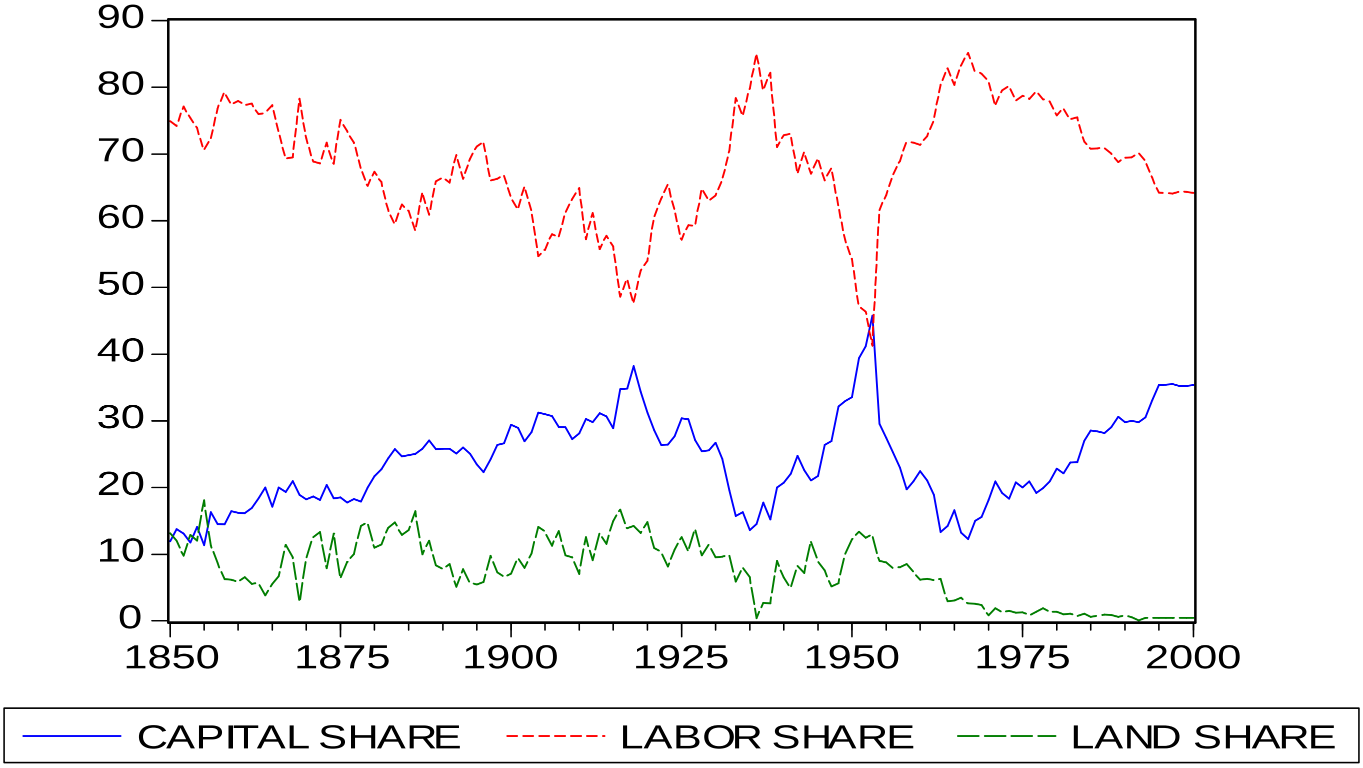

FIGURE 9
FACTOR SHARES IN GDP, 1850-2000 (%)