6

Measuring GDP, 1850–1958: Supply Side

In historical national accounts, as for most developing countries, the most reliable and easiest to estimate GDP figures are those obtained through the production approach.[1] As for most developing countries, real product has been computed from physical indicators rather than as a residual obtained from independently deflated output and inputs. The components' method has prevailed over the indicators' method as much as the data permitted it, and both direct and indirect estimating procedures have been employed.[2]

Estimating constant gross value added series involved several steps. In the first place, Laspeyres quantity indices were built up for each major component of output using 1913, 1929 and 1958 value added as alternative weights. Value added for 1913 and 1929 benchmarks was computed through either direct estimate or, more often, gross value added levels for 1958, taken from the input–output table (TIOE58) and the national accounts (CNE58) were projected backwards to 1913 and 1929 (with quantity and price indices expressed as 1958 = 1). Then, in an attempt to allow for changes in relative prices, these volume indices were spliced into a single series. The estimates with 1913 weights have been accepted for 1850–1913, while variable weighted geometric averages of

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the indices obtained with 1913 and 1929 (1929 and 1958) weights have been adopted for 1913–1929 (1929–1958), a procedure that allocates a higher weighting to the closer benchmark. Lastly, a volume index of real gross value added (GVA) for 1850–1958 was constructed by weighting output chain volume Laspeyres indices for each major branch of economic activity with their shares in total gross value added for 1958.

An effort to construct price indices was carried out from a wide range of price series of uneven quality and coverage.[3] Chain Paasche price indices for agriculture, industry and services were built up.[4] In fact, since volume indices are of Laspeyres type, that is,

$$Q^L = \sum q_i p_o / \sum q_o p_o, \qquad (6.1)$$

Paasche price indices,

$$P^P = \sum q_i p_i / \sum q_i p_o, \qquad (6.2)$$

are, then, required to derive current values,

$$V = Q^L * P^P = \sum q_i p_i / \sum q_o p_o \qquad (6.3)$$

where q and p are quantities and prices at the base year o or any other year i.

Yearly series of gross value added at current prices were derived for each branch of economic activity by projecting backwards its level at the 1958 benchmark, provided by official national accounts (CNE58), with its Laspeyres quantity and Paasche price indices, expressed with reference to 1958 = 1.[5] Total gross value added at current prices was derived by aggregation of sectoral value added. An implicit Paasche GVA deflator was calculated by dividing current and constant price series. Adding indirect taxes (net of subsidies) to total current GVA provided nominal GDP at market prices. Real GDP at market prices was obtained by deflating nominal GDP with the GVA deflator.

Four major branches of economic activity are taken into account: (a) agriculture, forestry and fishing; (b) manufacturing, extractive industries and utilities; (c) construction; and (d) services.

6.1 Agriculture, Forestry and Fishing

6.1.1 Agriculture

Two steps were followed in computing agricultural value added.[6] Firstly, final output, that is, total production less seed and animal feed, was constructed. Then, gross value added was derived by subtracting purchases of industrial and services inputs, from final output.

Unfortunately, annual data on crops and livestock output are incomplete and their coverage uneven over time. Nonetheless, available data allowed me:

(a) To compute agricultural final output at different benchmarks: *circa* 1890, 1898/1902, 1909/1913, 1929/1933, 1950 and 1960/1964 by valuing physical output for each product at farm-gate prices.[7]

(b) And, then, to derive, Laspeyres real output (Q^L) for each benchmark (bk) by deflating current values (V) with a Paasche chain price index built on a large sample of agricultural goods (q and p are quantities and prices at the base year o or any other year i).[8] That is,

$$Q^L_{bk} = V_{bk}/\ P^P_{bk}bk\ = 1890, 1898/1902, 1909/13, 1929/33, 1950, 1960 \tag{6.4}$$

being P^P_{bk} a chain Paasche,$P^P_{bk} = \sum p_{ip}q_{ip}/\sum p_{ip-1}q_{ip}$

The lack of quantitative evidence on low acreage, high-value crops such as fruits and vegetables that increase its importance at higher income levels and urbanization, makes the deflation of current value estimates a preferable alternative to the construction of volume indices on reduced quantitative information.[9] Actually, prices tend to move together within closer bounds than quantities.[10]

(c) Next, real final agricultural output series was derived splicing each pair of adjacent benchmarks with a yearly index of final output built on reduced information.[11] The procedure was to project each benchmark with a quantity index constructed at its relative prices and to compute, then, a weighted geometric average of the series resulting from each pair of adjacent benchmarks, in which the closer benchmark to each particular year was allocated a higher weighting,

$$\begin{aligned} Q_t^L &= \left(Q_{bko}^L * O_t^L\right)^{(n-t)/(n-o)} * \left(Q_{bkn}^L * O_t^L\right)^{(t-o)/(n-o)} \\ &= O_t^L * \left(Q_{bko}^L\right)^{(n-t)/(n-o)} \left(Q_{bkn}^L\right)^{(t-o)/(n-o)} \end{aligned} \tag{6.5}$$

where Q is Laspeyres real final output index, O is a Laspeyres quantity index (built on reduced information) for year t, bk represents each benchmark estimate, and o and n are the initial and final years within each period.[12]

(d) Lastly, agricultural final output at current prices was obtained by extrapolating the 1958 level of final output (CEN58) backwards with the real final output index and a Paasche price index.[13] The Paasche price index was constructed by interpolating each pair of adjacent chain price benchmarks (Table 6.1, column 2) with a yearly Paasche price index derived on reduced information.[14] The linkage procedure for each pair of adjacent benchmarks was projecting each benchmark price level with the

Table 6.1 Agricultural final output: benchmark estimates, 1890–1960/64

	(1)	(2)	(3)
	Current value	Paasche price	Laspeyres volume
	(Million Pta)	Chain index	Chain index
c. 1890	2795	89.63	80.76
1898/1902	3190	95.22	86.77
1909/1913	3861	100.00	100.00
1929/1933	8919	173.76	132.96
1950	52,018	1173.27	114.84
1960/1964	156,526[a]	2158.34[b]	187.85[c]

Notes [a]value at 1960 prices. [b]1960 price level. [c]1960 prices
Incomplete coverage led to assumptions about the production of several crops in 1890 and 1900. Total output for major groups (vegetables, raw materials, fruits and nuts, meat, and poultry and eggs) was inferred on the basis of observed sample-to-total output ratios for 1909/1913
Source Quantities, prices and values derive from GEHR (1991), Simpson (1994) (unpublished data set), and the original sources quoted there, and Ministerio de Agricultura (1979a)
Ratios of final output to total production for each crop are shown in the Appendix, Table A.1. Coefficients to transform livestock output into quantities of meat, wool and milk are presented in the Appendix, Table A.2

variations of the annual price index and, then, computing a variable geometric mean in which the closer benchmark to a particular year received the higher weighting.[15]

The Construction of Annual Quantity and Price Indices on Reduced Information

The annual quantity and price indices constructed on a sample of agricultural produce, and employed to interpolate adjacent benchmark estimates of real final output, deserve some comments. A two-stage procedure was followed to build the quantity index in order to prevent undesired over-representation of particular crops in aggregate output. Ten groups of products were firstly defined, for which independent indices were constructed. This procedure did not prevent adding guesses to the data since it was assumed that, within each group, those products not included in the sample moved exactly like those that were part of it. However, the more homogeneous the group of goods is, the less strong the implicit assumptions of this method are. In any case, when output is directly estimated from a sample of products, the implicit assumptions are stronger than in my proposed two-stage calculation procedure.[16] Thus, index numbers were built for major groups of products: cereals, legumes, vegetables, raw materials, fruits and nuts, must, unrefined olive oil, meat, poultry and eggs, and milk and honey.[17]

Incomplete production data constitute a major obstacle to the construction of an agricultural output index for nineteenth-century Spain. Assumptions and conjectures are required, then, to establish trends in agricultural output and to fill in the missing data. Estimating output trends under information constraints can be approached through (a) the volume produced, in which most is made of the scattered evidence available; (b) the commercialization of crops deflated by the (expanding) length of the transportation network (road and rail) in order to prevent an upward bias in the rate of growth of agricultural production, as mercantilization evolved faster than production in the early stages of development; and (c) the demand approach, in which output is deducted from an estimate of consumption derived from a demand equation calibrated with levels of disposable income (real wages) and relative prices for food, together with their relevant elasticities.[18] The volume and commercialization approaches are used here to derive output levels.

Data coverage of crop output is much lower prior to 1891 than thereafter, and it is practically non-existent for the period 1850–1881.[19] Output for major agricultural groups had to be derived from scattered information on the production of wheat, barley, must, raw olive oil and sugar cane and beet, plus fruit export data for the period 1882–1890, whose data coverage represents 64% of final production (excluding livestock) in 1890.[20] Up to 1882, non-livestock agricultural output was proxied by trading series for major crops using evidence from maritime and rail transportation (the latter previously deflated by the network's length).[21] The commercialization series included cereals, legumes, wine, olive oil, fruits and nuts, and raw materials (raw silk, sugar cane).[22] Accepting traded crops as proxies for crops output implies the arguable assumption of a highly commercialized agriculture in which both distribution and production show a similar profile.[23] If trade in agricultural products rose faster than output, the resulting index would incorporate an upward bias.[24]

Estimates are even weaker for the years 1850–1865, when only maritime transportation data were available (coastal transport since 1857), and in the cases of wheat and legumes, output had to be derived from consumption estimates (by arbitrarily assuming a constant consumption per head times population) adjusted for net imports.[25]

Once quantity series were established for the main commodity groups, the calculation procedure used for the post-1865 estimates was applied to compute output.[26]

Evidence on livestock prior to 1905 is only available for 1865 and 1891.[27] Meat and milk outputs were obtained by applying conversion coefficients to livestock numbers for 1865, 1891 and 1905/1909 and valued at 1891 prices.[28] Annual figures for livestock output were derived through log-linear interpolation, both for 1865–1891 and for 1891–1905. The case for accepting such a crude procedure is to reach a wider coverage for agricultural production by including livestock output, which apparently had an opposite trend to that of crops output over the late nineteenth century.[29] However, it is worth noticing that a decline in livestock numbers does not necessarily mean that livestock output fell as an increased turnover of animals took place stimulated by the rise in the demand for meat and dairy products associated with urbanisation.[30] For the earlier years 1850–1864, output was obtained under the assumption that per caput consumption remained constant and equivalent to that of 1865.[31]

Then, a second step was estimating the aggregate index as a weighted average of output indices for major agricultural groups with their shares in the benchmark's agricultural final output as weights (Table 6.2). Volume indices were computed for different time spans valuing quantities of each product at the farm-gate prices for each benchmark (Table 6.3).

To construct a yearly price index, single series for a sample of goods within each agricultural subsector were gathered from a wide range of sources.[32] Individual price series were assembled for cereals (wheat, barley, rice), legumes (chick peas), vegetables (potatoes), fruits and nuts

Table 6.2 Agricultural final output at current prices, 1890–1964 (%)

	c.1890	1898/1902	1909/1913	1929/1933	1950	1960/1964[a]
Cereals	27.8	34.4	31.3	25.4	25.6	16.2
Pulses	3.7	3.1	3.3	3.2	3.0	2.0
Vegetables	13.2	13.3	13.1	16.5	17.2	16.4
Raw materials	2.9	3.7	3.3	3.7	3.9	6.8
Fruits and nuts	2.1	7.1	8.3	11.0	11.0	12.7
Wine must	18.5	11.2	6.8	6.3	6.4	4.1
Crude olive oil	7.9	5.8	6.0	5.9	2.6	4.9
Meat	12.4	11.1	13.9	15.5	11.1	14.7
Poultry and eggs	6.3	5.6	7.0	7.1	11.0	8.0
Non-animal	74.7	77.4	70.7	71.2	68.4	62.3
Animal	25.3	22.6	29.3	28.8	31.6	37.7

Note [a]1960/1964 final output computed at 1960 prices

Source Quantities are derived mostly from GEHR (1989, 1991), completed with Comín (1985a), Simpson (1986, 1994) (unpublished data set) and Carreras (1983) for the pre-Civil War years; and Barciela (1989) and Ministerio de Agricultura (1974, 1979a) for the 1940–1964 period. Prices are taken from GEHR (1989), Simpson (1994) (unpublished data set) and Ministerio de Agricultura (1974, 1979a)

Table 6.3 Construction of agricultural volume indices, 1850–1958

Periods	Benchmark year	Coverage at benchmark (%)
1850–1909	1891/1893	77.5
1890–1929	1909/1913	86.4
1913–1950	1929/1933	86.1
1929–1958	1950	86.5
1950–1958	1960	85.1

Sources Appendix, Table A.3

(oranges and almonds), must, unrefined olive oil, raw materials (sugar beet, wool), meat (beef, veal, pig and lamb), eggs and milk. Laspeyres price indices were constructed, then, for each group of goods with benchmarks' weights. An aggregate price index was, in turn, obtained as the average of subsectoral Laspeyres price indices weighted by their annual quantity indices.[33]

Gross Value Added

Nominal gross value added was obtained by deducting purchases outside the agricultural sector from final output at current prices. Real gross value added was derived, in turn, by subtracting industrial and services inputs at constant prices from real final output. An implicit deflator was derived from nominal and real gross value added series. Purchases outside the agricultural sector were proxied by the consumption of mineral fertilizers, and the level of non-agricultural inputs for 1958 was backcasted with the annual rate of variation of mineral fertilizers consumed in agriculture.[34]

6.1.2 Forestry

Evidence for forestry is only available since 1901 and quantities of wood, firewood, resin, cork and esparto grass were valued at 1912/1913, 1929/1933 and 1960 prices and added up into single values from which a chain quantity index was derived.[35] Output at current prices is available since 1901.[36] Gross value added at current prices was computed through backward projection of the 1958 level in national accounts (CNE-58) with the value index.[37] An implicit deflator was derived from the current value and volume indices.

6.1.3 Fishing

For fishing, quantity and current value series are available from 1904 onwards, but only scattered information exists for 1878, 1883 and 1888–1892 (and no data at all for 1935–1939).[38] The quantity of fresh fish captured is available but, since no allowances can be made for composition changes, the alternative of deflating the current value of fish captures was preferred on the grounds that, within a given industry, price variance is lower than quantity variance. Gross value added at current prices was obtained through backward extrapolation of the 1958 level (CNE58) with the rate of variation of the total value of captures.[39] When current values of total production were missing (1850–1903), gross value added was extrapolated backwards on the basis of output (computed under the assumption of constant per capita consumption times the population and adjusted for net exports) and a price index for cod.[40] An implicit deflator was derived from the current value and volume indices.

6.1.4 Value Added for Agriculture, Forestry and Fishing

Value added at current prices for agriculture, forestry and fishing was reached by adding up each subsector's estimates. Aggregate volume indices for agriculture, forestry and fishing output were derived as an average of the subsector indices with their share in its aggregate gross value added for 1913, 1929 and 1958 as weights, respectively.[41] Then, a single quantity index was computed as a variable weighted geometric average of the three indices.[42] The composition of the aggregate index is as follows: for 1850–1913, 1913 weights were accepted; for 1913–1929, a weighted geometric average of 1913 and 1929 weighted indices; for 1929–1958, a weighted geometric average of 1929 and 1958 weighted indices. An implicit deflator was obtained from current and constant price value added.

6.2 Industry

New series of industrial output and its main components, in nominal and real terms, are constructed in this section. The pathbreaking research carried out by Albert Carreras supplied the basis from which new series for extractive industries, utilities and manufacturing output were built up.[43]

The difficulties faced by historical attempts to produce hard empirical evidence on industrial performance can be illustrated by assessing Carreras‘ seminal contribution.[44] His index of industrial production used a fixed weighting system with alternative base years (1913, 1929, 1958, and 1975) that were, in turn, spliced into a single series using end years. For the period under study here, the 1958 input–output table (TIOE58) supplied the unit value added used as weights that were, then, extrapolated backwards to 1929 and 1913 with industrial prices, under the assumption that they approximated the trends in unit value added.[45] Unfortunately, the author was unable to establish earlier base years for the nineteenth century, and as no regard was paid to changes in relative prices, the further back in time we move from 1913, the less representative of industrial performance his index becomes. In addition to the use of fixed weights, limited coverage is usually a major liability for any industrial index. Carreras‘ index reaches an acceptable coverage, 65% in 1958 and approximately 50 and 70% for 1929 and 1913.[46]

The main objection to Carreras' index is its weighting scheme. At each benchmark (1913, 1929, 1958 and 1975), annual physical output for every product was weighted by its unit value added to compose an aggregate series that was, then, spliced into a single chain index using end years.[47] The final series approximates well overall industrial performance insofar the sample of goods from which the industrial output index is derived remains 'representative' for the whole industry. Unfortunately, the coverage of different sectors is asymmetrical in Carreras' index, and as one moves backwards in time, it declines and becomes more uneven, increasing the risk of undesired over-representation of particular products since a mere fraction of a subsector may eventually dominate the overall index.[48]

Table 6.4 Composition of manufacturing value added in 1958

	(1)	(2)	(3)
	Carreras simple (%)	CNE58 (%)	Deviation[a] (%)
Food, beverages and tobacco	18.1	17.0	6
Textile and clothing	17.1	21.2	−21
Timber, cork and furniture	0.4	7.1	−288
Paper and printing	1.9	4.4	−84
Chemical	4.2	10.2	−89
Stone, clay, glass and cement	1.5	4.4	−108
Metal, basic	12.7	6.2	72
Metal, transformation	35.3	17.3	71
Transport equipment	5.4	7.6	−34
Other	3.4	4.6	−32

Note [a][100 * ln ((1)/(2))]
Source Carreras (1983) and Spanish National Accounts Base 1958 (CNE58)

An illustration of this argument is provided by the coverage of Carreras' index at the 1958 benchmark. A glance at Table 6.4 shows the extent to which its coverage is asymmetrical. Metal industries (basic and transformation), for instance, are clearly over-represented conditioning the aggregate industrial index when it is computed directly, as in Carreras' case. Industrial growth might suffer, then, from an upward bias as a result of over-weighting capital goods, whose growth rate is usually higher than the industry's average.[49] In the construction of quantity indices for manufacturing industry, an attempt will be made to prevent some of the shortcomings in Carreras' industrial production index.

6.2.1 Manufacturing

Lack of information prevented the computation of total production and inputs, at current and constant prices, separately, from which nominal and real value added would be derived. In turn, changes in real value added are represented by variations in quantity indices constructed from production evidence for each manufacturing sector, as it is usually done in historical national accounts and occasionally in developing countries.[50]

In order to construct an index for manufacturing output, Laspeyres indices for each branch ($Q_{i,t}$) were, firstly, computed, and then, the aggregate index (Q_t^*) was obtained as their average, using each branch's share in total manufacturing value added at the benchmark year as weights ($P_{i,o}$).[51] That is,

$$Q_{i,t} = \sum q^i_{jt} p^i_{jo} / \sum q^i_{jo} p^i_{jo} \tag{6.6}$$

and then,

$$Q_t^* = \sum Q_{i,t} P_{i,o} / \sum Q_{i,o} P_{i,o} \tag{6.7}$$

where

$$P_{i,o} = \sum q^i_{jo} p^i_{jo} / \sum q_{jo} p_{jo} \tag{6.8}$$

Here q and p represent quantities and prices; subscripts o and t are the benchmark year and any other year, respectively; j = 1,… n are goods, and i = 1, … s are sectors; superscript i denotes quantities and prices of goods included in sector i. Goods in sector i are not included in any other sector.

Using this approach, the problem of lack of representativeness will be less acute than in the case of Carreras index, since the assumptions that (a) total output evolves as its main components, and (b) its coverage remains unchanged over a given period, are more easily acceptable at branch level than for the industry as a whole.

For manufacturing, eleven branches have been distinguished (Table 6.5). Basic series of physical quantities were taken from Carreras (1983, 1989), supplemented with production data on wine, alcohol, brandy, beer, meat slaughtering and timber.[52] Thus, most data employed in the construction of the manufacturing output index correspond to intermediate and primary inputs that would lead, in turn, to underestimating industrial growth, as efficiency gains in the use of inputs are not allowed for. In order to offset this shortcoming, I arbitrarily assumed a yearly 0.5% efficiency increase in the use of inputs for engineering industry and incorporated quality adjustments in the transport equipment industry.[53]

Table 6.5 Breakdown of manufacturing value added, 1913–1958 (%)

	(1)	(2)	(3)
	1913	1929	1958
Food, beverages and tobacco	38.4	29.6	17.0
Textile	18.8	14.4	14.5
Clothing and shoemaking	10.1	7.0	6.7
Timber, cork and furniture	7.6	11.3	7.1
Paper and printing	2.2	1.7	4.4
Chemical	2.5	4.3	10.2
Stone, clay, glass and cement	0.7	4.4	4.4
Metal, basic	6.0	6.6	6.2
Metal, transformation	6.3	12.7	17.3
Transport equipment	5.0	6.6	7.6
Other	2.4	1.4	4.6

Source CNE58 for 1958; for 1913 and 1929, see text

In the construction of a Laspeyres quantity index for manufacturing production, a two-stage procedure was followed.

(a) *Quantity indices for each manufacturing branch*. Unit value added for each product in 1958 was backward extrapolated to 1929, 1913, 1890 and 1870 with its own price indices under the arbitrary assumption that the value added/total production ratio remained stable over time.[54] Whenever possible, direct estimates of unit value added were applied.[55] Also, adjustments by Morellá on Carreras' unit value added estimates for 1958 were accepted.[56] Then, for each branch of manufacturing, Laspeyres quantity indices were constructed with each benchmark's unit value added estimates as weights.[57]

(b) *Quantity index for aggregate manufacturing*. A Laspeyres quantity index for total manufacturing was obtained by adding up all *branch* indices with their benchmark shares in 1913, 1929 and 1958 current value added as weights (Table 6.5) that were obtained by extrapolation of 1958 levels (CNE58) with each branch's Laspeyres quantity and Paasche price indices. The resulting three indices were, then, spliced using a variable weighted geometric mean, in which the closer to a given year *t*, the larger the weight allocated to a particular benchmark.[58]

Paasche price indices for each *branch* of manufacturing industry were constructed by dividing, for a given *sample* of goods, its current value (expressed in index form) by a Laspeyres quantity index.[59] Current values for the sample of goods were obtained by multiplying quantities by prices that were, then, added up. An important caveat is that manufacturing price indices were constructed on very scant price data, strongly skewed towards raw materials and intermediate goods that, in turn, would tend to bias upward current manufacturing value added.[60] Later, an implicit Paasche deflator was obtained for aggregate manufacturing by dividing total current value added (in index form) by the Laspeyres quantity index.

6.2.2 Extractive Industries

As regards extractive industries, mining and quarrying were considered, with the latter usually representing less than 10% of sectoral value added. The construction procedure of quantity and price indices and of nominal and real value added levels was identical to the case of manufacturing.[61]

6.2.3 Utilities

Only gas and electricity output series were available on yearly basis, and an aggregate chain index was obtained by weighting gas and electricity output with their contributions to sectoral value added for 1913, 1929 and 1958, in which gas was allocated a larger share to include water supply.[62] Nominal gross value added was reached through the backward extrapolation of 1958 levels with Laspeyres quantity and Paasche price indices. Quantity indices were spliced into a single index following the same procedure used for manufacturing and extractive industries. In turn, the same construction method of price indices applied to manufacturing and extractive industries was adopted.

6.2.4 Value Added for Manufacturing, Extractive Industries and Utilities

Finally, an aggregate quantity index for industry (excluding construction) was derived as an average of manufacturing, extractive industries and utilities indices using their 1913, 1929 and 1958 sectoral shares in industrial gross value added as weights. Then, to obtain a single Laspeyres chain index of industrial gross value added, the three indices were spliced through a variable weighted geometric mean in which weighting varied according to the distance from the considered year (as in (12)). Current price estimates were obtained by adding up each industry's value added. An implicit deflator was derived from current and constant price estimates.

6.3 Construction

Five subsectors were distinguished in the construction industry, residential and commercial, railway, road building, hydraulic infrastructure and other public works.

6.3.1 Residential and Commercial Construction

I started from the available information on the stock of urban and rural dwellings and derived the number built in each inter-censal period by adding a rough estimate of the number of houses demolished in the period to the *net* increase in the stock.[63] Also, size and quality changes in housing were taken into consideration and overall improvements were arbitrarily assumed to take place at 0.5% annually.[64] Demolition rates were obtained through alternative methods that cast very close results. One procedure, adopted from the British case, was to derive decadal rates for demolition by assuming that 85% of the new homes built a century earlier would be demolished while the surviving 15% would disappear steadily over the next century (Feinstein 1988: 388). An alternative was the demolition rates computed for Spain by Bonhome and Bustinza that I accepted up to 1940.[65] For the years 1940–1958, I derived them from existing sources (Nomenclators and Censuses of dwellings).[66] The resulting demolition annual rates were 1861–1910, 0.21; 1911–1940, 0.28; 1940s, 0.36; and 1950s, 0.26.

To sum up, the change in the quality-adjusted stock of dwellings includes the net increase in stock plus the replacement of demolished dwellings, that is, the increase in gross stock, to which a yearly 0.5% quality improvement was applied. In order to distribute the inter-censal increase in the gross stock annually, available figures for the consumption of cement and timber were used for 1850–1944, while the annual number of new dwellings (mostly subsidized construction) was taken for 1944–1958.[67] To obtain yearly output figures, repairments and maintenance expenses were added to the quality-adjusted increase in gross stock. Repairments and maintenance were assumed to represent 1% of the current stock (which was obtained through log-linear interpolation between pairs of adjacent censal benchmarks). Finally, urban and rural construction indices were combined into a single index using their respective shares in the total value of dwellings.[68] A specific deflator was, in turn, built up that combined construction materials costs and mason wages with 1958 input–output weights (TIOE58).[69] Annual current value added for the residential and commercial construction industry was obtained by projecting the level of gross value added for 1958 backwards with the quantity and price indices.[70]

6.3.2 Non-Residential Construction

Railways

Expenditure on investment and maintenance in railways at 1990 prices computed by Cucarella (1999) is the basis of my estimates. He relied on decadal averages of nominal expenditure on investment and maintenance in railways estimated by Gómez Mendoza (1991) that were distributed annually over 1850–1920 using the number of kilometres under construction, for investment, and those under exploitation, for maintenance, and that he completed for the late 1920s and early 1930s with his own estimates (Cucarella 1999: 84–85). In addition, government's and Spanish national railways company's (RENFE) investment and maintenance expenditures in railways estimates by Muñoz Rubio (1995) were employed from 1940 onwards. Cucarella (1999: 78–80) deflated his current value estimates with a wholesale price index. I converted Cucarella's constant price estimates into nominal values using his own deflator and deflated the series again with a specific railway construction price index that combines the costs of railway materials and mason wages with 1958 input–output weights (TIOE58).[71]

Roads

Investment, repairs and maintenance expenditures on roads at current prices are available since 1897 (Uriol Salcedo 1992). Nominal road expenditure was backcasted to 1850 with the rate of variation of public expenditure on roads (Comín 1985b). The resulting yearly figures for 1850–1935 were adjusted to match the decennial estimates by Gómez Mendoza (1991). Finally, current expenditure estimates were deflated with a specific price index computed by combining materials costs and mason wages with 1958 input–output weights (TIOE58).[72]

Hydraulic Infrastructure and Other Public Works

Investment, maintenance and repairs expenditures on hydraulic infrastructure and maritime and harbour expenditure by the central government were deflated with a specific price index including construction materials and wages.[73]

Indices of non-residential construction were built up combining railway and road construction, hydraulic infrastructure and other public works with their 1913, 1929 and 1958 shares in the sector's value added.[74] A compromise, single quantity index for the whole period 1850–1958 was built up as a variable weighted geometric average of each pair of adjacent benchmark's indices (as in the case of manufacturing).

It is worth mentioning that Alfonso Herranz-Loncán (2004) estimated output in infrastructure for 1860–1935 at a more disaggregated level than the one presented here. His results are coincidental with mine but show higher volatility, due to the fact that only investment is considered while maintenance is neglected (Fig. 6.1). For this reason, I have not incorporated Herranz-Loncán estimates here.

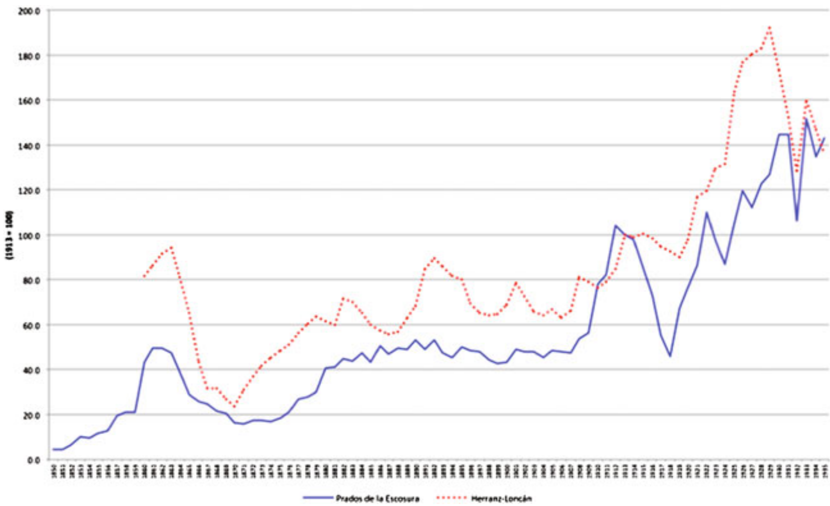

Fig. 6.1 Non-residential construction volume indices, 1850–1935: alternative estimates (1913 = 100). *Source* Prados de la Escosura, see the text; Herranz-Loncán (2004)

Current value series for each branch of non-residential construction was obtained by linking the level of gross value added for 1958 to its Laspeyres quantity and price indices and, then, added up to represent total value added in non-residential construction. An implicit deflator was computed.

6.3.3 Value Added in Residential and Non-Residential Construction

Residential and non-residential construction output was, then, combined into a single index for the construction industry with their 1913, 1929 and 1958 shares in the sector's value added, from which a spliced volume index was derived using a variable weighted geometric average.

Nominal gross value added for the entire construction industry was obtained by adding up residential and non-residential construction value added at current prices. An implicit (semi-Paasche) deflator was derived from current value (in index form) and the aggregate volume index.[75]

6.4 Services

Estimating value added in services represents the main obstacle in the construction of historical national accounts, especially in the case of those services for which no market prices exist, and also an unsurmountable problem in international comparisons.[76] In the present estimate, the use of employment data has been avoided and output indicators used instead.[77] When the output of services is derived using labour input data, productivity cannot be estimated since by construction it is implicitly assumed that output per worker remains stagnant. Major subsectors considered here are transport and communications, trade (wholesale and retail), banking and insurance, ownership of dwellings, public administration, education and health, and other services including restaurants, hotels and leisure, household services and liberal professions. Several steps were taken to produce annual quantity and price indices for the different branches of the service sector.

6.4.1 Transport and Communications

Transportation and communication services include water (coastal and international), road, urban, air and rail transport plus postal, telegraph and telephone services.

For transportation by rail, merchandise and passenger output series are available for the period 1868–1958 and were backcasted to 1859 with the volume of merchandise and passengers transported.[78] A spliced index of total rail transport output was obtained with rates per passenger-kilometre and ton-kilometre for 1913, 1929 and 1958 as weights over 1859–1964 that was extrapolated back to 1850 with the rate of variation of railway tracks. Thus, 1913 weights were applied for the period 1868–1913, while variable weighted geometric averages of 1913 and 1929 (1929 and 1958) weighted indices were accepted for 1913–1929 (1929–1958). Prices, that is, average output per passenger-kilometre and ton-kilometre (in pesetas), were taken from Gómez Mendoza (1989) and Muñoz Rubio (1995). Value added at current prices in rail transport was obtained by linking the 1958 level (CNE58) to quantity and price indices (average prices per passenger-kilometre and ton-kilometre).

For maritime transport, coastal and international transport services were distinguished. For coastal transport, merchandise output (expressed in tons-kilometre), available since 1950, was projected backwards to 1857 with tons of merchandise transported, while only the number of passengers transported was available from 1928 onwards. An unweighted average of the quantity indices of passenger and merchandise coastal transport was computed for 1928–1958 that was, then, spliced with the merchandise index in order to cover the period 1857–1958.[79] International transport services for 1942–1958 were measured by the total value of passenger and merchandise freights received by Spanish ships and, then, deflated by their respective freight indices.[80] For 1850–1942, merchandise transport was computed by applying a freight factor to the total value of exports and imports carried under Spanish flag that was, then, deflated by a freight index.[81] An index for international sea transport was computed using 1958 passenger and merchandise freight rates as weights for 1942–1958 and, then, projected backwards with the merchandise index to 1850. Finally, value added for maritime transport at current and constant prices was derived projecting value added for 1958 (CNE58) backwards with freight and quantity indices for coastal and international transport.[82]

For road transport, merchandise and passenger outputs are available since 1950 and were backward projected to 1940 with the number of tons and passenger transported.[83] A road transport output index was computed as an average of merchandise and passenger output for 1940–1958 and backward projected to 1850 with the road length that, to allow for its use, was weighted by the stock of motor vehicles over 1900–1940.[84] Value added at current prices in road transport was obtained by linking the 1958 level (CNE58) to the output index and a price index for gasoline.[85]

Urban transport was approximated by the number of passengers transported by tramways, trolley buses, buses and metro from 1901 onwards (Gómez Mendoza 1989). Value added at current prices was reached through backward projection of the 1958 level (CNE58) with the rates of variation of the sector's revenues.[86]

For air transport, passenger output is available since 1929 and merchandise output from 1950 onwards that was projected backwards to 1930 with the rate of variation of total merchandise transported; both series were combined into a single quantity index using with equal weights.[87] Value added was computed annually by backcasting the level for 1958 with the output index and a price index for gasoline.[88]

Finally, road, urban, water, air and rail indices weighted by their contributions to transport gross value added in 1913, 1929 and 1958 (CNE58) provided an aggregate index for transport services.[89] A spliced quantity index was constructed for 1850–1958 as a variable weighted geometric average of each pair of adjacent benchmark's indices.

Annual value added in transport services (at current prices) was reached by adding up rail, water, road, air and urban transport value added derived through linking 1958 value added levels (CNE58) to their quantity and price indices. An implicit deflator resulted of dividing current value added (in index form) by the aggregate volume index.

For communication services, postal (number of letters and parcels sent), telegraph (number of telegrams) and telephone (calls from 1924 onwards, backcasted with lines in service to 1897) indices were merged into an aggregate index using their 1913, 1929 and 1958 revenues as weights that were, then, spliced into a single index using variable weighted geometric average.[90] The current value of communications services was derived by linking the 1958 value added level (CNE58) to each subsector's yearly revenues.[91] An implicit deflator resulted from current value added (in index form) and the quantity index.

6.4.2 Wholesale and Retail Trade

Due to dearth of data on distribution, it was assumed that trade output was a linear function of physical output, and a quantity index was derived by combining, with 1958 weights, agricultural (including fishing), mining and manufacturing output plus imports of goods, from which a 2-year moving average was computed to allow for inventories.[92] Value added at current prices was obtained by linking the 1958 level to the quantity index and a price index (computed on the basis of the same trade components and 1958 shares).

6.4.3 Banking and Insurance

Value added at current prices was computed by splicing 1958 value added for banking and insurance services (CNE58) with the joint index of banking deposits and insurance premia. Deposits in commercial and savings banks and the value of insurance premia, expressed in index form (with 1958 = 1), were weighted according to their shares in the 1958 input–output table's sectoral value added (TIOE58) to derive an aggregate nominal index. Value added at current prices was deflated with a wholesale price index.[93]

6.4.4 Ownership of Dwellings

It was assumed to evolve as the quality-adjusted stock of dwellings.[94] Value added at current prices was derived splicing the 1958 level (CNE58) to the quantity index and a rent of dwellings deflator.[95]

6.4.5 Public Administration

Services output for public administration was measured by wages and salaries paid by the central government, which were deflated by a cost of living index.[96] Value added at current prices was obtained by backcasting the 1958 benchmark level with the rate of variation of wages and salaries paid by the central government.

6.4.6 Education and Health

For education services, an index of schooling weighted by deflated government expenditure on education, to allow for quality changes, was used.[97] For health, the number of hospital patients was combined with deflated public expenditure on health in order to incorporate quality improvements.[98] Value added in education and health was obtained by projecting value added in 1958 with their quantity indices and a wholesale price index.

6.4.7 Other Services

In the cases of household services and liberal professions, the usual assumption that output evolved as the labour force employed in each sector was accepted, namely that no productivity growth occurred, and yearly figures were obtained from log-linearly interpolating census data.[99] Value added was reached by linking the 1958 level to the quantity index and a wage index (household services) or the wholesale price index (liberal professions). Finally, for hotel, restaurant and leisure services were crudely approximated combining indices of room occupancy and leisure.[100] Value added was derived by splicing 1958 level with the quantity index and the cost of living.

6.4.8 Value Added in Services

Next, index numbers for the different branches of services were merged into an aggregate index, with 1913, 1929 and 1958 weights, which correspond to their contributions to total gross value added in services (Table 6.5). A compromise, single index was computed through a variable weighted geometric average, as in the cases of agriculture and industry.

Aggregate gross value added at current prices was computed by adding up all services' value added. An implicit deflator was obtained from current value (in index form) and the aggregate quantity index.

6.5 Total Gross Value Added and GDP at Market Prices

A real gross value added index was constructed for 1850–1958 by weighting output volume indices for each major branch of economic activity (agriculture, industry, construction and services) with their shares in total gross value added for 1958.[101] Nominal gross value added was obtained by adding up GVA at current prices for each major branch of economic activity. GDP at market prices resulted from adding indirect taxes less subsidies to total GVA. An implicit gross value added deflator was derived from nominal and real values expressed in index form (1958 = 1). Real GDP at market prices was derived with the GVA deflator.

Notes

1. Cf. Heston (1994) for a survey of developing countries GDP estimates.
2. By a component is meant a variable that is an element of GDP (i.e. agricultural output) and by an indicator a variable that is correlated with real output when the latter is available (i.e. tons-km transported by the railways) (Balke and Gordon 1989: 41).
3. Actually, the dearth of data on nineteenth-century prices has prevented economic historians from building price indices, and Sardá (1948) wholesale price index still remains widely used despite general complaints about its low and biased coverage. Available indices for wholesale prices in the early twentieth century have not been challenged so far (as it is also the case of the price index built by the Comisión del Patrón Oro, Gold Standard Committee, in 1929. Consumer price indices are provided in Reher and Ballesteros (1993), Ballesteros (1997), and Maluquer de Motes (2006, 2013).
4. Unfortunately, it was not always possible to derive Paasche price indices for every sub-branch of each sector of economic activity. In such a case, Laspeyres chain indices were used. This problem, resulting from defective statistics, is also common in today's national accounts (Cf. Corrales and Taguas 1991).
5. This procedure is most common in present-day developing countries (Heston 1994: 35). Official national accounts with 1958 base (Contabilidad Nacional de España 1958, CNE58) for the years 1954–1964 are presented in Instituto de Estudios Fiscales (1969).
6. The Ministry of Agriculture (Ministerio de Agricultura 1979) computed final output and value added in agriculture for the years 1950–1958. Aggregate national accounts (CNE58), however, are only available since 1954.
7. Unfortunately, since coverage was incomplete, assumptions about the production of several crops in 1890 and 1900 were made. Cf. Table 6.1. I am indebted to James Simpson for kindly allowing me access to the

unpublished agricultural quantity and price data set for 1890–1930 that underlies his own work (Simpson 1994).

8. Cf. For its coverage, cf. Appendix, Table A.3. It must be noticed that final output and value added series are constructed for the entire period 1850–1958 despite the fact that Ministry of Agriculture's (1979) figures at current prices were preferred for 1950–1958. The reason why the estimate is extended over the 1950s is to dispose of homogeneous deflators over the whole time span.
9. This is also a common feature of developing countries today, cf. Heston (1994).
10. There are differences in levels of real final agricultural output between Table 6.1 and Simpson (1994) that lead to productivity differences. The discrepancies mainly stem from the fact that, in Table 5.2, a deflator derived from the covered output (i.e. goods whose quantities and prices are available) is assumed to be representative for the entire agricultural sector, and it is, therefore, used to deflate current final output. Simpson (1994), in turn, assumed that the quantity index that results from the covered output is representative of agriculture as a whole. There is a long-standing debate about which approach is preferable. Cf. Maddison (1995), p. 231–232.
11. That is, on a large sample of agricultural produce, it is worth mentioning that *total* production at benchmark years over 1891–1931 has already been provided by GEHR (1983) and Simpson (1994). Also, annual quantity indices for *total* production for 1891–1935 are presented in Comín (1987) and GEHR (1987).
12. Thus, for 1890–1913, a weighted geometric average of 1891/1993 and 1909/1913 based quantity indices was taken; for 1913–1929, a weighted geometric average of 1909/1913 and 1929/1933 based quantity indices; for 1929–1950, a weighted geometric average of 1929/1933 and 1950 based quantity indices; and for 1950–1958, a weighted geometric average of 1950 and 1960 based quantity indices. For 1850–1890, in turn, an 1890-based Laspeyres agricultural quantity index was accepted.
13. The level of agricultural final output derives from Ministerio de Agricultura (1979b: 155).
14. That is, on the basis of the same variable sample of produce on which the index of final output was constructed.

15. Thus, for 1890–1913, a weighted geometric average of 1891/1893 and 1909/1913 based price indices was taken; for 1913–1929, a weighted geometric average of 1909/1913 and 1929/1933 based price indices; for 1929–1950, a weighted geometric average of 1929/1933 and 1950 based price indices; and for 1950–1958, a weighted geometric average of 1950 and 1960 based price indices. For 1850–1890, in turn, 1890-based Laspeyres agricultural price index was accepted.
16. Cf. Fenoaltea (1988). Table A.3 in the Appendix presents, for every benchmark year, the coverage of each group in the annual quantity index. For a more formal description of the method, see the section on industry.
17. In order to derive each subsectoral index, physical quantities of final output within each group of goods were valued at their benchmark year prices and the aggregated value expressed in index form. Quantities are derived mostly from GEHR (1989, 1991), completed with Comín (1985a), Simpson (1986, 1994 unpublished data set) and Carreras (1983) for the pre-Civil War years; and Barciela (1989) and Ministerio de Agricultura (1974, 1979a) for 1940–1950. For the Civil War, scant information, only for cereals, is provided in Barciela (1983, 1989) and Almarcha (1975).
18. Simpson (1994, 1995) followed option (a), while Prados de la Escosura (1988) used both (a) and (c).
19. Partial evidence for 1857–1860 is collected in Prados de la Escosura (1988).
20. Output was interpolated for missing years in the cases of wheat (1887) and olive oil (1887 and 1889).
21. The reason to adjust the traded volume by the length of the network is that this a period of construction of roads and railways that clearly reduced transportation cost and, hence, incentivize commercialization. I am indebted to Albert Carreras for the suggestion.
22. Specific commercialization series used were transportation by rail (metric tons/km) for cereals (wheat and rice) and wine, and by sea (including coastal and export trade) for wine, olive oil, sugar cane and beet, fruits and nuts. Information (except for fruits and nuts that come from Gallego and Pinilla (1996) and *Estadística(s) del Comercio Exterior*) was derived from Carreras (1983, i, 386–502). Raw wool output was taken from Parejo (1989).

23. Cf. Simpson (Simpson 1992, 1994, 1995) for objections to this point of view, but cf. Federico (1986) for the wide diffusion of the market economy in another nineteenth-century Mediterranean agriculture, Italy. Domínguez (1994) research on northern Spain shows that peasants had regular access to the market by mid-nineteenth century.
24. It is not clear that the relationship between total output and commercialised output was stable over time and it seems reasonable to presume that the gap would decline as the economy developed.
25. The level of per capita consumption for 1865–1869 was arbitrarily assumed to remain stable over 1850–1865. That is, $D = c * N = (1 - s) * Q + (X - M)$, where D is the demand for wheat (legumes), c is its consumption per caput, N is the total population, Q is output, s is the proportion of seed and animal feed, X is exports, and M is imports. Thus, total wheat (legumes) output will be obtained as $Q = (c * N - (X - M))/(1 - s)$. Implicit in this calculation is the assumption that disposable per capita income and agricultural relative prices did not experience significant alterations over these 15 years and represent a particular case of a demand function.
26. That is, 1891/1893 prices were applied to physical output of each crop and the resulting annual values added up for the previously defined groups of products and expressed in index number form, from which a quantity agricultural index was obtained by weighting them with their shares in the 1890 benchmark.
27. Less reliable estimates for livestock numbers are available for 1859 and 1888. Cf. Mitchell (1992) for data and GEHR (1978/1979, 1991) for a critique of the sources.
28. Since it has been argued that livestock numbers are underestimated for the 1891–1916 period, conversion coefficients from 1929 and 1933 livestock censuses were adopted (Simpson 1994; GEHR 1978/1979, 1991). Animal produce for 1865 was derived from livestock numbers by applying the turnover of animals in García Sanz's (1994). It is noticeable that the percentage of livestock slaughtered changed over the late nineteenth century, in particular, for sheep and cattle (Cf. García Sanz 1994; GEHR 1983; and Simpson 1994). Constant average weights per animal in 1920, derived in Flores de Lemus (1926), were accepted in Simpson (1994) and GEHR (1978/1979) and maintained in my estimates since no alternative estimates were available. Coefficients applied are presented in Appendix, Table A.2.

29. The cautious estimating procedure would, nevertheless, offset the claimed upward bias in growth rates stemming from approximating crops output from traded crops. An additional reason to choose such a rough procedure is that livestock output could be arguably seen as less volatile than crops output, and by its inclusion in the estimate of agricultural output, excess volatility would have been reduced.
30. Agrarian historians coincide in pointing to a decline in livestock output simultaneous to a rise in crops output over the late nineteenth century (GEHR 1978/1979, 1983, 1989). The literature does not address, however, the issue of over time change in animals' weight (most authors keep using weights per unit taken from the 1920 census by Flores de Lemus (1926)) and, more significantly, the increased turnover of animals. García Sanz (1994) shows the share of livestock slaughtered in 1865, and its differences with similar estimates for 1900 or 1930 (much closer among themselves) are striking, in particular, for cattle (the proportion in 1865 is, at least, 1–3 with respect those of 1904 or 1929), a feature consistent with the rise in urbanization within the period that brought a rise in beef consumption. Mutton consumption rose, in turn, (as sheep became increasingly less oriented towards wool production) and goats' meat experienced a marked decline.
31. The same procedure used for crops output was applied here. Alternatively, the 1858 livestock census could be used, but its noticeable underestimation of livestock numbers prevented me from doing it.
32. Sources used for yearly agricultural prices were Arenales (1976), Barciela (1983, 1989), Carreras (1989), Comín (1985a, c), *Estadística(s) de Comercio Exterior* (various years), GEHR (1981a, b, 1989), Gómez Mendoza and Simpson (1988), Martín Rodríguez (1982), Ministerio de Agricultura (1974, 1979a), Ministerio de Trabajo (1942), *Anuarios Estadísticos de España* (various years), Paris Eguilaz (1943), Piqueras (1978), Reher and Ballesteros (1993), Sánchez-Albornoz (1975, 1979, 1981) and Simpson (1994, unpublished data set).
33. Actually, since quantity indices are of Laspeyres type, price indices should be of Paasche type to derive current values (see expressions (I), (II) and (III) above). It is worth noticing that a hybrid of Laspeyres and Paasche price indices, which stems from defective statistics, is still common in today's national accounts (Cf. Corrales and Taguas 1991).
34. Fortunately, the small share of agricultural final output represented by purchases outside agriculture keeps the size of the bias introduced by

such crude proxies within reasonable limits. The source for the 1958 benchmark was Ministerio de Agricultura (1979b: 155). The N + P_2O_5 + K_2O content of mineral fertilizers in Gallego (1986) and Barciela (1989) provides a homogeneous annual indicator for the years 1892–1958 that was backcasted with fertilizer imports to 1850. Missing values for the content of mineral fertilizers in 1935–1939 and 1945–1950 were log-linearly interpolated from available data for 1935, 1945 and 1950. For 1940–1944, it was assumed the same value as for 1945. For mineral fertilizers, prices were taken from Pujol (1998), Carreras (1989) and *Anuario(s) Estadístico(s)*. Quantities and prices for fertilizer imports were derived from *Estadística(s) del Comercio Exterior*.

35. The index was derived from splicing four sub-indices: 1901–1913, values at 1912/1913 prices; 1913–1929, geometric average of values at 1912/1913 and 1929/1933 prices; 1929–1940, values at 1929/1933 prices; 1940–1958, values at 1960 prices. Splicing the subseries was done using ratios for overlapping years. Sources used were GEHR (1989, 1991), Barciela (1989) and Ministerio de Agricultura (1979a, b).
36. Reseña Estadística (1952) for the current value of total output, 1901–1950. Current values of total and final output are provided in Ministerio de Agricultura (1979) for 1950–1958.
37. It was arbitrarily assumed that variations in value added at current prices corresponded to those in total output in nominal terms.
38. Sources used are Giráldez (1991) for 1883–1934, completed with unpublished data obtained by Gómez Mendoza (1983) for 1878, 1888–1892 and 1904–1907; and Barciela (1989) for 1940–1958.
39. The value of total production is considered to provide an acceptable proxy for value added. Cf. Hemberg (1955) and Giráldez (1991), pp. 520–521.
40. Cod prices in Arenales (1976).
41. Gross value added for 1958 comes from 1958-based national accounts, CNE58 I.E.F. (1969). The shares for 1958 were: agriculture, 0.8963; forestry, 0.0722; fishing, 0.0315. For the period 1850–1900 when forestry data are missing, agriculture's share was increased correspondingly. For the Civil War years (1936–1939), when no data exist for forestry and fishing I assumed these two sectors evolved as agriculture.
42. In the compromise single index, each benchmark's index gets a larger weight the closer it is to each particular year (the formula used is (12)).

43. Cf. Carreras (1983, 1984, 1990, 1992). Most of the annual data and the weighting system used for this section were derived from Carreras (1983).
44. An alternative estimate can be found in Prados de la Escosura (1988), Chap. 4, in which Fisher indices were computed for 1860, 1890 and 1910 benchmarks using 1856, 1900 and 1920 weights.
45. The actual procedure followed by Carreras (1983, 1984) to derive unit value added for 1913 and 1929 was applying the ratio of gross *value added* at factor cost to *total value* for 1958 to industrial prices in 1913 and 1929, assuming implicitly that such a ratio was stable over time.
46. Industrial gross value added used to obtain these percentages derived from contemporary estimates by Vandellòs (1925) for 1913 and de Miguel (1935) for 1927. The coverage of Carreras' industrial production index is still lower than the one by Lewis (1978) for the UK, which covered 91% of manufacturing and mining value added in 1907.
47. In Carreras (1987, 1990), the final index results from linking the series for 1831–1913 (built using the 1913 benchmark) with the series for 1913–1935 (1929 benchmark), the series for 1935–1958 (1958 benchmark) and the series 1958–1981 (1975 benchmark).
48. Cf. Harley (1982) and Fremdling (1988) for a critique of analogous problems in British and German industrial production indices built by Hoffmann (1955). A debate on industrial growth in early nineteenth-century Spain along these lines can be found in Prados de la Escosura (1988), Chap. 4 and Carreras (1990), Chap. 3 (*addenda*). Cf. Rosés (2003) for a re-assessment.
49. However, as Morellá (1992) suggests, the Gerschenkron effect, that is, the downward bias in the growth rate introduced by end-year weighting may offset it.
50. Cf. Holtfrerich (1983) and Fenoaltea (2003, 2005), for German and Italian historical accounts, and Heston (1994: 35, 47), for present-day developing countries. Cf. Gandoy (1988) for a critique of the use of production indices instead of real value added derived as a residual of double deflated output and inputs and David (1962) and Fenoaltea (1976) for support of single deflation.
51. As it has been shown above, the same method was applied to the construction of the agricultural final output series.

52. Almarcha et al. (1975), Coll (1985, 1986) and Comín (1985a), together with the reference provided in the section on agriculture above, provide complementary sources.
53. Lewis (1978) made the same assumption for the UK Quality indices for shipbuilding and locomotive production have been applied the tons constructed. For shipbuilding, Feinstein (1988) quality index has been adjusted to the Spanish case. Thus, for 1850–1869, no adjustment has been made; a 0.35% annual increase was applied to 1870–1885 that rose to 0.7% for 1885–1900 and to 0.83% over 1901–1936, while no increase was assumed for 1937–1949. Finally, a 1% quality improvement was accepted for 1950–1958. For the production of locomotives, a quality adjustment has been derived from Cordero and Menéndez (1978) evidence on the increase in power per type of locomotive (including electric and diesel engines).
54. This is the procedure followed by Carreras (1983) for 1913 and 1929.
55. Historical estimates for unit value added in mining, cement and metal and engineering industries derived from Coll (1985, 1986), Escudero (1989) and Gómez Mendoza (1985a, b) were employed.
56. Cf. Morellá (1992).
57. Thus, each branch or sectoral index was built using 1870 benchmark's unit value added for 1850–1870; indices with 1870 and 1890 unit value added weights for 1870–1890; and 1890 and 1913 unit value added weights for 1890–1913. Then, a geometric mean was calculated for each sub-period, and a single sectoral index was reached for 1850–1913 splicing the three segments 1850–1870, 1870–1890 and 1890–1913 on the basis of overlapping years. For the post-1913 period, branch indices were derived with 1913 and 1929 unit value added for 1913–1929 and with 1929 and 1958 unit value added weights for 1929–1958. I did not follow the common practice in historical industrial accounts of smoothing the resulting series with some sort of moving average in order to allow for stocks (Cf. Batista et al. 1997; Maluquer de Motes 1994) since I did not have any knowledge about the size and evolution of industrial stocks.
58. Thus, 1913 weighted indices were used for 1850–1913 and variable geometrical averages of 1913 and 1929 based indices, for the years 1913–1929, and of 1929 and 1958 based indices, for 1929–1958.
59. This implies that goods whose prices were not available were assumed to have the same price behaviour as those within the sample. For

manufacturing, price indices for different subsectors (food, textile, shoemaking, metal, chemical, cement, timber, paper) were constructed from a wide variety of sources. Thus, for food industry, its price index was based on price series for wine, brandy, beer, olive oil, flour, rice, sugar, coffee, cocoa and tobacco. Prices for yarn and semi-manufactures of cotton, silk, wool, hemp and jute were, in turn, the basic ingredients of the textile price index. Again, for metal industries, both basic and transforming, iron ingots, steel and cast iron, tin, lead, copper, blister, zinc, tin, silver and mercury, that is, inputs prices, were the almost exclusive ingredients of their price indices. Prices for shoes, corks, common and Portland cement and paper were the available information for shoemaking, cork, cement, paper and printing industries. For the chemical industries, a wider coverage was achieved. In any case, price coverage was uneven and the sources quite heterogeneous. The main sources for industrial prices used, including mining, utilities and construction, were Arenales (1976), Barciela (1989), Carreras (1989), Coll (1985, 1986), Martín Rodríguez (1982), Ministerio de Trabajo (1942), Paris Eguilaz (1943) and Prados de la Escosura (1981).

60. This is so because as efficiency increases, intermediate consumption is reduced rendering, hence, a lower increase (or a sharper decline) for the value added deflator than for inputs prices or for the deflator of total production.
61. No data were available for quarrying before 1920 and extractive industries' output was backcasted till 1850 with mining output. The sources for quantities and prices were Carreras (1983, 1989), Coll (1985) and Escudero (1998). Coal, iron ore, lead ore and pyrites are the main components of the price index for mining (see note 98).
62. For water supply, no national aggregate figures were found and only scattered data are available for a few capital cities (Madrid (Rueda Laffond 1994), Barcelona, Bilbao (Antolín 1991) and Pamplona (Garrués 1998)). For utilities, gas and electricity prices were available (see note 98). Data for gross value added come from 1958 national accounts (CNE58) distributed by branches with the 1958 input–output table (IOT58). In allocating a higher weight to gas, to compensate for the lack of data on water supply, I followed a suggestion by Fenoaltea (1982: 627).
63. No distinction can be made between residential and commercial use of dwellings. However, Tafunell (1989b) points out that in 1890s

Barcelona non-residential dwellings did not reach 5% of total dwellings, with the ground floor of residential buildings being commonly allocated to industrial and services' activities. The sources are *Nomenclators* and *Censos de viviendas*. Residential construction indices are available for several cities, including Madrid and Barcelona for the late nineteenth and early twentieth century, i.e. Tafunell (1989b); Gómez Mendoza (1986). Data on the stock of urban dwellings are available in Tafunell (1989a).

64. The assumed annual increase in size and quality is similar to the one estimated by Cairncross (1953) for the UK and was also accepted by Lewis (1978).
65. Cf. Bonhome and Bustinza (1969). The extent to which the results from each estimate are similar is provided by the percentage of houses built in 1850 that still survived a century later (under the assumption that the demolished houses are always the oldest):

	1950	1960
Bonhome and Bustinza method	64.5	60.1
Feinstein method	64.6	59.4

66. Before 1860, the stock of dwellings was backcasted with the rate of population growth and a demolition yearly rate of 0.2% was assumed.
67. Input consumption was derived from Carreras (1983). A 2-year moving average was computed to allow for stocks. Consumption of timber and cement was combined into a single index with 1958 input–output (TIOE58) weights. Evidence on new dwellings comes from *Anuario(s) Estadístico(s)*.
68. The value of urban and rural dwellings (the cost of the average rural (urban) dwelling times its number) over the following periods, prior to 1860, 1861–1911, 1911–1940 and 1961–1960, was computed from data in Bonhome and Bustinza (1969) for dwellings built in these periods and still existing in 1965. The resulting shares for urban dwellings were 0.3448 (1850–1860), 0.5289 (1861–1910), 0.8623 (1911–1940) and 0.8663 (1941–1960).
69. The residential construction deflator included construction materials representing 49% (0.32, timber; 0.30, cement; 0.38, iron and steel) and mason wages, 51%.

70. The 1958 Input–output table (TIOE58) provided the shares for residential and commercial (0.7756) that was used to derive each sector value added from official national accounts (CNE58).
71. For 1936–1939, only the expenditure per kilometre of line by the major railway companies, Norte and MZA, on the nationalist side was available (no data are available on the republican side during the Spanish Civil War). Lacking line length and expenditure per kilometre of line on the whole of Spain, no attempt was made to compute total expenditure and I accepted expenditure per line kilometre in the Francoist side as a proxy for changes in railway construction during the war years, 1936–1939. The deflator for railways construction was obtained by allocating 65.6% to materials costs (0.13, timber; 0.23, cement; 0.64, rails) and 34.4% to mason wages.
72. 73.In the road construction deflator construction materials represented 55% (0.69, cement; 0.31, iron) and mason wages, 45%.
73. Data on government expenditure on hydraulic infrastructure are provided in Fundación BBV (1992) and public expenditure on maritime works and harbours in Comín (1985b). The deflator used was constructed from prices for public works materials and wages, weighted according to 1958 input–output table (TIOE58). Thus, 57.4% was allocated to public works materials (0.08, timber; 0.24, iron; 0.68, cement) and 42.6%, to mason wages.
74. The 1958 input–output table (TIOE58) offers the shares of each non-residential construction branch in its total value added provided by 1958 national accounts (CNE58). The shares for 1913 and 1929 were derived from the current value estimates described in the text. For 1936–1939, given the dearth of data, an index was built up on the basis of railways construction and spliced with the main index using 1935 as the link year. Also, an index including 1940 was constructed on reduced information as maritime, and harbour expenditure was missing and spliced with the main index with 1941 as the link year.
75. The 1958 Input–output table (TIOE58) provided the shares for residential and commercial (0.7756) and non-residential construction (0.2244) that were used to derive each sector value added from official national accounts (CNE58).
76. See Maddison (1983) and Krantz (1994). Cf. Melvin (1995) for the evolution of the concept of services.
77. The exception is household services.

78. Actually, while merchandise output, measured in metric tons-kilometre, is available since 1868, passenger output, measured in passenger-kilometre, is only available for the two main railway companies, Norte and MZA, before 1913. I linked MZA and Norte's passenger output over the years 1867–1913 to total passenger output for 1913–1958. The sources are Gómez Mendoza (1989) and Muñoz Rubio (1995). For the Civil War (1936–1939), the output series were interpolated with evidence on merchandise and passenger transported by Norte and MZA on the nationalist side, cf. Muñoz Rubio (1995), pp. 282 and 287.
79. The source for merchandise output since 1950 is Instituto de Estudios de Transportes y Comunicaciones (1984). Merchandise and passenger transported are provided in Frax (1981) and Gómez Mendoza (1989) for 1850–1950.
80. Data from Estadística de fletes y seguros (1942–1956) and Ministerio de Hacienda, Dirección General de Aduanas (1957–1958) kindly supplied by Elena Martínez Ruíz.
81. The freight factor series is used, that is, the ratio of freight costs to total traded value, and the total value of Spanish international trade is derived from Sect. 6.4. The freight indices correspond to iron ore, for exports, and a weighted average of wheat and coal freights, for imports. The sources for freights are Coll and Sudrià (1987), Isserlis (1938), North (1965) and Prados de la Escosura (1984). The share of tonnage transported under Spanish flag is derived from Valdaliso (1991) for 1850–1935 and from Anuario(s) Estadístico(s), thereafter.
82. Coastal freights per ton were computed for 1932–1958 from Valdaliso (1997). For 1857–1932, it was assumed that coastal freights evolved as freights in international trade (on freights see Sect. 6.4). Shares of coastal (0.6) and international transportation (0.4) in 1958 value added were derived using freight rates and tons and passenger transported.
83. Road output (both passenger and merchandise) is provided in Muñoz Rubio (1995) from 1950 onwards. Tons and passenger transported for 1940–1950 are derived from Anuario(s) Estadístico(s).
84. The stock of motor vehicles is provided in López Carrillo (1998). For the road length, the sources are Gómez Mendoza (1982, 1989) and López Carrillo (1998).
85. The price of gasoline is available since 1913 in Anuario(s) Estadístico(s) and was backward projected to 1901 with the price of petroleum in

Carreras (1989). For the late nineteenth century, it was assumed that road transport prices fluctuate along rail transport prices.

86. Actually, CNE58 only provides value added for 'other transport' that was distributed between urban and air transport using the 1958 input–output table (TIOE58).
87. The sources are Gómez Mendoza (1989) and Anuario(s) Estadístico(s).
88. This price index is the same used in the case of road transportation.
89. Weights were 0.44 for road transport; 0.1148, urban; 0.16, water; 0.0266, air; and 0.2586, rail, derived from CNE58 and TIOE58. For years in which information was incomplete, indices were built on partial evidence and spliced with the main index. That was the case for 1936–1939, when only air, road and sea transport indices were available, and for 1850–1856 when just rail and sea transport indices existed.
90. Only figures for mail services go back to 1850; telegraph services are recorded for 1855 and, then, annually from 1860, and telephone services from 1886 (number of telephones, but calls only from 1924). The sources are Calvo (1998), Gómez Mendoza (1989) and Mitchell (1992). 1958 weights were 0.6198, telephone; 0.2955, post; 0.0847, telegraph. The spliced index was constructed as in the case of transportation.
91. Revenues for telegraph services are only available from 1896 (Gómez Mendoza 1989) onwards and for telephone services since 1925 (kindly provided by Nelson Alvarez).
92. This short cut has been used before by Lewis (1978), van der Eng (1992), Cortés Conde (1994, 1997), Batista et al. (1997) and Smits et al. (2000) in historical estimates for Britain, Indonesia, Argentina, Portugal and the Netherlands, respectively. Similar methods were applied to Denmark, Sweden and Germany (cf. Krantz 1994). In the Spanish case, this procedure was accepted in both contemporary and historical estimates (Vandellòs 1925; Schwartz 1977). 1958 shares in gross value added (CNE58), except for imports where total value was accepted (see next section), were the weights used for computing the trading quantity index. The shares used were: agriculture, 0.3953; manufacturing, 0.4575; mining, 0.0339; imports, 0.1133. Krantz (1994: 26) assertion that 'some form of association exists between commodity production and trade but a priori a total correlation cannot be expected' led me to prefer a 2-year moving average alternative of the form, $Y_t = 0.5\, X_{t-1} + 0.5\, X_t$, where Y represents distribution and X the combination of physical output plus imports in year t.

93. 1958 input–output table shares (TIOE58) were 0.7946 for banking and 0.2054 for insurance services. Data for insurance premia are only available from 1909 onwards, and evidence on banking deposits was accepted as a good proxy for banking and financial services beforehand. When information was incomplete, as it was the case during the Civil War, indices were built on partial evidence and spliced with the main index. The sources for banking deposits are Tortella (1974, 1985), for 1856–1899, and Martín Aceña (1985, 1988), from 1900 onwards. Insurance data are derived from Frax and Matilla (1996) for 1909–1937 and *Anuario(s) Estadístico(s)*, thereafter.
94. Estimates at census dates were log-linearly interpolated to derive annual figures (see section on construction industry above).
95. The average price of urban dwellings that times the mortgage interest rate offered by Banco Hipotecario (kindly supplied by Juan Carmona) provides the implicit rent of dwellings for 1864–1865 and 1904–1934, while Ojeda (1988) presents a deflator for dwelling rents for 1936, 1939–1958. The rent of dwellings deflator was interpolated with the rate of variation of the construction industry deflator.
96. No allowance for government's rents (and depreciation) from buildings was made. Wages and salaries paid by the government are taken from Comín (1985b). The cost of living index is derived from Ojeda (1988) for 1909–58, and it was backcasted to 1850 with Reher and Ballesteros (1993) price index. This option has been preferred to the alternative of deflating government's wages and salaries by a wages index. The latter would imply that no labour productivity increase takes place at all, since total wages and salaries paid by the government, that is, employment numbers times wages, are deflated by a wage index (Krantz 1994). This only holds, of course, under the assumption that wages in the public sector and in the economy as a whole evolve the same. In the favoured alternative, if wages and salaries rise faster than prices, a productivity increase will be attributed to government (Heston 1994: 46).
97. A geometric average was computed with indices of education enrolment (primary, secondary and tertiary education log-linearly interpolated) from Almarcha (1975), Anuario(s) Estadístico(s); Núñez (1993), Mitchell (1992) and government expenditure on education (Comín (1985b) deflated by a wholesale price index (Sardá 1948; Ojeda 1988). An alternative measure using Núñez (2005) data on education enrolment hardly alters the overall index so I have kept the initial estimates.

98. A geometric mean of the number of patients and public expenditure on health deflated with a wholesale price index, expressed in index form, was computed. The sources are Almarcha (1975) and Anuario(s) Estadístico(s). Before 1909, it was assumed that health services evolved as education services.
99. The sources are Spain's population census. Alternatively, it could have been assumed steady labour productivity improvement over time as Lewis (1978: 264) did for late nineteenth-century Britain.
100. Evidence on room occupancy was only available since 1941. Over 1901–1941, the index of leisure was employed only. This leisure index was an average (with TIOE58 weights) of theatre and cinema (from 1940 onwards) and bullfighting (since 1901) attendance. For the late nineteenth century, it was assumed that the index fluctuates along the retail and wholesale trade index.
101. Alternatively, independent indices have been built for 1850–1913, 1913–1929 and 1929–1958 and, then, spliced using variable weighted geometric averages of the three indices. Differences between the chain index and the single 1958-weighted index are practically negligible due to the fact that chain indices have been previously computed for each main sector of economic activity. Therefore, I have preferred the aggregate GVA series that results from single 1958 weighting, so additivity of the aggregate index's components is maintained throughout 1850–1958. In the alternative approach, additivity would only hold for each period, but not for the aggregate, single GVA index.

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