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GDP and life expectancy in Italy and Spain over the long-run (1861-2008): insights from a time-series approach[1]

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Abstract: The article presents and discusses long-run series of per capita GDP and life expectancy for Italy and Spain (1861-2008). After refining the available estimates in order to make them comparable and with the avail of the most up-to-date researches, the main changes in the international economy and in technological and socio-biological regimes are used as analytical frameworks to re-assess the performances of the two countries; then structural breaks are searched for and Granger causality between the two variables is investigated. The long-run convergence notwithstanding, significant cyclical differences between the two countries can be detected: Spain began to modernize later in GDP, with higher volatility in life expectancy until recent decades; by contrast, Italy showed a more stable pattern of life expectancy, following early breaks in per capita GDP, but also a negative GDP break in the last decades. Our series confirm that, whereas at the early stages of development differences in GDP tend to mirror those in life expectancy, this is no longer true at later stages of development, when, if any, there seems to be a negative correlation between GDP and life expectancy: this finding is in line with the thesis of a non-monotonic relation between life expectancy and GDP and is supported by tests of Granger causality.

Keywords: Italy, Spain, GDP, life expectancy, unified growth theory, demographic transition

JEL codes: N13, N14, N33, N34, O47, O52.

1. Introduction

When dealing with the long-run determinants of economic growth at the national level, i.e. with macro-economic history, from quantitative grounds two are the most

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popular approaches: cross-country studies, usually with the avail of cross-section data, or country-specific studies, usually with the avail of time series.[2] In cross-country studies, the data at hand are usually limited to a few benchmark years, or to short periods of time; although a wide range of countries and indicators may be included and discussed, the lack of time-series may prevent from dealing efficaciously with endogeneity, even when instrumental variables are used.[3] Time-series macroeconomic analyses of specific countries or regions are of course much more complete in historical coverage and usually make use of updated and refined data,[4] but this usually comes at the cost of international comparisons.[5]

In this article, we extend time-series econometrics to a comparison between two or more countries: our goal is to maintain some degree of generalization (*l'espris de geometrie*), without losing in accuracy (*l'espris de finesse*). Namely, we present long-run time-series comparisons between the two most important countries of Southern Europe, Italy and Spain − which are usually regarded similar for culture and values, for some key institutional features and even for economic performance[6] − and compare them with France, their main neighbouring country to which both have often looked up as a proper term of evaluation. Our analysis focuses on economic monetary indicators (GDP at constant prices) and social no-monetary ones (life expectancy), running from the year of Italy's Unification (1861) until the outbreak of the present economic crisis (2008). The long-run convergence notwithstanding, are there significant cyclical differences between the two countries, and how "exceptional" is their performance, for instance when compared with their most important neighbour? Furthermore, are there some common features of the patterns of GDP and life expectancy, and of their relationship, which can be observed in both Italy and Spain? There is a growing literature about the relation between improvements in life expectancy and the growth of GDP per capita, mostly based on contributions from the unified growth theory, where the demographic transition plays a crucial role in the transition from stagnation to growth (Galor and Weil, 2000; Galor 2012). A number of cross-country studies have found a positive effect of life expectancy, or a negative effect of mortality, on income

[2] Some combination of the two may also be used: Prados de la Escosura (2007) provides a long-run comparisons among European countries via combining cross-section and time series data.
[3] For an extended overview of cross-country studies with instrumental variables, see Durlauf et al. (2005).
[4] For Italy, see Fenoaltea (2003, 2005) and, more recently, Felice and Vecchi (2012). For Spain, see among the others Pons and Tirado (2006), Prados de la Escosura (2010a), Sabaté, Fillat and Gracia (2011), Prados de la Escosura, Rosés and Sanz-Villarroya (2012). For other countries, see for instance the remarkable study on Turkey: Altug et al. (2008).
[5] Unless of course the well-known series by Maddison (2010) are used, but when it comes to a detailed scrutiny of national cases Maddison's estimates not always are reliable. For a criticism of Maddison's Italian estimates, see Fenoaltea (2011). Fort time-series analysis using Maddison's figures, see for instance Ben-David and Papell (2000). Time-series analysis with alternative estimates are usually limited to the industrial output: Crafts, Leyborne and Mills (1990); see also the Williamson project (Williamson, 2011).
[6] At least in four important aspects: both are catholic countries, share the Latin heritage (from neo-Latin language to the codified law), are late-comers in the European industrialization, and are medium-big sized countries with significant regional differences.

per capita (Bloom and Sachs, 1998; Gallup et al., 1999; Lorentzen et al., 2008), but the debate is still open: Acemoglu and Johnson (2007) have found no evidence of an impact of life expectancy on income growth, while more recent studies have suggested that the causal effect of life expectancy on growth is non-monotonic, i.e., it is negative although insignificant before the onset of the demographic transition, positive after that (Cervellati and Sunde, 2011). All these studies are based on cross-section comparison, and we believe that an important contribution to the debate may come from a time-series approach.

For our analysis, we work upon recent advancements in the historical research, which make possible to review and discuss the most updated series of GDP, as well as to present new long-run series of life expectancy for both Italy and Spain. In the case of GDP, we make use of the new series at constant prices for Italy (Baffigi, 2011; Felice and Vecchi, 2012), by many standards more reliable than the previous one included in Maddison (1991, 2010), and compare it with the one available for Spain produced by Prados de la Escosura (2003), which is incorporated in Maddison (2010) and unlike others (Maluquer de Motes, 2009a) looks more similar to the Italian one in its methodological approach. In the case of life expectancy, we link the most updated estimates, for Italy in benchmark years (Felice and Vasta, 2012) and for Spain (Blanes Llorens, 2007), with previously available information on life expectancy or mortality, in order to produce long-run comparable series running from 1861 to 2008. All these series are then confronted with those available for France, from well-known international database (Maddison, 2010; HDM, 2011a).

For both the indicators, comparisons are made through simple quantitative tools such as graphs and growth rates, and more refined ones such as econometric testing. After presenting the new series, the main changes in the international economy, as well as in technological and socio-biological regimes, are introduced and employed as analytical grids to re-assess the performances of the two countries. As a further step, through time-series econometrics structural breaks in the series of per capita GDP and life expectancy are searched for, identified and discussed.

The article is organized as follows. In section §2 we present our updated series of GDP and life expectancy for Italy and Spain, either if they are mostly new (per-capita GDP for Italy, life expectancy for Italy and Spain) or a simple refinement of the previous series to make the two countries more properly comparable (per-capita GDP for Spain). In §3 we present the results and introduce the discussion by way of two-pairs comparisons between Italy and Spain. In §4 we enter into a more detailed analysis, by way of historical grids based on the main international changes in the world economic history, as well as in technological and socio-biological regimes. Section §5 is dedicated to discussing differences in structural breaks between the two countries and to the issue of (Granger) causality between life expectancy and GDP. Section §6 concludes, by providing some answers to the abovementioned research questions.

2. The data

2.1. GDP per capita

As known GDP was invented in the 1930s, in the US, and only after world war II it was progressively adopted by other countries, *in primis* those of western Europe. This is the reason why GDP figures for periods previous world war II are always the product of reconstruction by economic historians or statisticians. The Italian *Istituto Nazionale di Statistica* was one of the first institutions to engage itself in the task of providing a long-run series of Italy's GDP, spanning from Unification (1861) until the 1950s (Istat, 1957), but the results were on the whole disappointing, not least due to the opacity of sources and methods (e.g. Fenoaltea, 2010). Since the 1950s (Gerschenkron, 1955; Fenoaltea, 1969) until our days (Fenoealtea, 2003, 2005; Carreras and Felice, 2010; Battilani, Felice and Zamagni 2012), economic historians have tried to amend the main flaws by providing their own indices of national production, for specific sectors or periods. Only recently, under the joint auspices of Bank of Italy, Istat, and the University of Rome II, these efforts have been unified into a long-run series of Italy's GDP, both at current and constant prices and spanning over 150 years, whose procedure and sources are fully verifiable (Baffigi, 2011; Brunetti, Felice and Vecchi, 2011). Soon after it was released, the brand-new series has been updated (Felice and Vecchi, 2012), to include the last advancements in the literature covering the interwar years (Felice and Carreras, 2012). We make use of this latest series, after revising the per-capita figures in order to consider the population *de facto*, rather than the resident population, as should be "by the book" with Gross *Domestic* Product.[7] In order to have the revised series, however, first we must estimate a series of the Italian *de facto* population at present boundaries; this is done through a few simple steps using the data of population de facto at historical borders, from official censuses in benchmark years, and the long-run series of resident population at historical and at present boundaries, from Istat (2012a).[8]

[7] By definition, per-capita Gross National Product should be based on resident population, per-capita Gross Domestic Product on present population.
[8] In more detail, as a first step the benchmarks of the population *de facto* at historical borders (referring to the years: 1861, 1871, 1881, 1901, 1911, 1921, 1931, 1931, 1936, 1951, 1961, 1971, 1981, 1991, 2001, 2011) are interpolated, with geometric average using the cycles of the resident population at historical borders; this way, a series of the population *de facto* at historical borders is obtained. As a second step, the series of the population *de facto* at historical borders is converted into the series of the population *de facto* at present borders, using for each year the coefficient "population at historical borders / population at current borders" from the series of resident population.

In the case of Spain, we have resorted to the estimate by Leandro Prados de la Escosura (2003), which was incorporated in Maddison (2010). This was not the only available series, however. Recently, Jordi Maluquer de Motes (2009a) has published in *Revista de Economía Aplicada* an alternative estimate of Spanish GDP at current and constant prices; the reply by Prados de la Escosura (2009) and a further clarification by Maluquer de Motes (2009b) were jointly published in the same journal. The two series are indeed quite different: for the years 1850 to 1970, the one by Maluquer is on average 24,5% higher than the one by Prados, and thus Spain's backwardness as compared to the rest of Europe is significantly reduced (Escudero and Simón, 2010, p. 234). The main reason of this discrepancy is due to the way different series at constant prices, based on different base years, are linked in 1958, that is in the year when the reconstruction by economic historians (1850-1958) and the one by the official national accounts (1958 to date) meet. Since the value from this latter is higher,[9] a major problem is how to bridge this difference. Maluquer chooses to consider superior the new estimate from national accounts: therefore he accepts the difference, which is then rescaled to the historical series from 1958 backward.[10] Prados' alternative strategy is instead to consider the historical estimate made at historical prices more reliable than the new estimate made with a more recent price system, and thus to refuse the difference for 1958 (i.e, to take as good the lower value): the difference is then distributed onward until the next base year for the constant-price series, in this case 1995; more specifically, it is allocated from 1958 to 1995 with weights increasing with the distance from 1958 (Prados de la Escosura, 2009, pp. 12-14). As a consequence, Prados' series remains unchanged from 1958 backward, although the growth rate from 1958 to 1995 is probably artificially increased. One second source of discrepancy is due to the fact that Maluquer uses one single deflator for all the series, the consumer price index, rather than implicit sectoral deflators as Prados does.

Surely Prados' approach pays more attention to the actual value of production in the past, by assuming that historical estimates in the base year at historical prices are more reliable than subsequent estimates made with different price systems (although there might be some reason for preferring instead Maluquer's index, for instance the use of some updated historical information).[11] Since we are interested in a comparison with Italy, we choose with little doubt Prados' estimate, essentially because both its

[9] As usual, and mostly due to the different price-basis used. This happens because, when prices and quantities are inversely correlated, late-weight indices, such as those of national accounts, tend to grow slower than early-weight ones (e.g. Gerschenkron, 1947).

[10] Namely, for 1958 Maluquer enlaces his series to the official accounts produced by Uriel, Moltó and Cucarella (2000), which in 1958 has a GDP higher by 10.7% than the one estimated by Prados (Maluquer de Motes, 2009b, p. 35).

[11] The new series of population estimated by Maluquer himself (Maluquer de Motes, 2008) and the series about prices and consumption also reconstructed by Maluquer (Maluquer de Motes, 2005): as we are going to explain, the former is here incorporated in Prados' index, since this can be done at no risk of weakening the consistency of Prados' estimates.

deflation system based on implicit deflators, and the redistributing rule used to link deflators with different base years, are conceptually similar to the methods used for reconstructing the Italian series (and they are also in line with Maddison's approach).[12] However, we find no reason for distrusting Maluquer's new estimate of the Spanish population (Maluquer de Motes, 2008): the author provides a series which is for the first time geographically and methodologically consistent through the different periods of Spanish history, and always refers to the population *de facto*, the one which should be used for per capita GDP (as mentioned). Therefore, we incorporate these data in order to produce up-to-date estimates of per capita GDP based on the population de facto,[13] which is comparable to the one we have produced for Italy. The differences between the old and the new population series are noteworthy above all for the years following the 1929 crisis, where Maluquer's new data for the first time include the emigrants returning from abroad: this results in higher estimates for the population and lower ones for GDP per capita and, as we will see (section §5), this change has some impact when it comes to search for structural breaks in the Spanish series.[14]

Both series are expressed in a common unit of measure, 1990 international Geary-Khamis purchasing power parity dollars (1990 G-K dollars, thereafter). For Spain, in Maddison (2010) Prados' series of total GDP is already expressed in 1990 G-K dollars. For Italy, we have had to transform the new series by Felice and Vecchi (2012) from constant 2011 euros to constant 1990 liras, using the standard deflator for the Italian cost of living, from Istat (2012b); after this, Italian 1990 liras were converted in 1990 G-K dollars, using the coefficient for Italy (1384.11 liras for 1 G-K dollar) reported in Maddison (2006, p. 189).

The results are displayed in table 1.

[12] For Italy, see Baffigi, 2011, pp. 56-59; Brunetti, Felice and Vecchi, 2011, p. 234. See also Maddison (1991).
[13] We divide Prados' series of total GDP by Maluquer's series of population de facto. We use the population *de facto* at the 1st of July.
[14] The series of the population *de facto* for Italy and Spain are presented in the Appendix.

Table 1. *GDP per capita (1990 K-S dollars) in Italy and Spain, 1861-2008*

	Italy	Spain		Italy	Spain		Italy	Spain
1861	1,556	1,246	**1911**	2,403	2,011	**1961**	6,401	3,452
1862	1,576	1,243	**1912**	2,410	1,984	**1962**	6,782	3,805
1863	1,614	1,263	**1913**	2,520	2,052	**1963**	7,137	4,148
1864	1,616	1,258	**1914**	2,385	2,004	**1964**	7,348	4,504
1865	1,714	1,215	**1915**	2,250	2,014	**1965**	7,607	4,747
1866	1,711	1,273	**1916**	2,427	2,086	**1966**	8,045	5,044
1867	1,562	1,263	**1917**	2,435	2,043	**1967**	8,596	5,321
1868	1,594	1,133	**1918**	2,377	2,011	**1968**	9,153	5,580
1869	1,615	1,170	**1919**	2,293	2,031	**1969**	9,688	6,029
1870	1,654	1,198	**1920**	2,330	2,165	**1970**	10,207	6,328
1871	1,618	1,290	**1921**	2,233	2,203	**1971**	10,333	6,633
1872	1,581	1,465	**1922**	2,400	2,272	**1972**	10,664	7,109
1873	1,573	1,590	**1923**	2,594	2,281	**1973**	11,335	7,666
1874	1,654	1,454	**1924**	2,640	2,326	**1974**	11,878	8,155
1875	1,663	1,493	**1925**	2,814	2,448	**1975**	11,554	8,350
1876	1,621	1,517	**1926**	2,816	2,414	**1976**	12,301	8,602
1877	1,631	1,667	**1927**	2,724	2,595	**1977**	12,554	8,835
1878	1,672	1,617	**1928**	2,863	2,578	**1978**	12,908	9,029
1879	1,677	1,518	**1929**	2,984	2,731	**1979**	13,625	9,066
1880	1,703	1,643	**1930**	2,825	2,610	**1980**	14,052	9,191
1881	1,754	1,673	**1931**	2,764	2,510	**1981**	14,149	9,167
1882	1,777	1,684	**1932**	2,795	2,524	**1982**	14,194	9,269
1883	1,794	1,714	**1933**	2,743	2,435	**1983**	14,346	9,448
1884	1,769	1,709	**1934**	2,716	2,491	**1984**	14,803	9,535
1885	1,796	1,658	**1935**	2,847	2,507	**1985**	15,206	9,683
1886	1,837	1,616	**1936**	2,723	1,923	**1986**	15,634	9,961
1887	1,885	1,584	**1937**	3,010	1,757	**1987**	16,127	10,487
1888	1,877	1,641	**1938**	3,111	1,752	**1988**	16,790	11,022
1889	1,821	1,633	**1939**	3,230	1,908	**1989**	17,341	11,568
1890	1,824	1,632	**1940**	3,081	2,073	**1990**	17,678	12,050
1891	1,850	1,666	**1941**	2,970	2,026	**1991**	17,929	12,319
1892	1,851	1,784	**1942**	2,779	2,133	**1992**	18,090	12,382
1893	1,879	1,714	**1943**	2,342	2,196	**1993**	17,944	12,206
1894	1,889	1,727	**1944**	1,925	2,278	**1994**	18,348	12,453
1895	1,904	1,708	**1945**	1,740	2,104	**1995**	18,901	12,756
1896	1,932	1,570	**1946**	2,361	2,178	**1996**	19,141	13,026
1897	1,934	1,645	**1947**	2,779	2,195	**1997**	19,512	13,490
1898	1,926	1,754	**1948**	2,993	2,179	**1998**	19,812	14,055
1899	1,946	1,761	**1949**	3,190	2,143	**1999**	20,123	14,660
1900	1,997	1,786	**1950**	3,444	2,193	**2000**	20,880	15,377
1901	2,029	1,899	**1951**	3,751	2,396	**2001**	21,284	15,882
1902	2,064	1,828	**1952**	3,904	2,576	**2002**	21,233	16,107
1903	2,086	1,817	**1953**	4,166	2,547	**2003**	20,971	16,333
1904	2,126	1,795	**1954**	4,295	2,718	**2004**	20,993	16,595
1905	2,173	1,758	**1955**	4,562	2,805	**2005**	20,849	16,912
1906	2,250	1,838	**1956**	4,760	3,009	**2006**	21,070	17,322
1907	2,294	1,885	**1957**	5,006	3,080	**2007**	21,154	17,623
1908	2,345	1,947	**1958**	5,262	3,183	**2008**	20,608	17,501
1909	2,368	1,967	**1959**	5,603	3,078			
1910	2,374	1,887	**1960**	5,963	3,094			

Sources and notes: see the text.

2.2. Life expectancy

Measures based on GDP are not, of course, the only indicators of economic growth, not to mention of human welfare. A wide range of social indicators, from per capita calories to average heights, to life expectancy, can be used to supplement or integrate GDP − not only because of the lack of GDP historical figures (Steckel, 2009) − combined in composite indicators (among which the Human development index, HDI, is now by far the most successful one),[15] or considered individually in a "dashboard" approach.[16] Although estimating social indicators for past periods is in principle not more difficult than reconstructing GDP − on the contrary, this latter poses by far greater conceptual problems[17] − international historical series of social indicators are badly lacking; nothing comparable with the impressive reach of the Maddison project, criticisable as it is. Before 1950, usually only benchmark estimates are available for education, heights, and nutrition. Things are a bit better for life expectancy: here some consistent series have been published, mostly thanks to the efforts by the Max Planck Institute for Demographic Research of the University of California (i.e., the Human Mortality Database, HMD hereafter);[18] however, their database does not always include home-made research made by economic historians in specific countries and which, if properly assessed and possibly incorporated, could be useful to enlarge both the international scope and the historical coverage of the database. For Italy, a wide range of social indicators has been published in the recent book by Giovanni Vecchi (2011), in benchmark years; in the case of life expectancy, an alternative and more recent estimate has also been published, in benchmark years from 1871 to our days (Felice and Vasta, 2012). For Spain, the Nisal research project has now made available on-line an impressive range of social and well-being indicators, including historical estimates of life expectancy previously published by Roser Nicolau (2005);[19] furthermore, for this country we now have very accurate new estimates of life expectancy in benchmark years (Cabré et al., 2002) and even in a yearly series from 1911 to 2004 (Blanes Llorens, 2007), both of them thus far not considered by HMD.

Thanks to this information, and to the available historical series published in the HMD, it is now possible to produce historical and consistent series of such an important social indicator as life expectancy, for both Italy and Spain spanning from 1861 until 2008, which are therefore directly comparable with the GDP series of the previous

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[15] UNDP (2010). For historical cross-country estimates, see Crafts (1997, 2002) and Prados de la Escosura (2010b); for Italy, see Brandolini and Vecchi (2011), Felice and Vasta (2012); for Spain, see Escudero and Simón (2010).
[16] Ravallion (2012). For Italy, see Vecchi (2011).
[17] Cfr. Boldizzoni, 2011, pp. 81-86.
[18] Freely available at: http://www.mortality.org/.
[19] Freely available at: http://www.proyectonisal.org/.

section. These new series of life expectancy are here presented and discussed for the first time.

For Italy, the basic reference are the estimates recently published in Felice and Vasta (2012), in benchmark years spanning from 1871 to 2007: from 1911 these estimates are roughly the same as those published in the HMD;[20] differences between the two are present for the early period, when, however, HMD's researchers themselves consider their figures far less trustworthy.[21] All these estimates − those by Felice and Vasta as well as those by HMD and even the Vecchi's ones − are at historical borders and thus, for a proper time-series analysis, they need to be converted to current borders. This conversion is made possible thanks to the fact that Felice and Vasta report life expectancy data also for the Italian regions, at historical borders: we make the conversion under the hypothesis that the ratio between life expectancy in Trentino-Alto Adige and a part of what is now Friuli-Venezia Giulia (including Trieste) on the one side, and the rest of Italy on the other side, has remained unchanged from the liberal age (when Trentino-Alto Adige and a part of Friuli-Venezia Giulia were not part of the Italian Reign) to the interwar years (when following World War I these provinces were annexed). Once we have estimated the new benchmarks at current borders (for 1871, 1891, 1911, 1931, 1938, 1951, 1961, 1971, 1981, 1991, 2001, 2007), the yearly series is constructed by interpolating through the benchmarks the yearly series of HMD (2011b), through a geometric average; from 1861 to 1870, the series is produced by projecting backward the value of life expectancy in 1871, with the inverse of the mortality rate on resident population for the years 1862 to 1871.[22]

If for Italy we have three sources of historical data for life expectancy, for Spain the sources are four. First, there are the benchmark figures published by Roser Nicolau (2005), mostly based on the estimates by the Spanish *Instituto Nacional de Estadística* (INE), running every ten years from 1900 to 1970, every five years from 1970 onwards, and with a last benchmark in 1998. Second, for the years 1908 to 2008 there is the yearly series by HDM (2011c). As expected, for corresponding years there are some differences between the benchmarks in Nicolau and the HDM series, which are due to different procedures of computing the population of Ceuta and Melilla and to the changes from the population *de facto* to the resident population; it is worth noticing,

[20] The Human mortality database provides an yearly series, at historical borders, from 1871 to 2008. Both Felice-Vasta and HMD differ from the benchmark estimates (which also are at historical borders) published in Vecchi (2011, p. 419), but to know the reasons of this discrepancy is impossible, at the present, because in the explanatory notes in Vecchi (2011, pp. 128-9) reference is made to an unpublished graduate thesis; in the case of Felice and Vasta, see the discussion at p. 35.

[21] Since "deaths counts are available only by five-year age groups (i.e., 0-4, 5-9,…, 65-74, 75+)" and "the data for 1883-84 demonstrate clear patterns of age heaping" (Glei, 2011, p. 3).

[22] The series of the mortality rate is available from Istat (2012c), for all the years 1862 to 2009; as expected, the correlation between mortality and life expectancy, for the years 1871 to 2009, is very high: Pearson coefficient of -0.955, with R^2 of 0.911. The value for 1861 is linearly interpolated, through a linear regression for the years 1862-1880, where year is the independent variable and life expectancy the dependent one.

however, that the HDM researchers do not seem aware of the previous work by Roser Nicolau,[23] therefore they do not raise this issue (Glei et al., 2012). This is little harm, since both works should by now be considered mostly outdated, thanks to the research carried out by Anna Cabrè and her co-authors, and more recently by Amand Blanes Llorens, who was a PhD student of Cabrè. At first, Cabré et al. (2002, p. 127) have published five years estimates of life expectancy in Spain, beginning as early as 1860, and running until 1995. A few years after, a PhD student of Cabré has published yearly series of life expectancy in Spain, from 1911 until 2004, as part of his PhD thesis (Blanes Llorens, 2007). This work is truly impressive, boasting a level of accuracy and detail with no parallels in other previous and subsequent researches, including the one by HDM (apparently unaware of this work too, unlike Blanes Llorens who discusses their work);[24] moreover, the results have never been published outside of the PhD thesis, and are here presented for the first time to a wider public.

The higher level of accuracy of the work by Blanes Llorens can be exemplified by the way of coping with under-registration of infant mortality, an issue which had indeed some impact on the overall trend of life expectancy in Spain when compared to Italy, as we are going to see in the next section. According to the Spanish laws, until 1974 the newborns who died within the first 24 hours of life were counted in the official censuses as aborted foetuses, or stillbirths, while from 1975 onwards they were included in the mortality tables. Therefore, deaths were under-registered until 1974. In order to estimate life expectancy, Blanes Llorens has recounted the number of these “false” stillbirths from the demographic statistics (*Movimiento Natural de la Población*) of INE from 1911 to 1975, and has accordingly modified his tables for those years to make them fully comparable with the following period (Blanes Llorens, 2007, pp. 57-59). HDM researchers also had coped with this problem, but had corrected infant death counts only from 1930 onwards (Glei et al., 2012, pp. 3-5).

Once we have accepted the new figures as superior, the only (minor) problem is that both the estimated series by Blanes Llorens, and the benchmark data by Cabré et al. are reported by sex, with no averages for the whole population; averages must therefore be calculated via the series of the population by sex, which is reconstructed from the data of official censuses for benchmark years (see Nicolau, 2004).[25] At this point, the different data of life expectancy for the whole population can be linked and unified, with the aim of producing the most updated and at the same time coherent

[23] Whose first version was published as early as 1989 (Nicolau, 1989).
[24] For a full description of sources and methods, see Blanes Llorens, 2007, pp. 43-114.
[25] Namely, historical data of population by sex are available for the following benchmarks: 1860, 1877, 1887, 1897, 1900, 1910, 1920, 1930, 1940, 1950, 1960, 1970, 1981, 1991, 2001, plus 2010. The annual series of the shares of female (and male) population is constructed via linearly interpolating the shares of the benchmarks, through the continuous compounded annual rate.

series of life expectancy for Spain.[26] To this scope, for the years 1911 to 2004 we use the series from Blanes Llorens (2007); these are in turn linked to the five-years estimates by Cabré et al. (2002) from 1861 to 1910.[27] In order to complete the cycle from 1861 to 1910, these are interpolated every five years, through geometric average, using the series of the inverse of mortality rates until 1907,[28] from Nicolau (2005), then using for the last two years, 1908 and 1909, the life expectancy series from HDM (2011c). For the very last stretch (2005-2008), we link the estimates by Blanes Llorens to the series by HDM; needless to say, in the overlapping years of the last period their figures are practically identical.

The new series are displayed in table 2.

[26] When it comes to econometrics, however, an alternative series constructed via linking the Nicolau data through the HDM estimates will also be tested, arguing that it shows statistical discrepancies that make us doubt of its reliability; alternatively, if the HDM series must be believed, it would reinforce rather than weaken the main results of the article.

[27] It is worth noticing that for the following period 5-years estimates by Cabré et al. are very close to the new figures by Blanes Llorens.

[28] Also in the case of Spain, for those years when it is possible to check for (i.e., from 1908 to 2001), we register a high correlation between mortality rates and life expectancy: Pearson coefficient of -0.958, R^2 of 0.918. In the series of mortality rates the years 1871 to 1876 are missing, and they should be reconstructed via linear interpolation through the continuous compounded annual rate, from 1870 to 1877; since, however, we have an estimate of life expectancy for 1875, the years of linear interpolation are indeed only four (1871 to 1874), plus one (1876).

Table 2. *Life expectancy at birth (years) in Italy and Spain, 1861-2008*

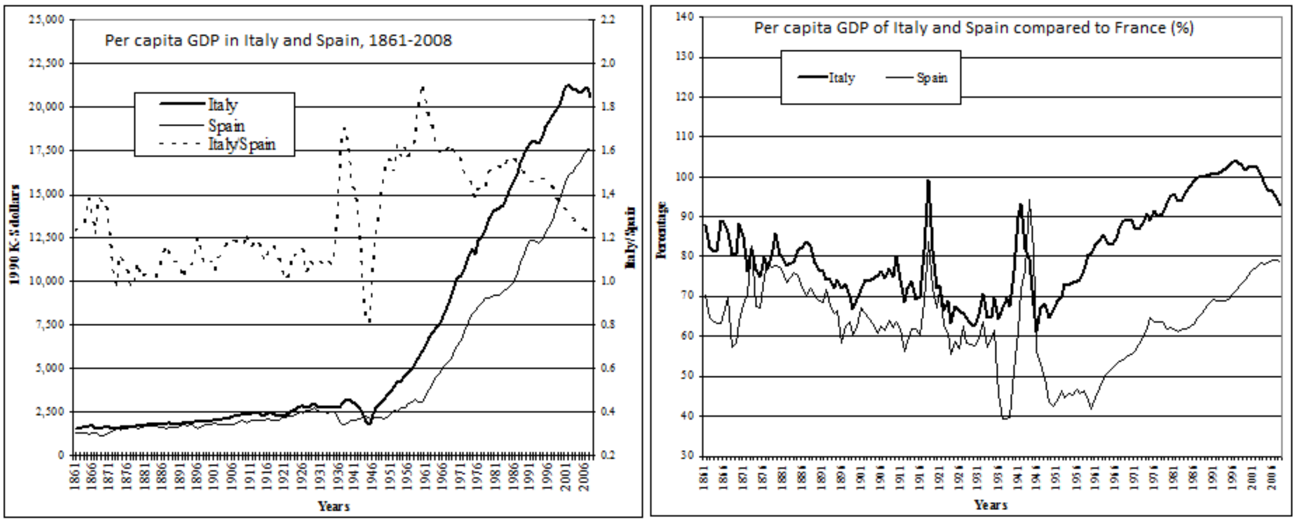
	Italy	Spain		Italy	Spain		Italy	Spain
1861	32.1	30.3	**1911**	44.2	42.2	**1961**	70.1	69.7
1862	32.0	31.0	**1912**	48.4	45.2	**1962**	69.4	69.7
1863	31.9	30.4	**1913**	47.9	43.7	**1963**	69.5	69.8
1864	33.1	29.7	**1914**	49.3	43.8	**1964**	70.6	70.6
1865	33.0	29.1	**1915**	41.9	43.6	**1965**	70.5	71.0
1866	33.9	34.1	**1916**	38.8	44.6	**1966**	71.2	71.2
1867	33.1	32.6	**1917**	37.3	43.3	**1967**	71.2	71.4
1868	32.4	28.7	**1918**	25.4	30.7	**1968**	71.0	71.7
1869	35.5	28.3	**1919**	41.7	41.9	**1969**	71.1	71.2
1870	33.1	30.1	**1920**	45.1	40.8	**1970**	71.8	72.2
1871	33.2	30.3	**1921**	48.8	43.9	**1971**	72.1	71.8
1872	33.6	30.5	**1922**	49.6	45.6	**1972**	72.3	73.0
1873	35.5	30.7	**1923**	51.1	45.6	**1973**	72.2	72.8
1874	35.4	30.9	**1924**	51.2	47.1	**1974**	72.8	73.1
1875	34.7	31.1	**1925**	51.0	47.6	**1975**	72.7	73.6
1876	36.9	31.2	**1926**	50.7	48.3	**1976**	73.0	73.9
1877	38.1	31.3	**1927**	52.4	49.0	**1977**	73.3	74.3
1878	37.2	31.5	**1928**	52.5	49.1	**1978**	73.6	74.5
1879	36.5	32.0	**1929**	52.2	50.1	**1979**	73.8	75.0
1880	35.0	32.1	**1930**	55.1	51.0	**1980**	73.7	75.5
1881	36.3	31.4	**1931**	54.8	50.9	**1981**	74.0	75.7
1882	36.2	30.5	**1932**	55.0	52.3	**1982**	74.5	76.3
1883	37.0	32.1	**1933**	56.8	52.4	**1983**	74.4	76.1
1884	38.4	28.3	**1934**	57.7	52.9	**1984**	75.2	76.5
1885	38.5	31.7	**1935**	57.3	53.1	**1985**	75.3	76.4
1886	36.6	32.9	**1936**	58.2	51.7	**1986**	75.7	76.7
1887	37.3	33.5	**1937**	57.2	48.1	**1987**	76.2	77.0
1888	38.2	34.9	**1938**	58.1	48.3	**1988**	76.4	76.9
1889	40.3	34.1	**1939**	59.5	47.9	**1989**	76.8	77.0
1890	39.5	34.1	**1940**	58.7	49.9	**1990**	76.9	77.0
1891	39.4	34.4	**1941**	56.1	48.9	**1991**	76.9	77.1
1892	39.5	34.7	**1942**	53.8	53.2	**1992**	77.3	77.5
1893	40.1	34.6	**1943**	50.3	55.2	**1993**	77.6	77.7
1894	39.9	34.1	**1944**	53.4	56.6	**1994**	77.8	78.1
1895	39.3	35.0	**1945**	55.8	58.1	**1995**	78.0	78.2
1896	40.1	34.5	**1946**	59.9	57.7	**1996**	78.4	78.3
1897	42.4	35.6	**1947**	62.0	59.4	**1997**	78.6	78.8
1898	41.1	35.6	**1948**	64.1	61.3	**1998**	78.7	78.9
1899	42.1	34.7	**1949**	64.6	61.0	**1999**	79.1	78.9
1900	39.9	34.5	**1950**	66.1	62.3	**2000**	79.5	79.4
1901	41.3	35.8	**1951**	65.5	61.9	**2001**	79.8	79.7
1902	41.0	38.0	**1952**	66.1	65.0	**2002**	80.0	79.8
1903	41.3	39.6	**1953**	66.8	65.7	**2003**	80.1	79.7
1904	42.7	38.4	**1954**	68.1	66.9	**2004**	80.9	80.2
1905	42.4	38.1	**1955**	68.5	66.7	**2005**	80.9	80.2
1906	43.7	38.0	**1956**	67.9	66.7	**2006**	81.3	80.8
1907	44.2	40.5	**1957**	68.0	66.6	**2007**	81.4	80.8
1908	42.1	42.0	**1958**	69.1	68.8	**2008**	81.6	81.1
1909	43.8	41.6	**1959**	69.5	68.7			
1910	46.0	41.5	**1960**	69.4	69.4			

Sources and notes: see the text.

3. How close, how far? A comparison by pairs of indicators (1861-2008)

The Italian and the Spanish series of GDP per capita, at constant prices (1990 K-S dollars), are displayed in the left side of figure 1, while in the right side the two series are confronted with the one available for France (the main neighbouring country of both Italy and Spain).

Figure 1. Per capita GDP in Italy and Spain, 1861-2008



Sources and notes: table 1; data for France are from Maddison (2010).

The story of the “race” between Italy and Spain can be summarized as follows: Italy began at a higher level, but lost some ground in the first decade following Unification; from the 1870s until the mid of the 1930s there was a slight ledge in favour of Italy, more or less unchanged through the ups and down from the end of the nineteenth century until the Spanish Civil War; after World War II, for fifteen years (1946-1961) the Italian gap toward Spain dramatically enlarged, but since the early 1960s Spain began to converge. From this outline we may therefore identify four phases: 1) the first decade (1861-1871), following Italy’s Unification, when Italy had a lead in per capita GDP between 20 and 40% over Spain; 2) the following longer phase (1872-1935), until the Spanish civil war, when the difference between the two countries was relatively mild, between 0 and 20% in favour of Italy; 3) a third phase (1946-1960), characterized by a growing gap in favour of Italy, from 6% in 1946 to a remarkable 91% in 1960; 4) then the final period when, although through ups and downs, Spain has converged towards Italy, reducing that gap down to 17-18% in 2008 − that is, to around the level which had characterized the second phase.

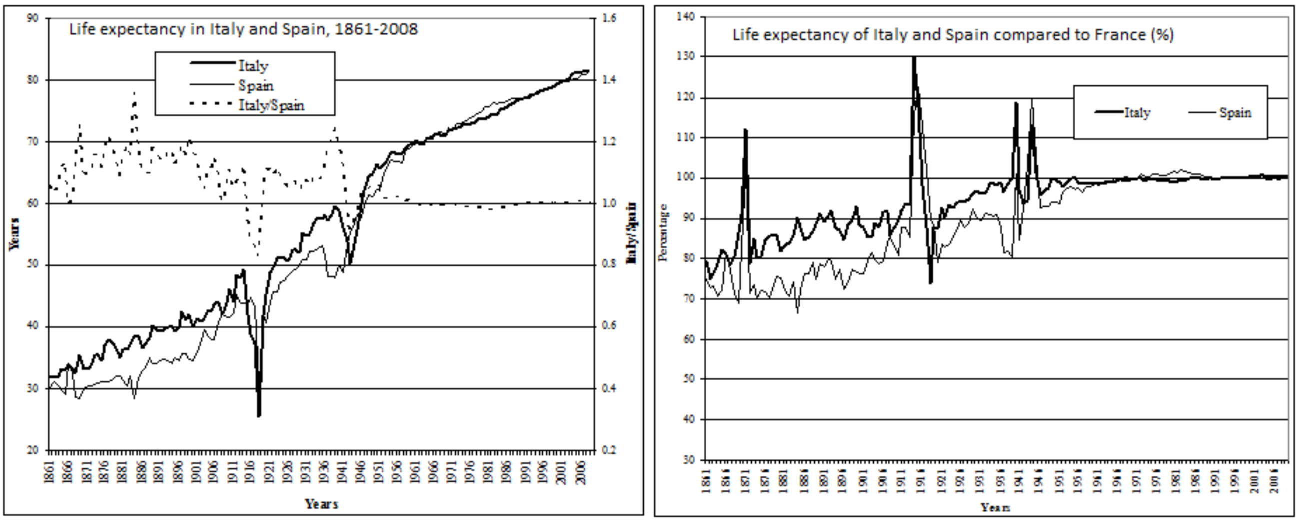
Further insights come from a comparison with France, as from the right side of the figure. Until the second half of the XX century, both Italy and Spain are declining relatively to France: Italy indeed was falling behind only until 1899, thereafter remaining more or less stable (although, again, through ups and downs); Spain instead continued to lose ground as late as until 1960. In the second half of the XX century, however, the two countries began steadily to converge, first Italy and later Spain. At the end of the 1980s Italy indeed even overcame France[29], but then from 2001 it has fallen behind again; conversely, Spain has continued to converge until 2008.

In short, Italy has passed from the status of European periphery to which it was confined until World War II, much closer to Spain than to France, to the one of European core in the second half of the twentieth century, but this status is now in doubt. Instead Spain began to converge later towards the European core, but its catching-up has not yet come to a halt (at least, not until 2008).

It is interesting to see as this evidence compares with the one we now have for life expectancy, whose new series for Italy and Spain are displayed in figure 2. Unlike with GDP, here at the beginning Italy's gap towards Spain enlarged, throughout the first decades following Unification up to the end of the XIX century; however, Spain began to converge at the beginning of the XX century, to reach Italy in the 1960s. There is here some discrepancy with the previous life expectancy data available for Spain, according to which the convergence of Spain began fifteen years earlier, around the second half of the 1880s, and closed some years before, in the decade following world war II; the discrepancy is indeed due to the fact that official censuses, and even HDM until 1930, underreported infant mortality, as we have seen in the previous section. Lastly, it is worth stressing as in terms of life expectancy in the second half of the 1990s there was a new «reversal of fortunes», with Italy once again taking the lead.

[29] The surpass is confirmed by GDP figures based on resident population. It should be remember that all these comparisons are at 1990 purchasing power parity (PPP), i.e., based on the differences in the cost of living observed in 1990.

Figure 2. Life expectancy in Italy and Spain, 1861-2008



Sources and notes: elaborations from table 2; data for France are from HDM (2011a).

In broad terms, we can say that there are two important similarities between the patterns of GDP per capita and life expectancy: the initial advantage of Italy; the convergence of Spain over the long-run. It is worth reminding that the convergence of Spain is confirmed by a wide range of other indicators of well-being, from heights,[30] to per capita calories,[31] to composite indicators such as the Human Development Index, which a part from income and life expectancy includes education and where Spain has indeed overtaken Italy in the last years.[32]

At a closer inspection, however, it is also clear how the two indicators differ in at least two more important respects: first, in life expectancy Spain began to converge in advance and even overtook Italy as early as the 1960s, i.e., when its convergence in per capita GDP had only begun; secondly, in life expectancy Italy in turn overtook Spain again in the late 1990s, i.e., at the same time when Spanish convergence in per capita GDP remarkably accelerated. Indeed, in the patterns of life expectancy we can also detect four phases, but this are significantly different from those of GDP: the first phase, 1861-1899, is one of growing divergence in favour of Italy; the second is the one of Spanish convergence, from 1900 to 1961, some ups and downs notwithstanding; a third phase, from 1962 to 1998, shows indeed a slight edge in favour of Spain; then comes a fourth final phase (1999 to date), which shows a new slight edge in favour of Italy.

[30] For Italy, see A'Hearn and Vecchi (2011, p. 57); for Spain, see María-Dolores and Martínez-Carrión, (2011, p. 35) and Martínez-Carrión and Puche-Gil (2011, pp. 444 and 447).
[31] For Italy, see Sorrentino and Vecchi (2011, p. 417); for Spain, see Cussó Segura (2005).
[32] For Italy, see Felice and Vasta (2012); for Spain, see Prados de la Escosura (2010b).

As for per capita GDP, also for life expectancy we can compare Spain and Italy with France (right side of figure 2). Here around 1861 France has a lead over Italy even higher than the one in GDP. Italy, however, began to converge soon, starting in 1863, and practically reached France around the mid of the 1950s; soon after convergence in GDP had begun, and well before it was completed. This is similar to what we have seen for Spain in comparison with Italy. During the last decades, Italy is improving its position in life expectancy also with respect to France, which by 1999 has been surpassed. Conversely Spain passed through more ups and downs and began to steadily converge towards France later than Italy, in the last years of the XIX century; it reached the same level of France roughly a decade after Italy, in the middle of the 1960s. At the beginning of the 1970s, Spain indeed overtook France as well, and managed to maintain such a lead throughout the 1980s. During the last two decades Spain and France rank practically at the same level, although Spain is slightly falling behind − once again, in sharp contrast with GDP.

From these comparisons, in the patterns of GDP and life expectancy some regularities or common features come out, which are worth being discussed. The first common feature is about the starting point: differences in GDP mirror those in life expectancy at lower levels of development; in these early stages, a clear lead in GDP results into a clear lead in life expectancy, and viceversa. This finding is not new: in the contemporary world, there is a strong correlation between life expectancy and income in poor countries, as displayed for example by the well-known Preston (1975) curve, and the same can be said for historical periods when material conditions were low (e.g. Fogel, 2004). By analysing the historical data for 16 western countries, in benchmark years from 1870 to 2000, Livi Bacci (2012, p. 125) has efficaciously simplified the reasons: “more food, better clothing, better houses, and more medical care have a notable effect on those who are malnourished, badly clothed, poorly housed, and forced to trust fate in case of sickness.”

The second regularity concerns the trend, i.e. the pattern of convergence: we observe that convergence in life expectancy begins earlier than the one in GDP. On this, we can say something more: we have convergence in life expectancy when the leading country (France in the case of Italy, or Italy in the case of Spain) is in the rising bend of its industrial transformation (which at the early stages may well have some negative consequences on life expectancy), while at the same time the follower is benefitting from a decline in mortality coming from breakthroughs in medicine and social conditions, but has not undertaken yet its industrial transformation. Although some tests of causality are needed (see further, section §5), this finding appears to be in line with recent results stemming from unified growth theory, which stress a positive impact of improvement in life expectancy upon economic growth, after the onset of the demographic transition (Galor and Weil, 2000; Cervellati and Sunde, 2011).

Finally, the third regularity we observe concerns the last period: at higher levels of development, further advancements in GDP may not result into advancement in life expectancy: the two indicators are no longer necessarily correlated. Indeed, it even seems that, if at this stage any correlation between the two can be established, this would be of a negative sign: countries falling behind in life expectancy may forge ahead in GDP, and viceversa. This result may be true well beyond the three countries here under investigation − think of the opposite evidence of the United States (forging ahead in GDP but falling behind in life expectancy) and Japan (similar instead to Italy) − and can be of some interest in order to re-model growth economics for nowadays rich and ageing countries. Demographers and economists have only begun to address this point. Concerning the impact of GDP on life expectancy, we may quote again Livi Bacci (2012, p. 125): “When increased production benefits already prosperous population the effects are minimal or nonexistent, if not negative, as may be the case with overeating and environmental deterioration.” The opposite impact of increased life expectancy on GDP growth also deserves some attention: in the context of the “second demographic transition” (Lestaeghe and Van de Kaa, 1986; Lestaeghe, 2000), when fertility has gone below the replacement level, or the so-called “longevity transition” (Eggleston and Fuchs, 2012), when the most part of additional years in life are realized late in life, very high life expectancy may result into a disproportionately old population, which hampers economic growth. In this respect our findings are thus in line with those recently proposed by Eggleston and Fuchs (2012) for the United States.

4. Historical periodizations

After presenting the new series, we now analyse the growth rates of Italy and Spain according to the different historical ages.[33] In the left column of table 3 we can see the main ages of (economic and political) world contemporary history: the first globalization era (ca. 1861-1914), the break-up of the system and the autarky going from world war I to world war II (ca. 1914-1948), then the golden age (ca. 1948-1973), the end of Bretton Woods and the oil shocks (ca. 1973-1985), finally the second globalization era (beginning roughly in 1985, the year of the counter-shock in oil prices).[34] This broad

[33] In order to smooth the consequences of specific yearly shocks, we make use of (3-period) simple moving averages. For the first and the last years of the series, data are from a 2-period simple moving average, using the subsequent (1862) or the previous (2007) year respectively.

[34] E.g. Hobsbawm (1987, 1994). According to Hobsbawm, the last period should begin with the fall of the Berlin Wall (1989). We prefer 1985 because this was the year when the trend in oil prices changed, which ultimately contributed also to the fall of the Soviet Union; 1985 was also the year when Mikhail Gorbachev came to power in Soviet Union,

historical framework is useful to discuss both GDP per capita and life expectancy, *prima facie* at least.

Table 3. *Growth rates in GDP per capita and life expectancy, by historical periods*

	GDP per capita			Life expectancy		
	Italy	Spain	France	Italy	Spain	France
1861-1914	0.80	0.92	1.12	0.70	0.67	0.23
1914-1948	0.66	0.21	0.89	0.93	0.96	0.93
1948-1973	5.46	5.16	4.26	0.52	0.75	0.45
1973-1985	2.52	2.03	1.70	0.34	0.40	0.33
1985-2008	1.39	2.60	1.56	0.34	0.25	0.32
1861-2008	**1.78**	**1.82**	**1.71**	**0.64**	**0.66**	**0.46**

Sources: elaborations from tables 1 and 2. *Notes*: see text.

For what concerns GDP, Spain grew more than Italy in the liberal age, but Italy outperformed Spain in the interwar years; Italy again grew more rapidly than Spain in the golden age and the following period; Spain, at last, grew more rapidly than Italy in the last stretch, after joining the European Community in 1986. If we look at life expectancy, however, we have exactly opposite results: that is, Italy grew more rapidly than Spain in the first period, but then more slowly in the following three periods; it grew again more rapidly in the last period. When including France in our analysis, this sort of negative correlation is partly confirmed: in GDP per capita, France outperformed both Italy and Spain in the first two periods, when indeed it lagged behind in life expectancy; although in the third and fourth phases both Italy and Spain converged in GDP and life expectancy, then again in the last stretch France outgrew Spain in life expectancy although was losing ground in GDP, and it outgrew Italy in GDP per capita but was losing ground in life expectancy.

In light of what we have seen in the previous section, these different performances do not come as a surprise. Indeed, they can be seen as qualifications of two out of the three main results from the previous section: convergence in life expectancy began earlier than the one in GDP (thus during the liberal age Italy outperformed in life expectancy Spain and France, whereas in the following phase Spain outperformed both Italy and France); at later stages of development, further advancements in GDP did not result into advancements in life expectancy, and viceversa. It is also worth noticing that these *different cycles* took place within *similar trends* over the long-run: for both GDP and life expectancy, highest growth of Spain, the less advanced country, lowest growth of France, the most advanced one, with Italy in the middle. In other words, there is a common trend of convergence, which is in part the product of the fact

beginning a series of reforms which were to change the world in a handful of years. Furthermore, in 1985 agreement among the EEC members was reached on the Single European Act (SEA); the SEA was signed one year later, the same year when Spain joined the EEC.

that in terms of backwardness in each country the initial conditions were similar for GDP per capita and life expectancy − the third of our results from the previous section.

A different kind of periodization focuses on the international changes in technological regimes for GDP per capita, in socio-biological regimes for life expectancy; that is, on those conditions which may specifically have an impact either upon GDP per capita, or upon life expectancy. With reference to technological regimes, a well-established literature (Freeman and Perez, 1988; Perez, 2002, 2010) considers four different ages: steam engine and railways (from the end of the nineteenth century until 1875, i.e. for our purposes from 1861 to 1875), steel and electricity (1875-1908), the era of combustion engine, oil, and mass production (1908-1971), then telematics and the new economy (1971 to date).

A periodization through technological regimes would makes little sense for life expectancy, since these affect mostly GDP;[35] in this case, we should rather look at changes which affect specifically this variable, related to scientific, socio-demographic and biological advancements and which we may call socio-biological regimes. The main issue is mortality reduction. In a recent article, Cutler et al. (2006) have reviewed the determinants of mortality reduction over the long-run, identifying three main phases: the first one, roughly from the mid-XVIII century to the mid-XIX century, when improvements in nutrition played the major role; a second one, from the mid-XIX century to the 1930s, when the reduction in mortality rates was driven by public health measures, the construction of urban infrastructures allowing for running water with indoor plumbing (which provided clean water and the removal of waste), and good advice about personal health practices; a third phase, starting in the 1930s, when the main determinant was the advent of modern medicine, to begin with vaccination and antibiotics. This framework is here partly refined and enlarged. Concerning the refinement, the dividing line between the first two phases is postponed to the last decade of the XIX century; the authors themselves recognize that "big public health did not fully come into its own until the acceptance of the germ theory of disease in the 1880s and 1890s, which led to a wave of new public health initiatives and the conveyance of safe health practices to individuals" (Cutler at al., 2006, p. 102; Mokyr, 2002; Tomes, 1998).[36] Concerning the enlargement, a fourth phase going from the

[35] This is not necessarily always true, however. An alternative and more inclusive periodization of technological regimes considers running water with indoor plumbing as one of the three central innovations − together with electricity and the internal combustion engine − of the second industrial revolution, which accordingly began in 1870 and lasted for about a century (Gordon, 2012). Running water with indoor plumbing had a huge impact upon the standard of living and life expectancy, and is here considered in our periodization specific for life expectancy (see forward).

[36] More specifically, we should talk of infectious diseases (measles, scarlet fever, diphtheria), respiratory diseases (bronchitis, pneumonia, influenza), and intestinal diseases (diarrhea, enteritis) (Livi Bacci, 2012, p. 122). The germ theory was fully accepted only after Robert Kock published its postulates in 1890, although these were partly known from 1875 (Madigan and Martinko, 2005). It should be added that the decision by Cutler et al. about the dividing line in

1960s until our days is here added: thanks to the development of modern medicine (mostly antibiotics in the 1930s and 1940s), in fact, by 1960 "mortality from infectious diseases had declined to its current level" (Cutler at al., 2006, p. 103); furthermore, from the 1960s the main driver for the decrease of mortality, at least in the advanced countries,[37] had become the reduction in cardiovascular disease mortality and the decline in infant mortality (Cutler at al., 2006, p. 104), the latter also due to the improvements in neonatal medical care for low birth-weight infants; at the same time, from the 1960s the demographic transition is by now completed or under completion,[38] while also the role of nutrition changed, from quantity to quality.

In view of this, in the case of life expectancy we propose the following periodization for «socio-biological» regimes: a) from the mid XVIII century until 1890, i.e. in our case 1861-1890, when improvements in nutrition are the main determinants of the reduction in mortality; b) 1890-1935, when the main drivers are hygienic health practices and the construction of health and hydraulic infrastructures, in part following the application of the germ theory; c) 1935-1960, when the reduction in mortality was driven by modern medicine, to fight against infectious diseases; d) 1960-2008, characterized by on-going improvements in the reduction of the death toll of cardio-vascular diseases and neonatal mortality, as well as by the completion of the demographic transition.

The results according to the two periodizations, technological regimes for GDP per capita and socio-biological regimes for life expectancy, are displayed in table 4. Once again, we record contrasting results according to the indicator used. In GDP per capita, Spain performs better than Italy in the (last stretch of the) first technological regime, while performs clearly worst in the following two regimes; Spain again performs better in the age of telematics (which for Spain is also the age of constructions). In life expectancy, on the contrary, Italy performs better in the first socio-biological regime, while it is outperformed by Spain in the following two; in the last period, life expectancy has on average the same growth rate in both countries. These differences are a consequence of the fact that Italy began to improve in life expectancy before than in GDP per capita, and earlier than Spain; when Spain was converging in life expectancy, Italy was forging ahead in GDP per capita, as we have seen; after both countries had reached very high levels of life expectancy, their growth rates became similar.

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the mid of the XIX century was based upon the experience of England, which at that time was the most advanced country: for a comparison between the causes of death in England and Italy, see Caselli (1991).

[37] In Italy, from Unification until the mid-1950s infant mortality reduced by 226‰ to 51‰, thus by a ratio of more than four times; however, in the following half a century it would have further collapsed by a ratio of more than ten times, down to 4,4‰ by 1999-2002 (Felice, 2007, p. 115). In Spain, convergence in infant mortality took place after 1960 (Nicolau, 1989, pp. 57 and 70-72.)

[38] Some differences among countries notwithstanding: in Spain, the demographic transition was completed later than in other countries, during the 1980s (Carreras and Tufanell, 2004, p. 38). In Italy, it lasted from 1876 to 1965, as in other European countries such as Germany (Livi Bacci, 2012, p. 118; Chesnay, 1986, pp. 294 and 301).

A part from confirmations, when looking at France there is another important result coming out of table 4. In life expectancy France was the leading country at the beginning of the period, but in terms of growth rates it was outperformed by both Italy and Spain in all the four socio-biological regimes; conversely, in GDP per capita France − although here too it was ahead of both Italy and Spain at the beginning of the period − in some technological regimes performed better than either Italy (the first regime), Spain (the third one), or even both (the second one). This evidence suggests that convergence in GDP per capita should not be taken for granted, unlike the case of life expectancy, where instead convergence through different regimes seems to be less reversible. The fact that convergence in life expectancy can be more permanent does not mean, however, that it is more stable, as we are going to see in the next section.

Table 4. *Growth rates in GDP per capita and life expectancy, by technological and socio-biological regimes*

Techno-logical regimes	GDP per capita			Socio-biological regimes	Life expectancy		
	Italy	Spain	France		Italy	Spain	France
1861-1875	0.36	1.28	1.06	1861-1890	0.75	0.38	0.22
1875-1908	1.07	0.80	1.13	1890-1935	0.83	0.96	0.62
1908-1971	2.40	1.99	2.15	1935-1960	0.75	1.11	0.75
1971-2008	1.90	2.64	1.72	1960-2008	0.33	0.33	0.29
1861-2008	**1.78**	**1.82**	**1.71**	1861-2008	**0.64**	**0.66**	**0.46**

Sources: elaborations from tables 1 and 2. *Notes*: see text.

5. Structural breaks and (Granger) causality

5.1. Structural breaks

Thus far, we have compared growth rates at different ages, in order to discuss as exogenous changes may have impacted upon domestic performance. In the above framework, the historical ages have been defined through the evolution of the international scenario and of technological and socio-biological regimes, both of them exogenous to the national context. It is now time to turn to time series analysis, in order to detect if there are some breaks in the series which can be referable not only to external shocks (such as World War II) and exogenous changes, but also to internal and country-specific breaks, whether or not they are in response to exogenous changes. On this, a time-series analysis has the advantage of not imposing any ex-ante periodization, thus being useful to see as the international context interacts with the evolution of domestic scenario.[39]

[39] Moreover, in terms of clarity at this point a time-series analysis is far more efficacious than further comparisons of growth rates based on more historical ages, this time defined in terms of national and country-specifics changes (which

In order to search for structural breaks in the series, we run the Quandt Likelihood Ratio (Quandt, 1960) or QLR test, which is a modified Chow test used to identify unknown structural breaks (Andrews, 1993). We follow the procedure presented in Stock and Watson (2007), here adapted from an autoregressive distributed lag (ADL) model in levels, with one lag, to a first-differenced autoregressive (AR) model, with two lags (Torres-Reyna, 2012).

First, let's have a first-differenced autoregressive model with two lags, AR(2):

[1] $\Delta y_t = \beta_0 + \beta_1\Delta y_{t-1} + \beta_2\Delta y_{t-2} + \gamma_0 D_t(\tau) + \gamma_1[D_t(\tau)*y_{t-1}] + \gamma_2[D_t(\tau)*y_{t-2}] + \varepsilon_t$;

where $D_t(\tau)$ is a binary variable, which equals 0 before the break (τ), 1 after:

[2] $D_t(\tau) = 0$, if $t \leq \tau$; $D_t(\tau) = 1$, if $t > \tau$;

in absence of break, the regression function is the same before and after τ, thus $\gamma_0 = \gamma_1 = \gamma_2 = 0$. Accordingly, we test:

H_0 $\gamma_0 = \gamma_1 = \gamma_2 = 0$
H_1 not H_0

i.e., under the null hypothesis (H_0) we have no break, while under the alternative hypothesis (H_1) we have break, since at least one γ is different from zero. Let's $F(\tau)$ be the F-statistics testing H_0. If the break date τ is unknown, as in our case, the QLR test calculates the highest value of $F(\tau)$ in the interval $\tau_0 \leq \tau \leq \tau_1$:

[3] $QLR = \max [F(\tau_0), F(\tau_0 + 1), \ldots , F(\tau_1)]$

This QLR statistic may identify one single structural break, several structural breaks, or even a slower evolution of the regression function. For our tests, we set $\tau_0 = 0.1*T$, $\tau_1 = 0.9*T$, which results in a 10% trimming from each tail. Although 0.15*T and 0.85*T are more commonly used for τ_0 and τ_1 respectively, we prefer a shorter trimming since it allows us to identify more structural breaks around the extremes of the distribution, as we will see, whereas the results for the central years of the distribution

would be the subject of endless discussion and would take this article far astray from its promised goals): to define international ages was relatively easy, given the wide (but not unanimous) consensus about the main epochs of world contemporary history, not only in terms of broad geopolitical scenarios, but also for what concerns technological and socio-political standards; historical grids resulting from domestic changes, specific for Italy and Spain, would be far less undisputed, while any comparison would be blurred by the fact that the historical grids would not be the same between Italy and Spain.

remain unchanged.[40] Two more caveats are warranted: 1) to have comparable results, we always use log transformation for both GDP and life expectancy; 2) in order to ensure that possible differences are not the product of different methodologies estimates, for each function we test two different series, our new one (Tables 1 and 2), and the main alternative available series. The tests are displayed in figure 5 (GDP per capita) and 6 (life expectancy).

From figure 3, the main result is that in the Italian series GDP many more structural breaks can be observed than in the Spanish series.[41] For Italy, there are a number of breaks from 1877 to 1888, a period roughly coinciding with the rise to power of what is called the Historical Left (1876) and the first protectionist and pro-industrialist policies pursued by those governments.[42] The second break, which is visible with the lower threshold (6.02) from the 15% trimming, comes at the end of the century, in 1899, and marks the beginning of the Giolitt's age (1900-13) and the take-off of the Italian industry.[43] Then comes the biggest break, the one at the end of world war II, with the beginning of unprecedented growth – the economic miracle − which would have brought back the country "from the periphery to the centre" (Zamagni, 1993), as the sixth world economic power. Finally, a fourth and negative break can be noticed, in 1993, coinciding with an economic recession and the first significant austerity measures to join the euro, and which marks the beginning of Italy's economic decline (Felice and Vecchi, 2013).

Confronted with this story, the series of Spanish GDP looks much flatter: the breaks come in the second half of the 1950s and reach the highest value in 1960, following the Franco's liberalization and the end of autarchy. The 1960 maximum marks the beginning of the Spanish economic miracle, with a fifteen-years delay on Italy.[44] In other words, in terms of GDP Spain did not experience the breaks Italy lived through in the second half of the nineteenth century, i.e., Italy's early ruptures towards higher economic growth: Spanish modernization in GDP began later and took place all at once. This results is significantly different from the one found by Molinas and Prados de la Escosura, with previous series for Italy and Spain, and benchmark comparisons between the two: according to them Spain and Italy would have attained similar levels of per capita income at around the same historical dates, but Spain converged later

[40] Critical values of the QLR statistics with a 10% trimming are from Andrews, 2003.

[41] The QLR test has been run also for France, but no significant breaks have been found (the highest observed break is in 1959); this is probably due to the higher level of GDP boasted by that country. Results will be provided on request to anyone interested.

[42] The first trade protections were introduced in 1878, significantly reinforced in 1887, while the first Italian enterprise of the second industrial revolution (steel, electricity) were born in the first half of the 1880s, even with the help of the state (as in the case of Terni, in steel). For extensive discussion on these topics, see Toniolo (1990), Zamagni (1993), Federico and Tena-Junguito (1998), Fenoaltea (2011).

[43] For a recent reappraisal, see Felice and Carreras (2012).

[44] Or a bit less, since in Italy's high growth rates of the early years following World War II were can be regarded as the "backlash" of world war II destruction − i.e., the product of the Reconstruction.

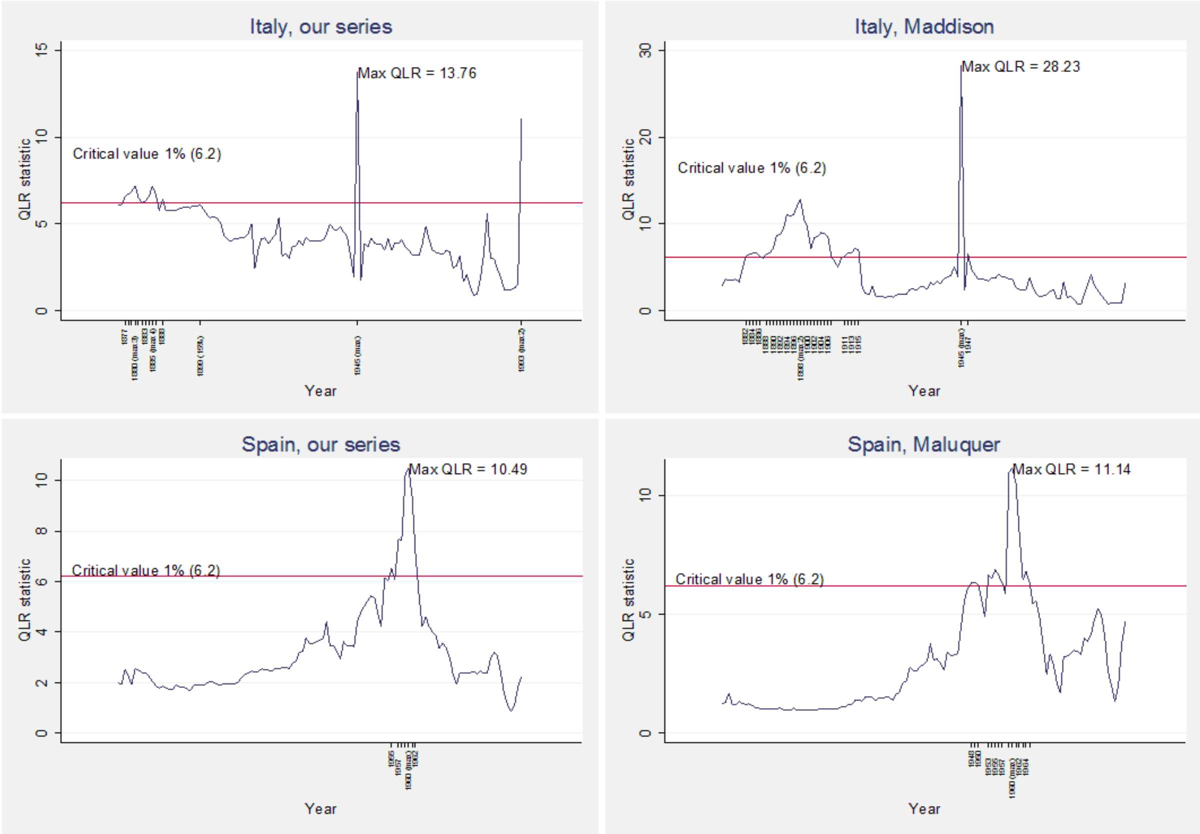
than Italy in structural change (Molinas and Prados de la Escosura, 1989). Such a discrepancy was only apparent: indeed, also in per capita GDP Spain began to modernize later than Italy.

Limitedly to Spain, our finding is in line with the results by Pons and Tirado (2006), who making use of a variant of Andrews (1993) methodology[45] also had found the lack of breaks in the Spanish (Prados') GDP series before the civil war, with a positive break as late as 1960.[46] Pons and Tirado also found two negative breaks in 1936 and 1940, the difference with us being due to the fact that we use the updated population series by Maluquer: via counting the returns of Spanish emigrants after the 1929 crisis, Maluquer finds higher numbers for the population de facto in the first half of the 1930s (Maluquer de Motes, 2008) and correspondingly reduces the level of GDP per capita for the same period; as a consequence, in our estimates the percentage decrease due to the civil war is also reduced.

Our results are also consistent with an earlier vast literature stressing the missed opportunities of the Spanish economy from the last decades of the XIX century until the Franco's liberalization policies in 1959: there was an essential continuity, characterized by sluggish economic growth and international isolation, from the Bourbon Restoration (1874-1923), to the dictatorship of Primo De Rivera and the short-lived Second Republic (1923-1939), to the first phase of Franchism (1939-1959) (Fraile, 1991; Nadal and Sudrià, 1993; Carreras 1990, 1997; Velarde, 1999). Accordingly, the first phase of Franchism, negative as it was (Carreras 1989; Comín, 1995; Prados de la Escosura, 1997), should be seen not so much as an interlude, but rather as an enduring constraint which delayed of about fifteen years the modernization of the Spanish economy.

[45] The Sup Wald test by Vogelsang (1997), extended by Ben-David and Papell (2000) to estimate multiple break-points. Unlike us, Pons and Tirado use an auto-regressive model in levels.
[46] For a pioneering application of Andrews methodology to the Spanish historical series of GDP, again with analogous results, see also Cubel and Palafox (1998).

Figure 3. Structural breaks in GDP per capita, QLR tests (10% trimming)



Sources and notes: see the text.

It is worth stressing that this difference between Italy and Spain is not a product of the series here used. Quite the contrary, the use of alternative series would result in even greater differences. As can be seen again from figure 3, the earlier Italian series by Maddison, which was mostly based on the old Istat's estimate,[47] show a considerable number of breaks throughout the liberal age, thus suggesting an evolution of the regression function until the most significant break in 1898: once again, soon before the beginning of Giolitti's age, and soon after birth of the German-style universal banks, which Gerschenkron (1955) regarded as the substitutive factor of Italy's industrialization. The difference with Spain could hardly be more remarkable, and it is indeed attenuated by our new series. In the case of Spain, the alternative series provided by Maluquer does not change significantly the Spanish story in terms of structural breaks: either we believe Prados or Maluquer, until the mid of the twentieth century there are no structural breaks in the Spanish per capita GDP.

The results for life expectancy are significantly different (figure 4). In this case, it is Spain to experience a number of structural breaks, whereas the Italian series is much more stable and indeed, having not been for the negative break of World War II, it

[47] With the exception of some industrial sectors for which the new estimates by Fenoaltea were used (Maddison, 1991).

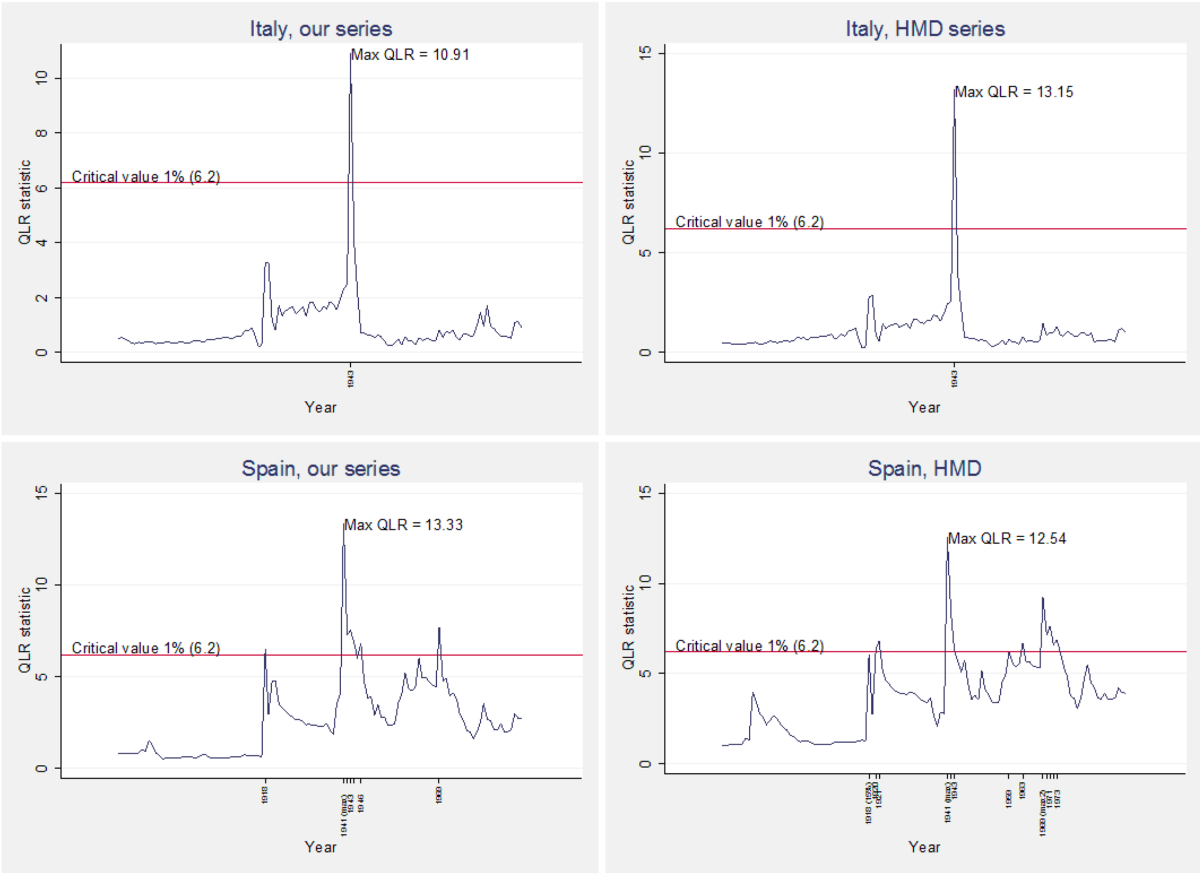
would have experienced no break at all. Once again, it should be emphasized as this discrepancy is not a result of the series we use: as it can be seen, the Italian data do not change significantly when passing from ours figures to the HDM's,[48] and in the case of Spain we have indeed a higher (not a lower) number of breaks with the old series: as with GDP, the differences between Italy and Spain are softened rather than reinforced by the use of the new series.

How can this discrepancy between GDP and life expectancy be explained? From what we have seen thus far, one could be tempted to say that this is simply the result of the fact that in Spain convergence in life expectancy began earlier. But at a closer inspection this does not seem to be the case. For what concerns life expectancy, in fact, the break in the Spanish series are of negative sign, which means that they are due to an abrupt rise of mortality in specific years. This higher sensitiveness to mortality is indeed a product of backwardness, not of modernization, and can even be seen as the other face of the delayed Spanish modernization in GDP: although Spain tends to converge earlier in life expectancy than in GDP, thanks to the spread of modern medicine and basic infrastructures, due to its delay in GDP it remains a poorer country with a larger agricultural sector, well up to the 1960s. As a result, although life expectancy is on average relatively high, in specific years it can remarkably fall from its heights: because of the longer permanence of poverty and malnutrition, which make a higher share of the population weaker in the face of other calamities, such as the 1918 Spanish flu pandemic.[49]

[48] With no surprise, given that the cycles are the same and only the benchmarks differ.

[49] We can have many confirmations of this, from different indicators which are not necessarily average growth of GDP. For example, we may look at the regional dispersion of industrialization and economic growth: in Spain, during the first century of our series industrialization interested regions with a fraction of population minor than in the case of Italy; i.e., in Spain the agrarian regions where in demographic terms more important than in Italy. In Spain, the population of Catalonia, Madrid and the Basque Country, the three most industrialized regions of the countries, passed from 16% in 1857 to 22% in 1950. At the same time, in Italy the population of the regions of the industrial triangle (Piedmont, Liguria, and Lombardy) was always above 25%; if we include the region of Rome, which had services more than industry, the population was around 30-32%. For Spain, see the estimates in Rosés et al. (2010) and population figures in Nicolau (2005); for Italy, see the estimates in Felice (2010, 2011) and population figures in Felice (2007, p. 16).

Figure 4. Structural breaks in life expectancy, QLR tests (10% trimming)



Sources and notes: see the text.

To sum up, in both Italy and Spain life expectancy tends to move along a positive rising trend, with no structural positive breaks (unlike GDP per capita, where instead we have one or more breaks which mark the beginning of modern economic growth); but life expectancy still is characterized by negative breaks, which are stronger where modernization in GDP is delayed − in Spain − and weaker when modernization in GDP is more advanced − in Italy (and in France, whose results from QLR test in life expectancy are analogous to those for Italy).[50]

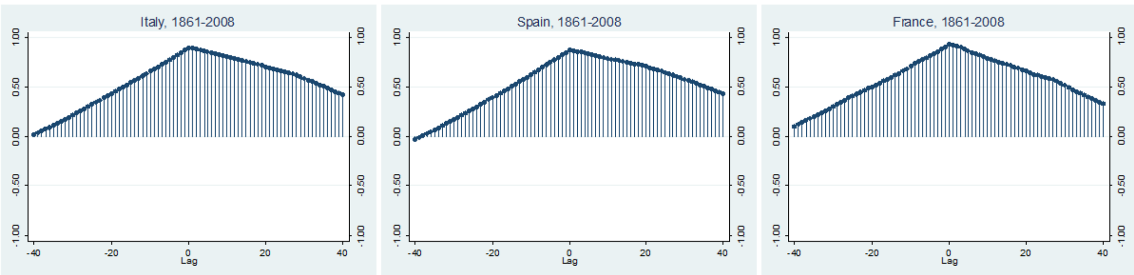
This result is an important qualification of the last finding from the end of the previous section: even though the pattern of convergence through different periods is much less reversible in life expectancy than in GDP, since convergence begins earlier in life expectancy, it is also more subject to temporary turbulences, or specific yearly shocks; precisely because of the lack of modernization in GDP. Although in life expectancy there is a positive *trend* of convergence which begins earlier and over the long run is less reversible than in the case of GDP, the *cycle* of life expectancy is more unstable, at least until the advent of a positive trend of convergence also in GDP.

[50] Results will be provided on request.

5.2. Granger causality

We may now turn to the correlation between life expectancy and GDP per capita. We test if there is some impact of the growth of life expectancy on the growth of GDP, or viceversa, and if this impact changes with the level of development. A first approximation is by way of cross-correlograms, a visual tool commonly used in descriptive statistics to estimate the degree to which two stationary time series are correlated and if one anticipates the other.[51] As can be seen from figure 5, over the long run it is life expectancy which anticipates GDP, not viceversa, and this effect is stronger in Italy and Spain, than it is in France. These two results are in turn the product of two findings from the previous sections: the fact that in both Italy and Spain convergence in life expectancy began earlier than convergence in GDP, from which the anticipation of life expectancy on GDP; and even the fact that as both GDP and life expectancy grow their link becomes weaker, which may explain why the anticipation looks milder in the case of France, the most advanced country.

Figure 5. *Cross-correlograms of life expectancy and per capita GDP*



Sources and notes: see the text.

Tests of Granger causality confirm only in part the results from descriptive statistics, but this is because of the differences between countries we have detailed thus far: Italy fits the expectations, but Spain and France don't, either because too backward (Spain) or too advanced (France). A variable *x* is said to Granger-cause another *y*, if the latter

[51] Given two series $x_{(i)}$ and $y_{(i)}$, with i = 1, 2, … N-1, the cross-correlation *r* at delay *d* is defined as:

$$[4] \quad r = \frac{\sum_{i=1}^{N-1} [(x_i - \overline{x}) \times (y_{i-d} - \overline{y})]}{\sqrt{(x_i - \overline{x})^2} \times \sqrt{(y_{i-d} - \overline{y})^2}}$$

where $\overline{x}$ and $\overline{y}$ are the means of the corresponding series which, in our case, are logarithm of life expectancy and GDP per capita (log transformation is employed to ensure stationarity). Correlation series, as those displayed in Figure 7, result from computing [4] for a certain number of delays *d*. For an introduction to this method, see Chatfield (1980, pp. 169-174).

can be better predicted using past values of both *x* and *y*, than it can by using past values of *y* alone; it is worth reminding that this doesn't mean that a change in *x* will cause a change in *y*, but only that past values of *x* contain useful information to foresee the changes in *y*, besides the information contained in past values of *y* (for example, because the two series are co-integrated) (Granger, 1969).[52] One way of testing for Granger causality is through OLS, by regressing *y* on lagged values of *y* and *x*: if the coefficients of the lagged *x* are statistically significantly different from 0, then it can be argued that *x* Granger-causes *y* (Stock and Watson, 2007). Let's have an autoregressive distributed lag model, ADL(4,4), in levels:

[5] $y_t = \beta_0 + \beta_1 y_{t-1} + \beta_2 y_{t-2} + \beta_3 y_{t-3} + \beta_4 y_{t-4} + \delta_1 x_{t-1} + \delta_2 x_{t-2} + \delta_3 x_{t-3} + \delta_4 x_{t-4} + \varepsilon_t$;

we test
H_0 $\delta_{1,\dots}\ \delta_4 = 0$
H_1 not H_0

i.e., under the null hypothesis (H_0) we have no Granger causality, while under the alternative hypothesis (H_1) we have it.

The F-statistics of the coefficients of the lagged x are displayed in table 5, either when the dependent variable is life expectancy, and thus *x* is GDP per capita, or when the dependent variable is GDP per capita, and thus *x* is life expectancy.[53] We also introduce a break in the series, corresponding to the maximum value from the QLR tests in the series of GDP series, 1945 for Italy and 1960 for Spain, which is intended to be a threshold between a less advanced and a more advanced economic status: accordingly, we test Granger regressions for three model, the long-term one (1861-2008), the one for the years before the GDP break, and the one for the years after that.

[52] The presence of Granger causality is a necessary but not sufficient condition of co-integration: the lack of Granger causality ensures that the two series are not co-integrated, whereas the presence of Granger causality does not necessarily mean that the two series are co-integrated. We have co-integration when the difference between a pair of integrated series is stationary. An "internal visualization way" of explaining co-integration is the one provided by Granger himself, in his Nobel lecture: "Suppose that we had two similar chains of pearls and we threw each on the table separately, but for ease of visualization, they do not cross one another. Each would represent smooth series but would follow different shapes and have no relationship. The distances between the two sets of pearls would also give a smooth series if you plotted it. However, if the pearls were set in small but strong magnets, it is possible that there would be an attraction between the two chains, and that they would have similar, but not identical, smooth shapes. In that case, the distance between the two sets of pearls would give a stationary series and this would give an example of cointegration" (Granger 2004, p. 422).
[53] In all these cases, we use log transformation to ensure that the series are stationary.

Table 5. *Granger causality via OLS: F statistics of the coefficients of the lagged x*

	x: life expectancy		*x*: GDP per capita	
	F	Prob > F	F	Prob > F
Italy				
1861-2008	3.55	0.0087***	1.59	0.1807
1861-1945	2.63	0.0414**	4.82	0.0017**
1946-2008	1.09	0.3693	1.59	0.1924
Spain				
1861-2008	1.61	0.1745	1.47	0.2144
1861-1960	1.18	0.3272	1.51	0.2062
1961-2008	0.56	0.6935	1.91	0.1298
France				
1861-2008	1.47	0.2135	1.44	0.2255

Sources and notes: see the text. *** Significant at the 0.01 level. ** Significant at the 0.05 level.

The results indicate the presence of Granger causality only in the case of Italy. Here, on the long-run life expectancy Granger-causes GDP per capita; moreover, Granger causality is concentrated in the first part of the series (1861-1945), as expected, when both life expectancy and GDP per capita are lower; in this first part, also GDP per capita in turn Granger-causes life expectancy. The lack of Granger causality in the Spanish series can be explained with the higher volatility of the Spanish series of life expectancy, which is subject to negative shocks well up to the second half of the twentieth century. In the case of France, the lack of Granger causality can instead be referable to the higher development of this country, which in fact according to QLR tests does not even experience a significant break in the series of GDP per capita.

6. Conclusions

After reviewing and updating the available estimates, and in some cases by taking advantage of unpublished material, this article has presented and discussed long-run series of GDP per capita and life expectancy for Italy and Spain (1861-2008). Our goal was not only to briefly reconsider the economic history of both countries by the light of the new evidence, but also to investigate the long-run evolution of GDP per capita and life expectancy, and their mutual relationship, by way of country comparisons and a time-series approach. After contrasting the series for Spain and Italy with the available series for their most important (and common) neighbour, France, the new data have been analysed through historical periodization and time-series econometrics.

Generally speaking, over the long-run convergence is confirmed for both the indicators: at the beginning of the period, Spain is the country most backward in life expectancy and GDP, but over the entire period it is also the country converging at the highest average rate; Italy ranks in the middle between Spain and France. The long-run convergence notwithstanding, significant cyclical differences between the two countries can be observed. Namely, Spain began to modernize later in GDP, which may have had as a consequence higher volatility in life expectancy until recent decades. Italy, by contrast, showed a more stable pattern of life expectancy, following early breaks in the GDP series; but it also showed a significant and negative GDP break in the last decades, a result which reinforces worries about its recent economic decline.

A part from the common convergence process, we find evidence or confirmation for four more major features in the patterns of GDP per capita and life expectancy. First, at the early stages of development, when both GDP and life expectancy are low, differences in GDP mirror those in life expectancy: a clear lead in GDP results into a clear lead in life expectancy. Second, convergence in life expectancy tends to begin earlier than convergence in GDP: in line with results from unified growth theory, after the onset of the demographic transition the growth of life expectancy seems to anticipate and may even cause the growth of GDP. Third, at later stages of development, when both GDP and life expectancy are higher, further advancements in GDP may not necessarily result into advancements in life expectancy, and viceversa: if any, there may be even a negative correlation between the two variables. Lastly, we observe that in life expectancy there is a positive *trend* of convergence which over the long run is less reversible than in the case of GDP, but the *cycle* is more unstable, until the advent of a positive trend of convergence also in GDP: since in the less advanced country convergence in life expectancy begins earlier than in GDP, here the former is also more subject to temporary turbulences, or specific yearly shocks, perhaps precisely because of the lack of modernization in GDP.

When tests of causality are run, because of the four common features we have recalled above, it results that the growth of life expectancy anticipates the growth of GDP, but life expectancy Granger-causes GDP only in the case of Italy; furthermore, this is true only for the first part of the period, before the maximum break in the series of GDP in the middle of the twentieth century. For Spain and France we do not have Granger causality, either because the country is too backward, such as Spain with a much higher volatility in life expectancy, or too advanced, such as France. These results confirm that the relation between life expectancy and income is non-monotonic and may be subject to many historical qualifications, as suggested also by a recent literature stemming from unified growth theory; needless to say, at the moment they are limited to the countries considered in this article.

Table A.1. *Population* de facto *in Italy and Spain at present boundaries, 1861-2008 (thousands)*

	Italy	Spain		Italy	Spain		Italy	Spain
1861	25770	15729	**1911**	35583	20054	**1961**	49904	30764
1862	25935	15870	**1912**	35891	20175	**1962**	50258	31110
1863	26123	15982	**1913**	36071	20299	**1963**	50647	31452
1864	26324	16067	**1914**	36425	20494	**1964**	51083	31821
1865	26528	16121	**1915**	36955	20733	**1965**	51504	32186
1866	26756	16188	**1916**	37198	20938	**1966**	51884	32550
1867	26908	16283	**1917**	37128	21124	**1967**	52256	32932
1868	26995	16317	**1918**	36764	21306	**1968**	52612	33288
1869	27172	16308	**1919**	36585	21226	**1969**	52980	33580
1870	27375	16327	**1920**	36817	21348	**1970**	53362	33832
1871	27546	16365	**1921**	37192	21506	**1971**	53745	34118
1872	27717	16405	**1922**	37568	21736	**1972**	54113	34468
1873	27872	16446	**1923**	37923	21933	**1973**	54553	34818
1874	27992	16487	**1924**	38253	22114	**1974**	54991	35162
1875	28119	16529	**1925**	38588	22314	**1975**	55345	35547
1876	28325	16570	**1926**	38906	22545	**1976**	55622	35984
1877	28556	16612	**1927**	39232	22787	**1977**	55852	36430
1878	28742	16686	**1928**	39550	23029	**1978**	56043	36838
1879	28916	16790	**1929**	39813	23277	**1979**	56181	37208
1880	29027	16893	**1930**	40114	23536	**1980**	56275	37535
1881	29167	17011	**1931**	40434	23856	**1981**	56336	37829
1882	29365	17122	**1932**	40756	24236	**1982**	56388	38081
1883	29552	17202	**1933**	41101	24625	**1983**	56501	38306
1884	29777	17298	**1934**	41465	24982	**1984**	56586	38507
1885	30025	17356	**1935**	41824	25317	**1985**	56638	38690
1886	30209	17425	**1936**	42169	25655	**1986**	56659	38852
1887	30373	17532	**1937**	41908	25773	**1987**	56674	39001
1888	30538	17604	**1938**	41677	25831	**1988**	56697	39138
1889	30733	17654	**1939**	42221	25601	**1989**	56719	39260
1890	30936	17674	**1940**	42795	25846	**1990**	56742	39367
1891	31097	17709	**1941**	43292	26021	**1991**	56765	39487
1892	31303	17773	**1942**	43672	26094	**1992**	56784	39650
1893	31522	17847	**1943**	43960	26284	**1993**	56896	39807
1894	31740	17911	**1944**	44191	26516	**1994**	56973	39948
1895	31923	17956	**1945**	44460	26765	**1995**	56993	40074
1896	32105	17978	**1946**	44859	27018	**1996**	57010	40190
1897	32328	18034	**1947**	45292	27248	**1997**	57047	40307
1898	32542	18208	**1948**	45752	27526	**1998**	57043	40421
1899	32752	18431	**1949**	46225	27801	**1999**	57021	40529
1900	32946	18573	**1950**	46720	28017	**2000**	57061	40654
1901	33159	18682	**1951**	47159	28185	**2001**	57110	40797
1902	33391	18840	**1952**	47373	28360	**2002**	57551	41314
1903	33603	19041	**1953**	47630	28588	**2003**	57984	42005
1904	33823	19216	**1954**	47937	28819	**2004**	58408	42692
1905	34059	19342	**1955**	48235	29040	**2005**	58822	43398
1906	34284	19451	**1956**	48487	29268	**2006**	59223	44068
1907	34519	19564	**1957**	48713	29509	**2007**	59610	44874
1908	34762	19690	**1958**	48970	29788	**2008**	59983	45593
1909	35012	19821	**1959**	49289	30100			
1910	35305	19940	**1960**	49617	30418			

Sources and notes: for Italy, see the text; for Spain, Maluquer de Motes (2008) until 2001 and Ine (2012) for the years 2002 to 2008.

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