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GROWTH RECURRING IN PREINDUSTRIAL SPAIN: HALF A MILLENNIUM PERSPECTIVE

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Abstract

Research in economic history has lately challenged the Malthusian depiction of preindustrial European economies, highlighting ‘efflorescences’, ‘Smithian’ and ‘growth recurring’ episodes. Do these defining concepts apply to preindustrial Spain? On the basis of new yearly estimates of output and population for nearly 600 years we show that preindustrial Spain was far from stagnant and phases of per capita growth and shrinkage alternated. Population and output per head evolved along supporting the hypothesis of a frontier economy. After a long phase of sustained and egalitarian growth, a collapse in the 1570s opened a new era of sluggish growth and high inequality. The unintended consequences of imperial ambitions in Europe on economic activity, rather than Malthusian forces, help to explain it.

JEL Classification: E10, N13, O10, O47

Keywords: Preindustrial Spain, Frontier economy, Black Death, Malthusian, Growth recurring

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Abstract
Research in economic history has lately challenged the Malthusian depiction of preindustrial European economies, highlighting 'efflorescences', 'Smithian' and 'growth recurring' episodes. Do these defining concepts apply to preindustrial Spain? On the basis of new yearly estimates of output and population for nearly 600 years we show that preindustrial Spain was far from stagnant and phases of per capita growth and shrinkage alternated. Population and output per head evolved along supporting the hypothesis of a frontier economy. After a long phase of sustained and egalitarian growth, a collapse in the 1570s opened a new era of sluggish growth and high inequality. The unintended consequences of imperial ambitions in Europe on economic activity, rather than Malthusian forces, help to explain it.

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"Prior to 1800, living standards in world economies were roughly constant over the very long run: per capita wage income, output, and consumption did not grow" asserted Gary Hansen and Edward Prescott two decades ago.[3] This stylised fact has spread among economists in more simplified terms: human societies remained stagnant in terms of income per person until the Industrial Revolution heralded the beginning of modern economic growth. Such a perception has been reinforced by the Unified Growth Theory's depiction of preindustrial societies as Malthusian (Galor and Weil, 2000).[4]

Although the Malthusian nature of preindustrial economies is defended by distinguished scholars (cf. Clark, 2007, 2008; Madsen et al., 2019), research in economic history has challenged it lately. Historians are now more prone to accept the overcoming of the Malthusian constraint in preindustrial western Europe as capital accumulation and productivity gains permitted higher population and income levels simultaneously, but with the caveat that such achievements were limited in scope and time (i.e., after the Black Death), and only had long term effects in the North Sea Area (Pamuk, 2007). Broadberry et al. (2015) path-breaking research, for example, rejects the term Malthusian to portray the early modern British economy.

Furthermore, in an attempt to break the growth-stagnation dichotomy in preindustrial societies, historians have highlighted 'efflorescences' (Goldstone, 2002: 333) and 'growth recurring' episodes (Jones, 1988; Jerven, 2011) that feature a succession of phases of growing and shrinking output per head and only give way to modern economic growth when shrinking phases become less intense and frequent (Broadberry and Wallis, 2017). Smithian growth, a process driven by gains from specialisation resulting from the expansion of international and domestic markets, may explain these episodes of sustained but reversible per capita income gains.[5]

[3] Hansen and Prescott (2002: 1205) aimed at modelling "the transition from stagnant to growing living standards".
[4] That is, assuming a fixed supply of land and population growth as a response to an increase in living standards.
[5] Morgan Kelly (1997: 939-940), provides a suggestive explanation of Smithian growth based on the idea of 'threshold behaviour', "Below a critical density of transport linkages, the economy is split into small markets with limited scope for division of labour. Once the critical density is reached, these small markets begin to fuse together into large, economy-wide market. The resulting increase in specialisation causes an acceleration in the growth rate".

Did Smithian growth occur in preindustrial Europe beyond the North Sea Area? New research suggests Iberia (Palma and Reis, 2019; Álvarez-Nogal and Prados de la Escosura, 2013), although qualitative perceptions of early modern Spain as a stagnant economy are deeply rooted (Kamen, 1978: 49; Cipolla, 1980: 250). In this paper an effort is made to provide yearly estimates of Spanish output and population for more than half a millennium. On the basis of new evidence on long-run economic performance we discuss the extent to which Malthusian, efflorescences, growth recurring, or Smithian growth are defining elements of preindustrial Spain.

As basically a methodological and data paper, it includes sections presenting controlled conjectures on population and sectoral and aggregate output estimates, and a discussion of their trends in the context of the historical debate. A summary of the results and a research agenda conclude the paper.

Our main findings can be summarised as follows: 1) Preindustrial Spain's economy was far from stagnant, exhibiting phases of output per head growth and contraction. 2) As a result, the peak average income levels reached in the 1340s and the 1570s were only overcome in the early nineteenth century. 3) Spain's performance matches Smithian growth during the long rising phase up to the Black Death, the century-long expansion up to the 1570s, and the sustained recovery from the late seventeenth century to the Peninsular War (1808-1814), when larger markets favoured specialization and urbanisation and promoted growth. 4) Population and output per head evolved along, a finding that provides support for the hypothesis of Spain as a frontier economy, and is at odds with the Malthusian narrative. 5) Why no significant long-run gains in living standards were achieved in Spain's frontier economy? In the absence of a persuasive Malthusian interpretation, an institutional explanation deserves to be explored. It can be hypothesised that sustained increases in fiscal pressure on dynamic urban activities to finance imperial wars in Europe triggered de-urbanisation and led to a collapse in average real incomes, from which early modern Spain never fully recovered. 6) Income was distributed in a rather egalitarian way until the mid-sixteenth century, as would be expected in a frontier economy. However, income distribution became increasingly unequal thereafter as the relative importance of land as a production factor increased.

Population: Quantitative Conjectures

Aggregate population figures for late medieval and early modern Spain consist of scattered benchmark estimates from household population surveys usually collected for taxation purposes, the so-called *vecindarios* (literally, neighbourhoods), that present the challenge of converting households into inhabitants, national censuses for the late eighteenth century, and sporadic assessments for the early nineteenth century.[6] Available benchmark estimates allow us, nonetheless, to derive long run population trends. Moreover, historians have relied on baptism records to represent population dynamics.[7]

Baptism indices are yearly available for practically all regions between 1700 and 1809, although its coverage declines as one moves back to 1580 and from 1809 onwards.[8] Thus, an annual national index can be derived by weighting each regional index, B_{rt}, expressed as 1790-99=1, by the average of regional population in 1787 and 1797 censuses, $N_{r1787\text{-}97}$.[9]

$$B_{.t} = \Sigma\ N_{r1787\text{-}97} * B_{rt} \qquad \text{for } 0 \le t \le T \qquad (1)$$

Figure 1 presents annual population estimates derived from baptism indices along those obtained through log-linear interpolation of each pair of adjacent benchmark estimates.[10] It can be observed that, from the early seventeenth to the late

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[6] Pre-1850 population estimates from household surveys and censuses are available for 1530, 1591, 1646, 1712-17, 1752, 1768, 1787, 1797, 1821, and 1833. Cf. Nadal (1984), Bustelo (1972, 1973, 1974), Pérez Moreda (1988), and Reher (personal communication). For the conversion of households into inhabitants, cf. Martín Galán (1985).
[7] Cf. Nadal (1988), Reher (1991), Llopis Agelán (2004), and Llopis Agelán and Sebastián Amarillas (2007).
[8] From 1700 onwards we used Llopis Agelán (personal communication), who kindly provided us with an updated dataset, completed with Nadal (1988) for 1580-1700. In the case of New Castile we have preferred Reher (1991) indices. For La Rioja, Gurría (2004) indices have been used. We assumed that missing regions were represented by neighbour ones (see fn. 12).
[9] As the regional coverage diminishes as we move back in time, we have constructed indices for each regional sample and spliced them into a single index given preference to the indices with broader regional coverage.
[10] The benchmark levels used have been 1340, 1420, 1530, 1591, 1646, 1712-17, 1752, 1787, 1797, 1821, 1833, and 1850.The main source is Pérez Moreda (1988: 368, 372, 384-385, 402) who surveys alternative estimates and conjectures. In the case of 1712-17, Pérez Moreda 1(988: 384), on the basis of Bustelo (1973, 1974) provides a 7.7-8.15 million range. Here we have been accepted the lower figure, 7.7 million after Llopis Agelán (2002: 123), and attributed it to 1717. The figure for 1787, comes from the census (Anes, 1975: 24) and that for 1850 from Prados de la Escosura (2017). The estimate for 1833 has been increased by 5% to offset its underestimate as Pérez Moreda (1988: 402) did for 1797. For 1340 and 1420 we have assumed Portugal's population as 1.0 and 0.5 million that was subtracted from the overall figure for Iberia (Pérez Moreda 1988: 368. His estimate for 1300 has been accepted for 1340 here. In order to allow for the Jew population expelled after 1492, we have accepted Pérez Moreda (1988: 368) estimate of 150,000 people and distributed over 1493-1497, starting from an arbitrary

eighteenth century, the baptism-based series shadows the interpolated series but at a lower level. It also reveals baptisms' high volatility that precludes inferring yearly population levels from it.[11] Moreover, inferring population trends from baptisms implies assuming that deaths rates kept a stable short-term relationship with birth rates[12] and net migration flows were negligible over time.[13]

Since these assumptions are highly unrealistic, Álvarez-Nogal, Prados de la Escosura, and Santiago-Caballero (2016) offered a compromise solution, namely, reconciling population benchmarks with decadal estimates of baptisms, available since the 1520s, so the resulting estimates capture migration (forced or voluntary) and over time variations in the proportion between birth and death rates (and between births and baptised children).

Thus, in a first attempt to estimate total population for the post-1520 period, we have followed this approach projecting each benchmark population estimate with decadal baptism series back and forth.[14] Since the projected benchmark levels with baptism indices do not match the adjacent benchmark estimates, a variable-weighted

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figure of 50,000 in 1493 and reducing it by 10, 000 each year. These figures should be, perhaps, augmented to include Muslim emigration as a consequence of the conquest of the Nazri Kingdom of Granada by the Catholic Kings in 1492.

[11] Unless we assume an almost perpetual pandemic scenario with population varying by the hundred thousand from one year to another!

[12] Llopis Agelán (personal communication) discusses the relationship between deceases and baptisms during the eighteenth century showing a 11 per cent decline in this ratio between its first and second half that, however, does not seem attributable to a decline in infant mortality. This author also warns us that the number of births exceeded that of baptised children and their proportion declined during the eighteenth century, that he estimates in 5-6 per cent for Old and New Castile.

[13] Some evidence exemplifies how misleading this assumption is. For example, the number of Moorish expelled from Spain (1609-1613) could have reached 300,000 (Pérez Moreda 1988: 380). As regards voluntary migration, flows to Spanish America have been estimated as 250,000 and 100,000 in the 16th and 17th centuries, respectively, and about 125,000 over 1700-1824 (Martínez Shaw, 1994: 152, 167, 249).

[14] Regional data on baptisms, expressed in index form, are available at decadal intervals for all Spanish regions since 1700, with its regional coverage narrowing down as one moves back to the 1520s. For 1580s-1790s we used Llopis Agelán (personal communication) and Llopis Agelán and Sebastián Amarilla (2007) decadal regional estimates, completed with Reher's for 1520s-1580s (personal communication). Since the coverage for earlier decades declines, we assumed that some regions moved along its neighbours, namely, Asturias presumably evolved as Galicia during 1610-30; Cantabria as the average of Galicia and the Basque region, 1620-30; and Galicia, Asturias, and Cantabria as the Basque region over 1580-1610. Also, Valencia and Murcia were assumed to move with Catalonia during 1580-1600, and with Balearics during 1580-1590. Regional coverage is restricted to the Kingdom of Castile and Navarre for the 1580s as information is available neither for Catalonia, Valencia, and Balearics, nor for the Canaries. Data for 1550-1580 are restricted to Castilla-León that was assumed to represent also the evolution of northern Spain (Galicia, Asturias, Cantabria, and the Basque region), Castilla-La Mancha, Madrid, and Extremadura (that was used to represent the evolution of Andalusia).

geometric average has been computed for each pair of estimates previously derived using adjacent benchmarks, in which the closest benchmark series gets a larger weight. Thus,

$$N_d = (X_d)^{(n-t)/n} * (Y_d)^{t/n} \qquad \text{for } 0 \leq t \leq T \qquad (2)$$

Being N the population at decadal estimates d, X and Y, the values corresponding to the projection of each adjacent benchmark (initial and final) figures (i.e., 1700 and 1750) with baptism decadal indices, respectively; and n the number of years in between 0 and T.

It could be argued that a similar reconciliation is also possible between benchmark interpolated series and those obtained from baptism yearly indices that would result in new annual series from 1580 onwards. We have, thus, carried out this alternative estimate using the yearly baptism indices and the benchmarks in expression (2). The outcome is presented in Figure 2, along the benchmarks log-linearly interpolated and its adjustment with decadal indices of baptisms. However, the high volatility of the baptism-based yearly series renders them unacceptable.

Unfortunately, this compromise solution is questionable. Projecting a population benchmark with baptism indices is misleading since population is a stock variable while baptism series, as a proxy for births, represent a flow. In fact, using baptisms as measure of population amounts to proxy capital stock by investment.

Following this analogy, we could use the Perpetual Inventory Method to reconstruct population. Thus,

$$N_t = (1 - \delta_t)\, N_{t-1} + B_t + M_t \qquad (3)$$

Where population N in year t equals population in the year $t-1$ multiplied by 1 minus the depreciation rate (δ) in year t, that here would be represented by the crude death rate, plus baptisms, B, as a proxy for the number of births, and net immigration, M, (that is, immigrants less emigrants) in the year t.

Unfortunately, although baptisms would roughly amount to crude birth rates, *cbr*, times population at the beginning of the year, we lack yearly crude death rates, *cdr*, and any attempt to derive population by assuming fixed *cdr* is unacceptable as crude birth and death rates fluctuate widely in the short run, and even more at times of pandemics.

Still, the ideal procedure to reconstruct annual population figures is to start from a reliable population figure at the beginning of a benchmark year adding up annually the natural increase in population, that is, births (b_t) less deaths (d_t), plus net immigration (m_t).

As there are population estimates available at various benchmarks (see footnote 5), all we need, then, is data on the natural increase in population (births less deaths) and net migration.

On migration no yearly data are available and only crude estimates can be proposed. As regards emigration to the Americas we have relied on Morner (1975: 64) who provides aggregate figures for five periods over 1506-1670 (1506-40, 1541-60, 1561-1600, 1601-25, 1626-50) and have distributed them annually within each period.[15] We also allowed for the outflow of Moorish population after their expulsion, that Pérez Moreda (1988: 380), reckons in, at least, 0.3 million. Thus, we have added a figure of 60,000 emigrants for each year between 1609 and 1613 inclusively. Estimates from 1670 onwards come from Martínez Shaw (1994: 151, 167, 249) for the periods 1670-1700, 1700-1800, 1800-30, and 1830-50 that have been distributed annually. As regards immigration, a figure around 0.2 million has been estimated for the sixteenth century, mostly French moving to Catalonia (Pérez Moreda, 1988: 374), that we have distributed assuming a steady inflow of 2,000 people per year.

However, as already mentioned, we lack yearly crude birth and death rates for Spain prior to the 1850s. Fortunately, David Reher (1991) computed them annually for New Castile since 1565. Hence, a possibility to provide plausible conjectures on annual population levels consists of constructing alternative population estimates in which each population benchmark (N_{bk}) is projected forth by adding the annual natural increase in population derived from yearly crude birth

[15] Although Martínez Shaw (1994) argues that Morner's figures for the early seventeenth century are grossly overexaggerated, we have accepted them as a way to offset the population disappeared as a consequence of war in Europe during the second quarter of the century.

and death rates for New Castile (cbr_{nct} and cdr_{nct}), plus net immigration estimates. This is the procedure to operate when we move forward (that is, when starting in 1787 we want to estimate population in 1788), while we need to subtract the natural increase in population and the net immigration in the previous year when we project population backwards (namely, when starting in 1787 we want to compute population in 1786).[16] That is,

$$N_{t+1} = N_{bk} + (cbr_{nct} - cdr_{nct}) * N_{bk} + m_t \qquad \text{for } t > bk \qquad (4)$$

$$N_{t-1} = N_{bk} - (cbr_{nct-1} - cdr_{nct-1}) * N_{bk} - m_{t-1} \qquad \text{for } t < bk \qquad (5)$$

Accepting crude birth and death rates from New Castile assumes implicitly that they are representative for the whole of Spain. Such arbitrary assumption is largely relaxed by the procedure used to reconcile the resulting series. In fact, the exercise suggested by expressions (4) and (5) provides a set of population series, one for each benchmark, that do not match each other for the years in which they overlap (Figure 3). Therefore, we need to carry out a reconciliation between these alternative estimates.

A solution is interpolating the series accepting the levels for each benchmark-year as the best possible estimates and distributing the gap or difference between adjacent benchmark series (say, series obtained by projecting the 1752 benchmark forward, N_{1752t}, and the 1787 benchmark backwards, N_{1787t}) in the overlapping year T at a constant rate over the time span in between the two benchmark years.

$$N^I_t = N_{1752t} * [(N_{1787T} / N_{1752T})^{1/n}]^t \qquad \text{for } 0 \le t \le T \qquad (6)$$

Being N^I the linearly *interpolated* new series, N_{1787t} and N_{1752t} the series pertaining to population obtained by projecting two adjacent population benchmarks (i.e., 1752 and 1787) with expressions (4) and (5), respectively; t, the year considered; T, the overlapping year between the two benchmarks' series (say, 1787); and n, the number of years in between the two benchmark dates (that is, 35 years, 1787 less 1752, in our example).

Alternatively, a variable-weighted geometric average for each pair of estimates derived using adjacent benchmarks, in which the closest benchmark series gets a larger weight, can be used (expression (2)). We have used both

[16] This crude approach is inspired by the inverse and back projection (Lee, 1985)

approaches with identical results but have kept the ones from the linear interpolation as this is the splicing procedure used in modern national accounts.

Figure 4 presents the new compromise estimate along the decadal-adjusted series and the benchmarks interpolation. The comparison reveals that the main discrepancies correspond to the pre-1700 period, as the new compromise series continues expanding during the first quarter of the seventeenth century while the decadal-adjusted series peaks in the 1580 declining thereafter, and, especially, in the second half of the seventeenth century with deep contractions in the late 1640s-early 1650s and in the mid-1680s. Also, the compromise series departs from the other two in the early nineteenth century capturing the impact of the demographic crisis in the early 1800s and during the Peninsular War.

In Figure 5, we present our proposal about the evolution of Spanish population that combines the compromise series since 1565 with the annual population figures obtained through the decadal adjustment (with baptisms data) of the benchmarks interpolated series for the period 1520-1565 and the benchmarks interpolated series for the pre 1520 period.

Agricultural Output

In preindustrial Europe, lack of data has led to estimate agricultural output indirectly (Wrigley, 1985; Malanima, 2011; van Zanden and van Leeuwen, 2012). Using a demand function approach, Álvarez-Nogal and Prados de la Escosura (2013) computed agricultural consumption per head, and assuming the net imports of foodstuffs were negligible, they used them to proxy output per head.[17] These findings may be largely considered explicit conjectures as they are based upon limited empirical evidence on real wage rates and land rents, used as proxies for disposable income per head, and hypothetical values for income- and own price elasticities. Exploring new indirect alternatives seems, hence, warranted while provides a test for the robustness of the demand approach estimates.

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[17] Real consumption per head of agricultural goods (***C***) can be expressed as

$$C = a\, P^{\varepsilon}\, Y^{\mu}\, M^{\gamma} \qquad ([7].$$

In which *P* and *M* denote agricultural and non-agricultural prices relative to the consumer price index, respectively; *Y* stands for real disposable income per head; ε, μ, and γ are the values of own price, income and cross price elasticities, respectively; and *a* represents a constant.

Early modern economic historians have used indirect information on a religious tax, the tithe, to infer trends in agricultural output. In Spanish economic history, studies of main crops' output using tithes date mostly from the 1970s and early 1980s. Monographs were mainly carried out at local or provincial level, although regional studies have occasionally been carried out. A first attempt at assessing the evolution of agricultural output in Spain on the basis of the tithe series was carried out by Gonzalo Anes and Ángel García Sanz (1982). More recently, we used tithes to infer the evolution of agricultural output in Spain between 1500 and 1800 (Álvarez-Nogal *et al*., 2016). Here we improve these estimates and expand its time coverage.

Tithe records go back to the Middle Ages but the dearth of written sources reduces the time span in which they are available. Tithes were imposed on farming and livestock production and although, nominally, represented 10 per cent of total production, in practice, its share fluctuated and was usually smaller.

In Spain, tithes can be traced back to the early fifteenth century for cereals and olive oil and to the end of the century for wine, while for fruits and vegetables and livestock tithes already exist for the sixteenth century. In Roman Catholic countries tithes did not disappear until the French Revolution and the Napoleonic Wars. In the case of Spain, tithes persisted until the 1830s (Canales, 1982), but its reliability to capture output tendencies after 1808 is hampered by lack of compliance as a result of the Peninsular War and the institutional collapse of the Ancien Régime.

The translation of tithes into output trends raises some questions. Collection procedures, whether direct or rented out to private agents, and the payment system (in kind or cash) changed over time and varied across regions. Also, the resistance of peasants to pay the tax varied, as did the tax exemptions of specific producers, and the opportunities for evasion resulting from the emergence of new crops. Does all this render tithes questionable as a proxy for output tendencies?

In favour of the use of tithes it can be asserted, though, that in late medieval and early modern Spain, where different fiscal systems operated, tithes provided homogeneous information across regions. Moreover, tithes were computed on total output, with the local priest acting as supervisor and making public the names and amounts paid by each producer. The latter also found in its publicity a guarantee of property rights on the harvested land (Santiago-Caballero, 2011, 2014). Lastly, the diversity of tithe beneficiaries multiplied the accounting records available allowing a direct comparison between alternative sources. All this has led historians to depict tithes as a fixed proportion of total production from which output trends can be inferred (García Sanz, 1979).

Figure 6 presents output for the main crops that exhibit highly coincidental trends (See Appendix 1 for its construction on the basis of tithes). Cereals show a long run expansion up to the 1570s. Wine and livestock produce, especially, shadow cereals tendencies. Wine production expanded remarkably during the first two-thirds of the sixteenth century, remaining at high output levels until 1590. This depiction also fits olive oil, a more volatile product. Most crops fell, then, during the early seventeenth century recovering, at different pace, between the mid-seventeenth and the mid-eighteenth centuries. In the late eighteenth century, opposite trends are found: fruits and legumes and olive oil sustained declined while cereals, must, and livestock produce expanded. A fall is observed across the board in the early nineteenth century.

In order to construct an index of agricultural output, one option is weighting the quantity index for each crop by its share in 1799 agricultural output. However, using fixed weights over such long time span introduces a serious index number problem, since relative prices change over time and, consequently, 1799 weights become less representative as one moves away from the late-eighteenth century.

A better choice seems to construct a Divisia index of agricultural output which is obtained by weighting yearly variations in each crop's output by the average, in adjacent years, of the shares of each crop in agriculture output at current prices and, then, obtaining its exponential. That is,

$$\ln Q_{at} - \ln Q_{at-1} = \Sigma_i \left[\theta_{Qit} \left(\ln Q_{it} - \ln Q_{it-1}\right)\right] \qquad (8)$$

Where share values are computed as:

$$\theta_{Qit} = ½ \left[\theta_{it} + \theta_{it-1})\right] \qquad (9)$$

Previously, current values, *V*, for each crop *i* at year *t* can be derived by projecting the value of each crop in 1799, V_{i1799}, backwards with the quantity index built on the basis of tithes, *Q*, and a price index, *P* (expressed as 1790/99 = 1) and then, added up in order to obtain the value of total agricultural output, V_j.

$$Va_t = \Sigma V_{it} = \Sigma V_{i1799} * Q_{it} * P_{ijt} \qquad [10]$$

Later, the share of each crop, V_{it}/V_t, needs to be obtained.[18]

The share of each major crop in agriculture output at current prices is presented in Figure 7. It can be observed that cereal and animal produce are the main contributors to agricultural output and show opposite trends, with animal produce increasing its share and cereals' share declining up to the 1570s and in the late seventeenth and early eighteenth century, and cereals' share expanding at the expense of animal produce's in the early seventeenth and late eighteenth century.

Figure 8 offers the evolution of aggregate agricultural output obtained computed both as Divisia and Laspeyres (with fixed 1799 weights) indices, that shadow each other, although the Laspeyres index exhibits increasingly higher levels as ones moves back time. This widening differential evidences the extent of the index number problem triggered by keeping fixed weights over time.

In the evolution of agricultural output, distinctive phases can be found. The first one was of sustained expansion that peaked in the early 1560s. A contraction occurred between the mid-1570s and the early 1600s followed, then, by stagnation. A long-run expansion took place from the mid-seventeenth to the mid-eighteenth century, peaking in the 1750s, when the highest output level in four centuries was reached. Output stabilised, then, until the end of the century and declined during the Peninsular War.

If we focus now on agricultural output per person (Figure 9), two main phases can be noticed, a high plateau covering from the 1440s to early 1570s, and a low plateau spanning between the 1650s and the 1750s, with a transitional phase of decline, between the late 1570s and the 1640s, in between, in which output per person shrank by one-third. A new phase of contraction is found in the late eighteenth century that reached its trough during the Peninsular War and represented one-fourth contraction since the 1750s.

How does the new tithes-based agricultural output per head compare to the earlier demand function estimates? Both series present roughly the same trends since the mid-fifteenth century, but while the demand approach series were already on high plateau since 1400 the tithes-based series showed lower levels and higher volatility up

[18] See the sources of agricultural prices in Appendix 2.

to the 1440s (Figure 10). The shift from a high to a low path of output per head is common to both estimates, which reach a trough in the early seventeenth century, although the tithes-based series present a sharper and neater decline, starting in the mid- late 1570s, rather than in the 1560s. The lower plateau covers the same period, 1650s-1750s, in the two set of estimates, but in the tithes-based ones the post-1650 recovery is stronger and exhibits less volatility. After 1800 the two series evolve alongside but the tithes-based shows stronger fluctuations.

It is worth noting that the parallel behaviour of the demand-approach and tithes-based series supports the view that crop and livestock destruction appears as the main factor behind the sharp decline in tithes collection during the Peninsular War, rather than the more intuitive view of peasants' lack of compliance with the religious tax.

Further support to this interpretation is obtained when we extend the comparison between the two alternative approaches to the early 1830s. Although both goods and regional coverage narrows down for the early nineteenth century, it is still possible to construct indices of agricultural output on the basis of tithes until 1835. Figure 11 shows how the tithes-based output departs sharply from output derived with the demand approach from 1820 onwards. The fact that the years between 1820 and 1833 correspond to a period of peace, suggests that it is non-compliance with the religious tax the reason why a growing gap emerges between the two indices. The so-called Trienio Liberal (1820-23), a phase of liberalisation, weakened Ancien Régime institutions and discouraged tithe compliance (Anes and García Sanz, 1982; Canales, 1982; Torras, 1976). The bottom line is, therefore, that the parallel trends of the tithe-based and the demand approach estimates supports the use of tithes as a reliable indicator of agricultural output tendencies until 1818 or, to be on the safe side, until the end of the Peninsular War (1814). Moreover, our findings challenge the dismissal of the demand approach as simple controlled conjectures. Lacking direct sources of agricultural production, as it is often the case in preindustrial societies, the demand approach appears to provide a reasonable procedure to infer output trends.

Since our goal here is to provide the best possible estimate for long run agricultural output, we propose a new index that accepts the demand approach estimates for 1818-1850 and the tithe-based ones for 1402-1818, and projects its level for 1402 back to 1277 with the demand approach index (red dash line in Figure 11).

Output in Non-Agricultural Activities: Urbanization as a Proxy

A reconstruction of trends in industrial and services output is beyond the scope of this paper. It would require a thorough investigation of industrial output, sector by sector, most probably on the basis of a variety of indirect indicators among which taxes deserve to be explored. In the case of services, the prospects to get a proper assessment of output are even bleaker. A crude short cut to proxy trends in economic activity outside agriculture is urbanization, more specifically, the use of changes in the urbanization rate (ratio between urban and total population) to infer trends in non-agricultural output per head.[19]

The association between urbanization and the expansion of modern industry and services is not new. Simon Kuznets (1966: 271) observed that urbanization implies “an increasing division of labor within the country, growing specialization, and the shift of many activities from nonmarket-oriented pursuit within the family or the village to specialized market-oriented business firms”. In the economic history literature, parallels have been drawn suggested between changes in urbanization rates and per capita income (Acemoglu et al., 2005; Craig and Fisher, 2000; Temin, 2006; and van Zanden, 2001). Wrigley (1985: 123) has argued, “A rising level of real income per head and a rising population of urban dwellers, other things being equal, are likely to be linked phenomena in a preindustrial economy”.

Although keeping a constant threshold over time, while population grows, is rather questionable (Wrigley, 1985: 124), we have arbitrarily adopted the definition of ‘urban’ population as dwellers in towns of 5,000 inhabitants or more.[20] Indeed, this measure provides a lower bound of the actual level of urbanization as it does not take into account the increase in population living in towns and cities of larger size.

However, a caveat is necessary. Urban population has been accepted here as a proxy for output in non-agricultural activities after excluding those living on

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[19] We follow here Álvarez-Nogal and Prados de la Escosura (2007, 2013). Malanima (2011) also relies on urbanization as a proxy for non-agricultural economic activity.

[20] This way, we maintain consistency with Bairoch et al. (1988) large database facilitating international comparisons. Alternative thresholds of 10,000 (de Vries, 1984) and 20,000 inhabitants have been used (Flora, 1981). Bairoch et al. (1988) employed alternatively 2,000, 5,000, 10,000, and 20,000 inhabitants.

agriculture. The reason is that the existence of 'agro-towns' (namely, towns in which a sizable share of the population was dependent on agriculture for living) appears to be a feature of pre-industrial Spain. Thus, we have computed trends in the rate of adjusted urbanization -that is, the share of non-agricultural urban population in total population- in an attempt to capture those in industry and services' output per head (See a detailed explanation of the computing procedure in Appendix 3).[21]

'Agro-towns' sink their roots in the *Reconquest*. In a frontier economy, towns provided security and lower transactions costs during the re-population following the southwards advance (Ladero Quesada, 1981; Rodríguez Molina, 1978). In the thirteenth century, Christian settlers from Aragon, Catalonia, and Southern France acquired farms but preferred to live in towns (MacKay, 1977: 69). It has been claimed that, in southern Spain, "agro-towns" were the legacy of highly concentrated landownership after the acceleration in the pace of the Reconquest and the Black Death, which increased the proportion of landless agricultural workers (Vaca Lorenzo,1983; Valdeón Baruque, 1966), although Cabrera (1989) attributes the rise of latifundia to the generalization of the seigniorial regime during the fourteenth and fifteenth centuries. In our estimates, 'agro-towns' appear mainly located in Andalusia, and since the late eighteenth century, also in Murcia and Valencia.

Albeit the existence of 'agro-towns', urban economic activity was closely associated to industry and services. In sixteenth century Old Castile, Yun-Casalilla (2004) reckons, only one in twelve in the urban labour force worked in agriculture. Pérez Moreda and Reher (2003: 129) suggest, for 1787, a similar proportion of farmers in Spain's urban population.[22]

Moreover, rural population carried out non-agricultural activities (storage, transportation, domestic service, construction, light manufacturing) especially during

[21] In order to mitigate the inclusion of 'agro-towns', Malanima (2011) proposed for the south of Italy a limit of 10,000 inhabitants for being considered urban, as opposed to the 5,000 inhabitants limit for the north and centre of Italy. Cf. Llopis Agelán and González Mariscal (2006) for a more astringent definition of 'urban' centre.

[22] However, Reher (1990) reckoned half the economically active population living in towns in Spain worked in agriculture by 1787. Nonetheless, Reher's computations are on the high side as he increased artificially the share of urban population employed in agriculture by allocating all day labourers to this sector while excluding servants from the labour force.

the slack season in agriculture (Herr, 1989, López-Salazar, 1986).[23] Perhaps, as Wrigley (1985: 137) noted, a more rigorous option would be to measure employment composition by sector in terms of days or hours worked, rather than assigning each worker to a specific occupation.[24]

Table 1. Urbanization Rates, 1340-1857: Benchmark Estimates (%)

	Unadjusted	**'Adjusted'**
1340	(11.6)	(9.2)
1420	(9.4)	(7.5)
1530	12.0	9.5
1561	18.9	13.0
1591	20.5	14.6
1646	8.7	8.7
1700	10.0	9.9
1750	14.6	13.8
1787	24.6	17.4
1857	31.4	22.9

Sources: Total urban population, Bairoch et al. (1988), Correas (1988), and Fortea (1995); for non-agricultural urban population, see Appendix. For absolute population, see the population section.
Note: Figures in brackets are highly conjectural.

Spanish urban population, adjusted to exclude population living on agriculture, has been computed at benchmark years for the period 1530-1857. Total and adjusted urban population levels for 1530 were projected backwards to 1300 and 1400 with Bairoch et al. (1988: 15-21) estimates. Urban population for Spain in, 1530, 1561, and 1646 has been inferred from data for the Kingdom of Castile. Urbanization rates, that is, urban population expressed as a share of total population, both unadjusted and 'adjusted', are presented at benchmark years in Table 1.

Annual 'adjusted' urbanization rates have been derived through linear interpolation of the benchmark estimates. Trends in the rate of urbanization are shown in Figure 12. The accelerated expansion of the early sixteenth century slowed down in its second half and was reversed during the first half of the seventeenth century. Then, urbanization recovered slowly accelerating after the Succession War to overcome the late sixteenth century peak by the second half of the eighteenth

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[23] Wool provides a case in point in early modern Spain. A mainly rural activity, it had both industrial and services (trade, transport, financial services) dimensions (García Sanz, 1986).

[24] The number of days (and hours) worked per EAP in Spain was lower in agriculture than in industry and services leaving extra time to work in non-agricultural activities. Cf. Santaolaya (1991), Vilar (1970: 19), and Ringrose (1983).

century. Interestingly, these figures are at odds with the rather stable rate of urbanization (around 20%) widely used estimates by Bairoch et al. (1988).

Aggregate Output

The next stage is to construct an index of aggregate output (Q). Rather than estimating long-run output with fixed weights which introduces an index number problem, as implicitly assumes that relative prices do not change over time, we have computed a Divisia index in which real GDP is obtained by weighting yearly output variations in agriculture, Q_{at}, and industry and services, proxied by 'adjusted' urban population, $N'_{urb\text{-}nonagr\,t}$, with the average, in adjacent years, of the shares of agriculture, θ_{Qat}, and non-agricultural activities, θ_{Qi+st}, in GDP at current prices.[25] That is,

$$\ln Q_t - \ln Q_{t-1} = \theta_{Qat} (\ln Q_{at} - \ln Q_{at-1}) + \theta_{Qi+st} (\ln N'_{urb\text{-}nonagr\,t} - \ln N'_{urb\text{-}nonagr\,t-1}) \quad (11)$$

where agricultural, θ_{Qat}, and non-agricultural, θ_{Qi+st}, share values are computed as:

$$\theta_{Qat} = \tfrac{1}{2} [\theta_{at} + \theta_{at-1})] \text{ and } \theta_{Qi+st} = \tfrac{1}{2} [\theta_{i+st} + \theta_{i+st-1})] \quad (12)$$

and, then, Q_t is obtained as its exponential.

In order to get sector shares in current GDP, θ_{it}, current values, V, for each sector i at year t are derived by projecting each sector's value added average in 1850/9, $V_{i1850/9}$, backwards with the quantity, Q, and price P, indices previously built for each sector, Q_{at} and P_{at} for agriculture, and $N'_{urb\text{-}nonagr\,t}$ ('adjusted' urban population) and P_{i+st}, for industry and services, respectively, (expressed as 1850/9 = 1) and, then, added up to attain the value of total output, $V_{\cdot t}$

$$V_{at} = V_{a1850/9}\, Q_{at}\, P_{at} \quad (13)$$

$$V_{i+st} = V_{i+s1850/9}\, N'_{urb\text{-}nonagr\,t}\, P_{i+st} \quad (14)$$

$$V_{\cdot t} = V_{at} + V_{i+st} \quad (15)$$

Later, the shares of agricultural and non-agricultural activities were obtained, respectively, as $\theta_{Qat} = V_{at}/V_{t\cdot}$ and $\theta_{Qi+st} = V_{i+st}/V_t$

As regards price indices, the price index already built in the section on agriculture has been accepted. For non-agricultural activities an unweighted Divisia

[25] In the case of agriculture, note, as discussed in the section on agriculture, real output estimates with the demand approach (Álvarez-Nogal and Prados de la Escosura, 2013) have been used for 1818-1850 and, then, spliced to the tithes-based index back to 1402 and, then, backwards projected to 1277 with the demand approach index. As regards non-agricultural output, the 'adjusted' index of urban population, that is, the 'adjusted' urbanization rate times population, has been accepted to represent it.

index was computed with industrial goods and consumer price indices and nominal wages.[26] This amounts to allocating one-third of the weight to industry (the industrial price index) and two-thirds to services (nominal wage and consumer price indices), which represents a good approximation to these sector shares in non-agricultural output in the 1850s (Prados de la Escosura, 2017) (For the source of prices see Appendix 2).

Figure 13 offers the evolution of aggregate output obtained computed as Divisia index along a Laspeyres index with fixed 1850/59 weights.[27] It can be observed that they match each other closely. Does this indicate lack of structural change in preindustrial Spain? We will address this issue later.

The new output index provides a proxy for the evolution of real GDP in the absence of direct alternatives. This approach has been deemed a reasonable second best (Fouquet and Broadberry, 2015). But how robust are these results? A possible test could be to consider an alternative scenario of three, rather than two, economic sectors: agriculture, industry and 'modern' or market services, and 'traditional' or mainly non-market services, the latter including government, health, education, leisure, professional and domestic services. It could be further hypothesised that lacking data on the output of non-market services its evolution could be proxied by that of population, under the plausible assumption that its labour productivity was largely stable over time.[28]

Thus, we have constructed an alternative output index with three sectors, agriculture, industry and market services (proxied by 'adjusted' urban population), and non-market services (proxied by population) which represented 40.6, 27.8, and 14.5 per cent of GDP in the 1850s, respectively. The deflators used for industry and the rest of services would be the same as the ones employed for non-agricultural activity in the baseline output estimates, while for non-market services the price index used is a

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[26] Thus, average rates of variation for manufacturing prices, the CPI, and nominal wage rates were arithmetically averaged and the price index obtained as its exponential.

[27] That is, $Q_{.t} = S_{a0} * Q_{at}/Q_{a0} + (1 - S_{a0}) * N'_{urb\text{-}nonagr\,t} / N'_{urb\text{-}nonagr\,0}$ (16)

where fixed 1850/59 shares for agriculture (S_{a0}) and non-agricultural activities ($1 - S_{a0}$) in GDP are used as weights. Cf. Álvarez-Nogal and Prados de la Escosura (2007).

[28] This assumption has led researchers to proxy the evolution of output in 'traditional' or non-market services by the number of people they employ or, lacking such information, by population (Cf. Broadberry et al., 2015; Prados de la Escosura, 2012).

weighted average of the consumer price index (2/3) and the nominal wage rate in index form (1/3). Output has been derived using a Divisia index as for the baseline index. Figure 14 offers the alternative indices. It can be observed that they show the same trends although softened during growing and shrinking phases in the case of the three-sector index as would be expected when an economic sector's output is proxied by population. This result suggests that the baseline index can be deemed a satisfactory proxy for the evolution of real output over time.

What does the long run evolution of output show? Distinctive phases can be distinguished (Figure 15). Three phases of expansion: 1) up to the 1340s, whose origins, we can conjecture, go as far back as to the mid-eleventh century; 2) from the early fifteenth century to the early 1570s, more intense during the central decades of the sixteenth century; and 3) from the mid-seventeenth to mid-nineteenth century, punctuated by the Succession (1701-13) and Peninsular (1808-14) Wars. Two phases of sustained decline complete the picture, the first one, triggered by the Black Death (1348), very intense until the 1370s, that lasted until the early fifteenth century; and a second one, from the late sixteenth to the mid-seventeenth century.

If we now turn to output per head (Figure 16), its evolution follows a wide W shape, with phases of growth which peak in 1341, 1572, and 1850, separated by deep contractions in the late fourteenth and early seventeenth century. Each phase of expansion (1277-1341, 1374-1572, and 1647-1814) shows similar pace but, as output per head declined sharply during shrinking episodes, each subsequent growth phase starts from a lower level and, hence, evolves along a lower path, with the results that per capita income levels hardly changed over the long run (Table 2). Nonetheless, in terms of average income levels, we can distinguish a relatively high plateau from the late thirteenth to the late sixteenth century, but for the Black Death and its aftermath, and a low plateau that covered the seventeenth and early eighteenth century.

Table 2 offers yearly rates of variation for population and absolute and per capita output. Panel A provides, from the second row onwards, growth rates between peaks and troughs, while Panel B presents a breakdown of expansion and contraction phases. We can observe that the shrinkage in the third-fourth of the fourteenth century is comparable in intensity to that of the late sixteen century. The results confirm the view that output per head and population evolved alongside, accelerating and declining simultaneously. In phases of expansion, population grew albeit output responded more than proportionally, while in phases of contraction, population growth slowed down turning negative in the third quarter of the fourteenth century and the first half of seventeenth century. The early nineteenth century appears as a distinctive period with population increasing at about twice the pace in previous expansion phases, and per capita income growing faster too (0.5 per cent).

Table 2. Output and Population Growth, 1277-1850 (%)*

	Output	Population	Output per head
Panel A			
1277-1850	0.26	0.22	0.04
1277-1341	0.47	0.07	0.41
1341-1374	-1.39	-0.15	-1.24
1374-1572	0.37	0.19	0.18
1572-1647	-0.62	0.07	-0.69
1647-1814	0.50	0.27	0.23
1814-1850	1.45	0.96	0.49
Panel B			
1374-1572			
1374-1474	0.20	0.04	0.15
1474-1517	0.28	0.17	0.12
1517-1572	0.77	0.48	0.27
1572-1647			
1572-1605	-0.96	0.24	-1.19
1605-1647	-0.36	-0.05	-0.30
1647-1814			
1647-1714	0.37	0.17	0.21
1714-1808	0.70	0.36	0.34
1808-1814	-1.23	0.06	-1.29

Sources: See the text.
Note: * annual average logarithmic rates. The periodization corresponds to that of output per head.

How does the new index of output per head compare to earlier estimates by Álvarez-Nogal and Prados de la Escosura (2013)?[29] In Figure 17 the two estimates are presented alongside. The new series appears more volatile in the fifteenth century, a fact that could be attributable to the lower coverage of tithe-based agricultural index

[29] Álvarez-Nogal and Prados de la Escosura (2013) also computed a Divisia index of output per head, using the 'adjusted' urbanization rate as a proxy for non-agricultural activities per person but derived consumption per head of foodstuffs with a demand approach from which agricultural output per head was inferred.

in terms of geographical and output composition. Moreover, in the new series the economic collapse in the late sixteenth century began earlier (in the late 1570s, rather than in the late 1590s) and was deeper. On the whole, the two estimates show a high degree of coincidence in the period 1402-1818, when they alternative used tithes and the demand approach to derive agricultural output.

Are there any lessons to be drawn from preindustrial Spain's experience? Some stylised facts about preindustrial societies can be perhaps put to the test. A first one is that of long run stagnation in average incomes. The expansive and contracting phases in the W-shaped evolution of Spain's real output per head contradict this widespread view, even though living standards did not experience an improvement over the very long run. These results lend support instead to the idea of growth recurring over six centuries. Furthermore, Broadberry and Wallis (2017) claim that, as shrinking phases become shorter and less frequent after growing phases, modern economic growth emerges, is confirmed by Spain's early nineteenth century experience (Figure 16).

A second stylised fact is the Malthusian nature of preindustrial economies. Trends in Spanish population and per capita income, expressed in logs, are offered alongside in Figure 18.[30] A direct association seems to exist between population and per capita income trends. Population and real output per head expanded simultaneously up to the Black Death, during the late fifteenth and most of the sixteenth century, and from the late seventeenth to the early nineteenth century; conversely, population and income per person shrank in the late fourteenth and early fifteenth century and in the early seventeenth century. How can we explain these results at odds with the Malthusian view? The existence of a frontier economy, resource abundant, in preindustrial Spain provides an answer. Given low population density and high land-labour ratios, demographic expansion appears to have had increasing economic returns in a largely pastoral society that was led by urban nuclei and connected to international trade networks. The frontier economy helps to explain why the Black Death had devastating economic effects despite its comparatively milder demographic impact, as the Plague destroyed a pre-existing fragile equilibrium (Álvarez-Nogal and Prados de la Escosura, 2013). Furthermore, why the Black Death

[30] The logarithmic transformation makes trends clearer as the slope of the curves provide the pace at which growth or decline occurred.

did not represent in Spain the watershed it constituted in *Carolingian* Europe and the British Isles may be explained by its specific traits. In western Europe, by wiping out between one-half and one-third of the population, the Black Death reduced demographic pressure on resources, raised land- and capital-labour ratios, and led to higher returns to labour vis-à-vis land or capital and higher relative prices for non-agricultural goods. Cheaper capital and labour scarcity led to lower interest rates and higher wages that incentivised physical and human capital accumulation and stimulated labour saving technical innovation and female participation (Pamuk, 2007). The fact that factor proportions in post-Plague western Europe were similar to those already existing in pre-Plague Spain contribute to explain why the negative consequences of the Black Death prevailed in the late fourteenth and early fifteenth century Spain.

Another stylised fact is the absence of structural change in preindustrial economies. Was this the case of Spain? We have already noticed that real output trends are hardly altered if derived as a Laspeyres or as a Divisia index, and such coincidence suggests a positive answer to the question. But before jumping to conclusions, let us take a glance at the share of agriculture in GDP (Figure 19). The agricultural share represented two-thirds of GDP in the pre-Black Death era and expanded to represent about three-fourths in the late fifteenth century, as the role of towns and commerce in economic activity declined. Then, the expansion of industry and services accounted for its mild contraction throughout the sixteenth century. After the agricultural collapse since the late 1570s 'ruralisation' helps to explain why the agricultural share increased up to three-fourths of GDP in the mid-seventeenth century. Steady decline of the agricultural share took place throughout the eighteenth century shrinking to less than half the value of GDP in the early nineteenth century. Moreover, output diversification, evidenced by the expansion of wine, olive oil, and fruits and legumes, during periods of per capita income growth, also suggests structural change within agriculture.

An interesting contrast appears between two periods of economic expansion and similar average incomes: the central decades of the sixteenth century present a high agricultural share, while a much lower one is observed in the late eighteenth and early nineteenth century. A decline in the share of GDP accruing to agriculture is usually taken as an indicator of structural change, so how can we explain the relatively high share in the sixteenth century? It can be hypothesised that the source of the demand pull may matter. In the sixteenth century a thriving urban economy in Spain's interior triggered the expansion and commercial orientation of agriculture, that included livestock -merino sheep, in particular-. Rising population and living standards demanded land to produce more agriculture goods and high-quality wool to be exported to North-western Europe. In the late eighteenth and early nineteenth century the pull of demand came not from the interior (with the exception of Madrid) but mainly from towns in the periphery. Lower market integration between the interior and the periphery, largely due to transport difficulties, helps to explain a weaker agricultural response, with the demand for grain in coastal areas met by imports rather than by domestic production from the interior as it had happened in the sixteenth century (Cermeño and Santiago-Caballero, forthcoming). Therefore, we can posit that some degree of structural transformation occurred in the Spanish economy during expansive phases of growth recurring.

Spain's long run performance has been presented, so far, in average terms, but how were the gains and losses over successive growing and shrinking phases of per capita income distributed among social groups? Was Spain a highly unequal society, as is often assumed in the literature on preindustrial societies? Two alternative indicators allow us to provide crude trends in income distribution. The Williamson Index, defined here as the nominal (that is, current price) ratio between output per head and unskilled wage rates and expressed with 1790/99=100, permits to draw trends in inequality. The rationale underlying the Williamson Index is that GDP captures the returns to all factors of production while the unskilled wage captures only the returns accruing to factor, raw labour. Ideally one would require GDP and wage dividing by per hour worked in order to normalise them, so our comparison of output per person and wage rates provides a crude metric that may distort inequality tendencies.[31] This way, average returns are compared with returns to unskilled labourers, that is, those at the middle of distribution are compared with those at the bottom. We cannot say, however, how close to the absolute poverty line unskilled wages are, although

[31] However, carrying out the comparison in current prices avoids the distortion introduced by the use of different deflators for output and wages.

attempts to compute welfare ratios (namely, the ratio between a male labourer's yearly returns and the cost on maintain his family) suggest that unskilled workers were living close to subsistence in early modern Spain (Allen, 2001; López Losa and Piquero Zarauz, 2016).

A second inequality measure compares land rent and wage rates. Here again we compare returns to factors of production, land and labour. Thus, both the Williamson Index and the land rent-wage ratio proxy the functional distribution of income. The rationale is that in early stages of development the gap between average incomes accruing to proprietors of land and capital and to labourers, rather than the dispersion within proprietors and labourers' returns, is the main driver of personal income distribution (Prados de la Escosura, 2008). Moreover, one can conjecture that returns accruing to labour are more evenly distributed than those accruing to land, or capital, for the same token, for which differences in the quantity and quality of the factor owned matter.

Two phases in the evolution of income distribution can be distinguished. One of low inequality, from the late thirteenth century (and probably earlier) up to the mid-sixteenth century and, another, of high inequality from the mid-sixteenth century onwards (Figure 20). Differences between the two inequality indicators can be observed, though. The land rent-wage ratio continued increasing sharply during the late sixteenth century and maintained higher inequality levels in the early seventeenth century. Conversely, the land rent-wage fell substantially in the early nineteenth century, a time of long-term stability in terms of the Williamson Index.

Furthermore, it can be observed that, in broad terms, the phase of low inequality corresponds to that of economic affluence, and that the phase of high inequality starts at the peak of affluence in the mid-sixteenth century but extends over the phase of economic decline. Moreover, since the mid-sixteenth century inequality followed closely the economic cycle, increasing in the sixteenth century, declining in the early seventeenth century, and growing again during the eighteenth and early nineteenth century.

Spain in International Perspective

How did Spain perform internationally? Angus Maddison (1995, 2006) compared average incomes across countries and over time in a common monetary unit and at constant prices. Maddison's set of international estimates of real income per head in 1990 Geary-Khamis dollars international prices resulted from projecting per capita GDP levels in 1990 dollars, expressed in purchasing power parity (PPP) terms -that is, adjusted for differences in price levels across countries-, back and forth with volume indices taken from historical national accounts. Although Maddison approach has been widely used, it can be seriously objected. Its main shortcoming derives from the severe index number problem it introduces in the comparisons, since the basket of goods and services produced and consumed in 1990, and their prices, become less and less representative as one moves back and forth in time.[32]

If we follow Maddison's approach and express product per head in 1990 Geary-Khamis (G-K) dollars, we observe that Spain's average income ranged between G-K $1990 600 and 1,100 over half a millennium (Figure 21). The absolute poverty line was set by the World Bank at 1 dollar a day per person in 1985 dollars, that represent G-K $1990 426.[33] It appears, hence, that preindustrial Spain remained always above the absolute poverty line, more than doubling it in the early fourteenth century, in the late fifteenth and the sixteenth century and, again, since the late eighteenth century.

And how does Spain compare to other countries of preindustrial Western Europe? Levels of real GDP per head expressed in 1990 PPP-adjusted dollars are presented in Figure 22. With all the caveats about the reliability of income levels derived with a remote benchmark, the evidence provided here tells us the extent to which countries' relative positions improved or worsened vis-à-vis other western European countries. Thus, at face value (that is, accepting G-K $1990 as a suitable standard for comparisons) Spain, at the time of the Black Death, had income levels similar to France's and superior to those of the Netherlands and the United Kingdom. Then, at the peak of a second phase of expansion, in the early 1570s, Spain was on pair with the U.K and ahead of France, but below the Netherlands. However, if we now look at the post-1600 era, we find that Spain fell behind during the early seventeenth century, as she declined faster than the U.K. while France grew mildly. During the late

[32] In a nutshell, Maddison's approach implicitly assumes that the relative prices of 1990, and therefore, 1990 technology, remained unchanged over time (Cf. Prados de la Escosura, 2000).
[33] Converted in 1990 dollars with the US GDP deflator from https://www.measuringworth.com/datasets/usgdp/

century while average incomes in the U.K. and, to less extent, in France, Spain's per capita income remained stagnant. Thus, by the end of the Spanish War of Succession (1701-13), Spain was already lagging behind in income terms and had reached a comparative trough. Hence, it is possible to differentiate between Spain's absolute decline in terms of income per head during the early seventeenth century and her falling behind late in the century. The following phase of expansion allowed Spain to catch-up with France by the end of the eighteenth century but was not strong enough to prevent another episode of falling behind in the early nineteenth century. Thus, even if we are sceptical about the results from a comparative exercise in G-K $1990 terms, the tendencies to converge and diverge would still hold.

Concluding remarks

In this paper we have tried to make the most of scattered data. Our results, as conjectural as they can be, allow us to offer some conclusions and to propose hypotheses for further research.

1) Spanish preindustrial economy was far from stagnant and long phases of absolute and per capita growth and decline alternated. The long term outcome confirms, however, the intuition of no significant long-term change in per capita terms over more than half a millennium.

2) Population and output per head evolved alongside, a fact at odds with the conventional depiction of preindustrial societies as Malthusian. We can support our assertion on the grounds of the high land-labour ratios found in a frontier economy. Moreover, the historical experience of Spain suggests that other frontier economies could probably be confirmed along the European periphery (i.e., Ireland or Scandinavia).

3) In the frontier economy, not only living standards were relatively high, but incomes were distributed in a rather egalitarian way. Both features characterised Spain until the mid-sixteenth century. An important implication is that economic affluence was achieved way before the arrival of specie from the Americas and, hence, suggest that the overseas expansion was the endeavour of a relatively advanced society.

4) If we extrapolate the trend in per capita income growth during 1517-1572 to the eighteenth century, we get similar levels to those of the U.K. Why Spain's performance up to the 1570s was cut short giving way to a sustained decline and

falling behind? Why did Spain never return to the virtuous path initiated in the late fifteenth and consolidated during three fourths of the sixteenth century? Conventional Malthusian narratives are not persuasive in a context of population expansion along income per head. The unintended consequences of Spain's attempt to preserve its European Empire needs to be explored as increasing taxation of urban centres, the locus of the commercial and industrial expansion of the sixteenth century, placed an unbearable burden on the most dynamic sectors leading to ruralisation, as people tried to escape from the collapsed towns.

5) Spain offers an inverted mirror image of the North Sea Area (England and Low Countries) experience where the pull of urban demand triggered an agricultural revolution as peasants had an incentive to raise their purchasing power to access the new urban goods and services. Conversely, in Spain, the lack of urban stimulus led to the decline in agricultural labour productivity while the labour force in the countryside shrank, a scenario at odds with the conventional Malthusian narrative.

6) A new equilibrium seems to have been reached since the mid-seventeenth century when agriculture expanded and played an increasingly central role in a poorer and more unequal society. Sustained but mild growth after the Napoleonic Wars watershed fell short of taking Spain back to the leading position she had enjoyed by mid-sixteenth century.

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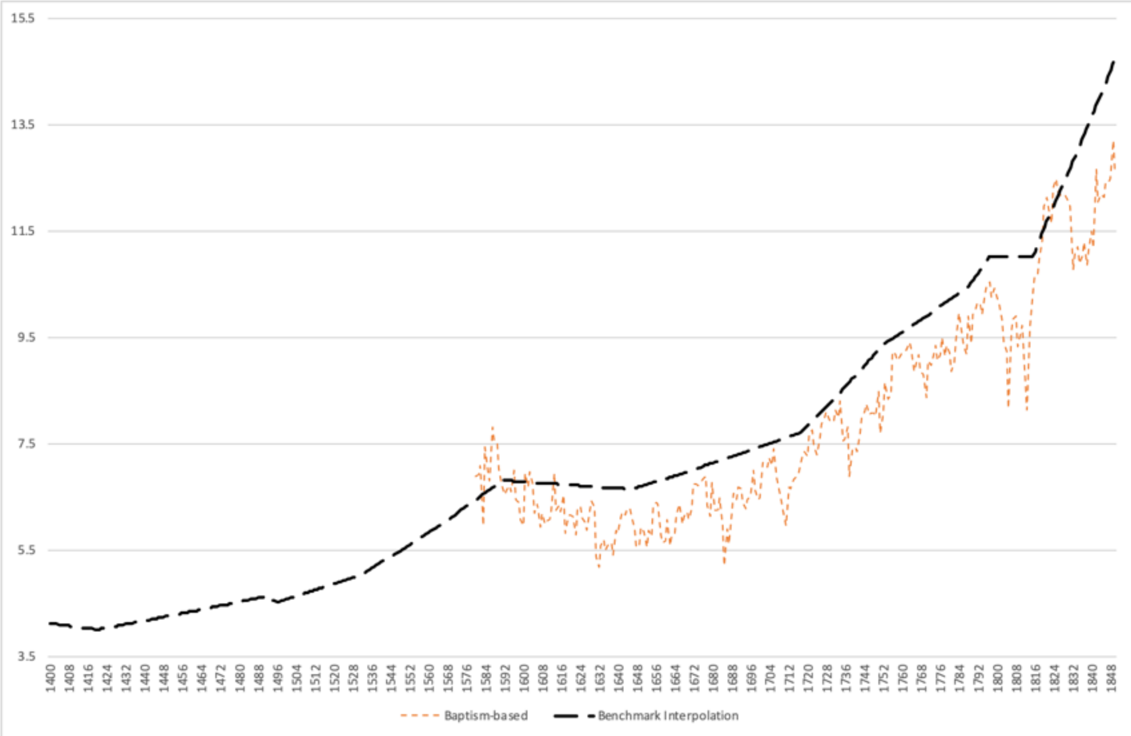

Figure 1. Population: Benchmarks' Interpolation and Estimates derived by projecting regional 1787-97 population average with baptism series, 1400-1850 (million).

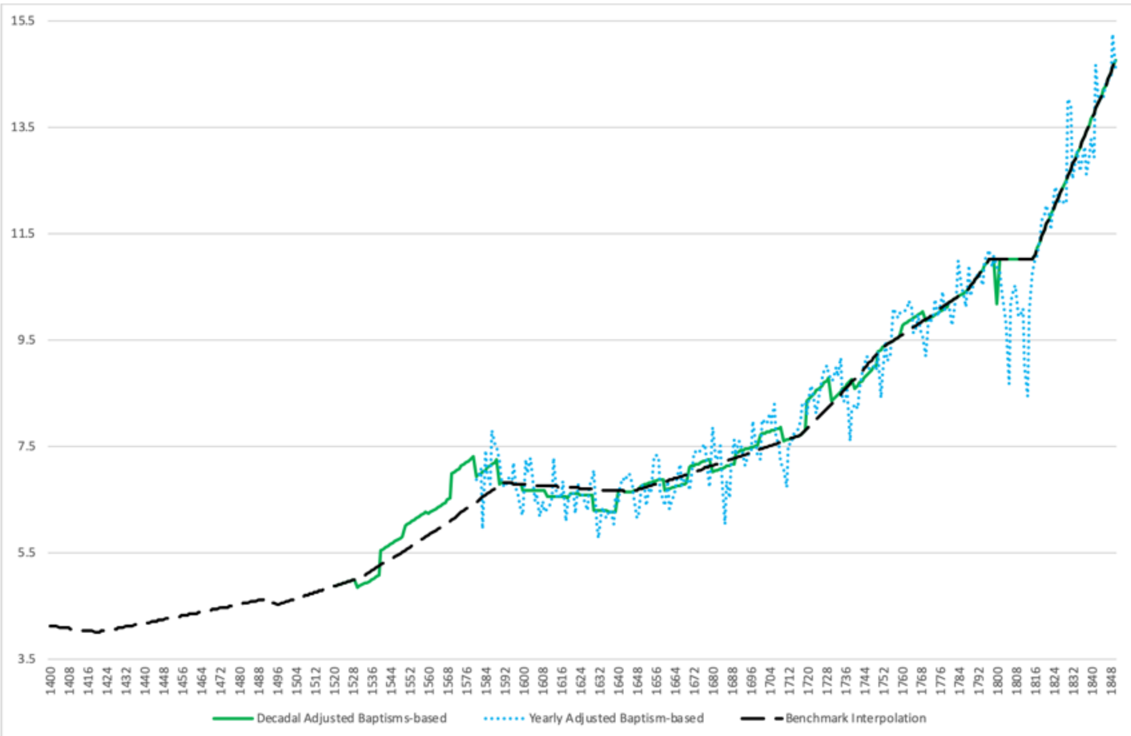

Figure 2. Population Conjectures: Benchmarks' Interpolation and Decadal and Yearly Adjustment with Baptisms, 1400-1850 (million).

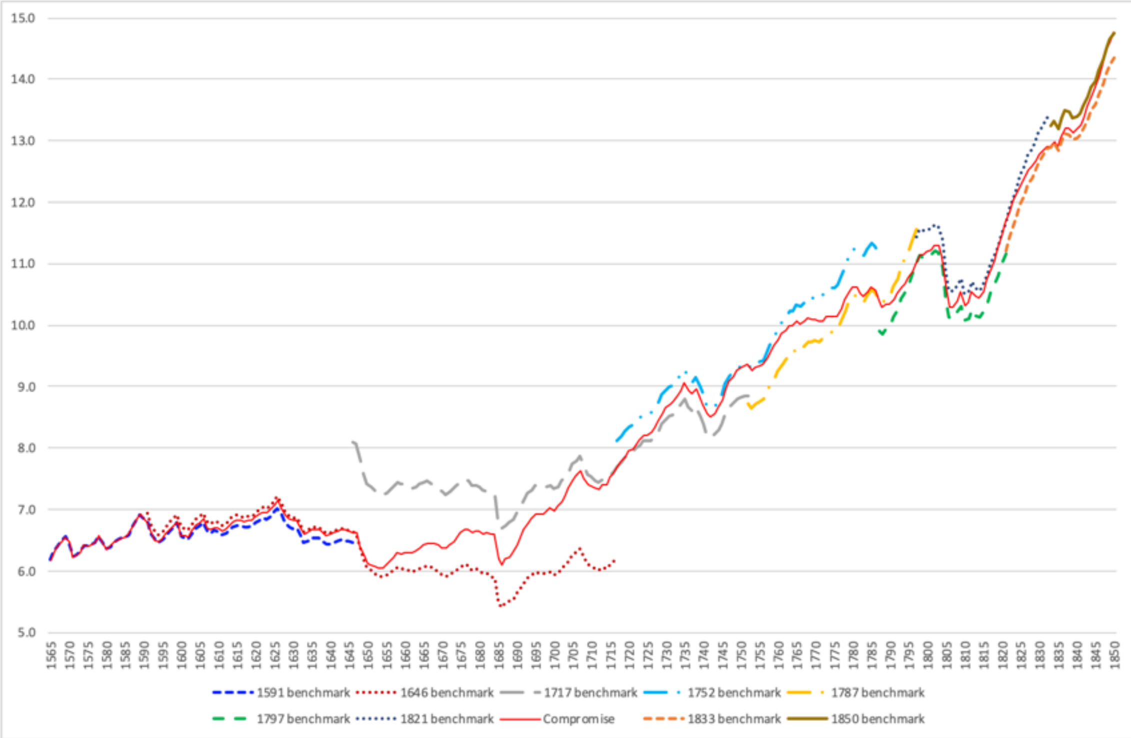

Figure 3. Population, 1565-1850: Alternative Benchmarks Projected with Reher's New Castile Crude Birth and Death Rates and Compromise Estimates (linear interpolation) (million)

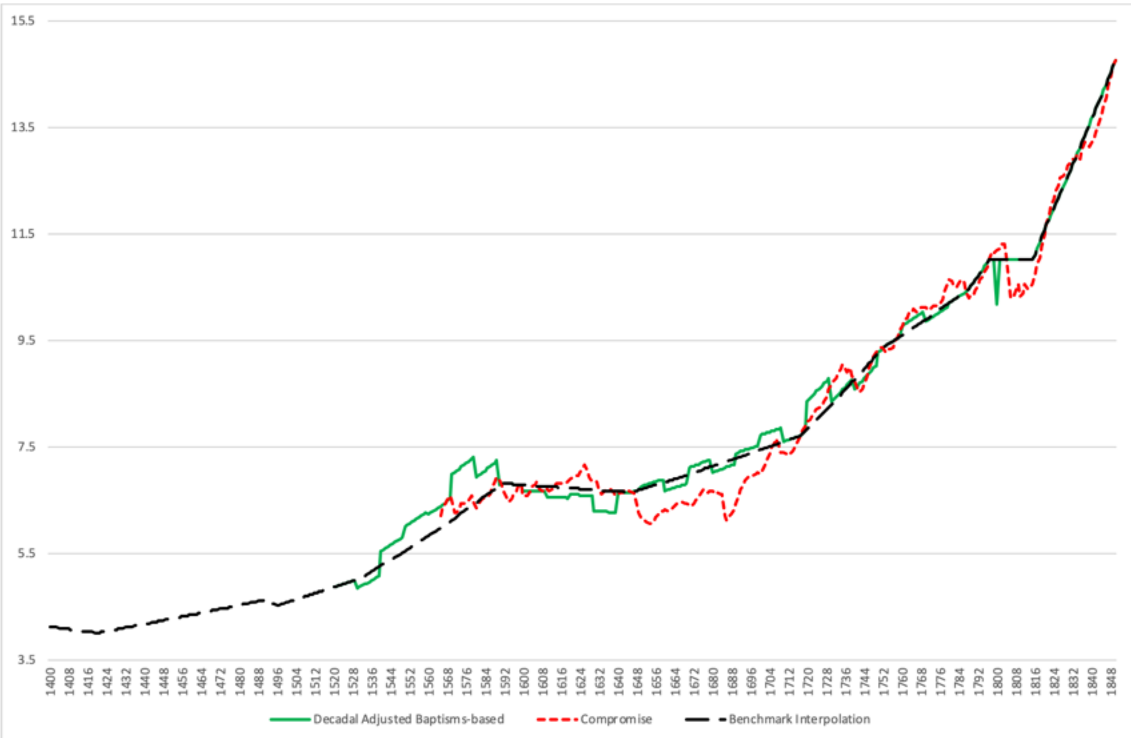

Figure 4. Population: Benchmarks interpolation, Decadal adjusted baptisms-based, and Compromise Estimates, 1400-1850 (million)

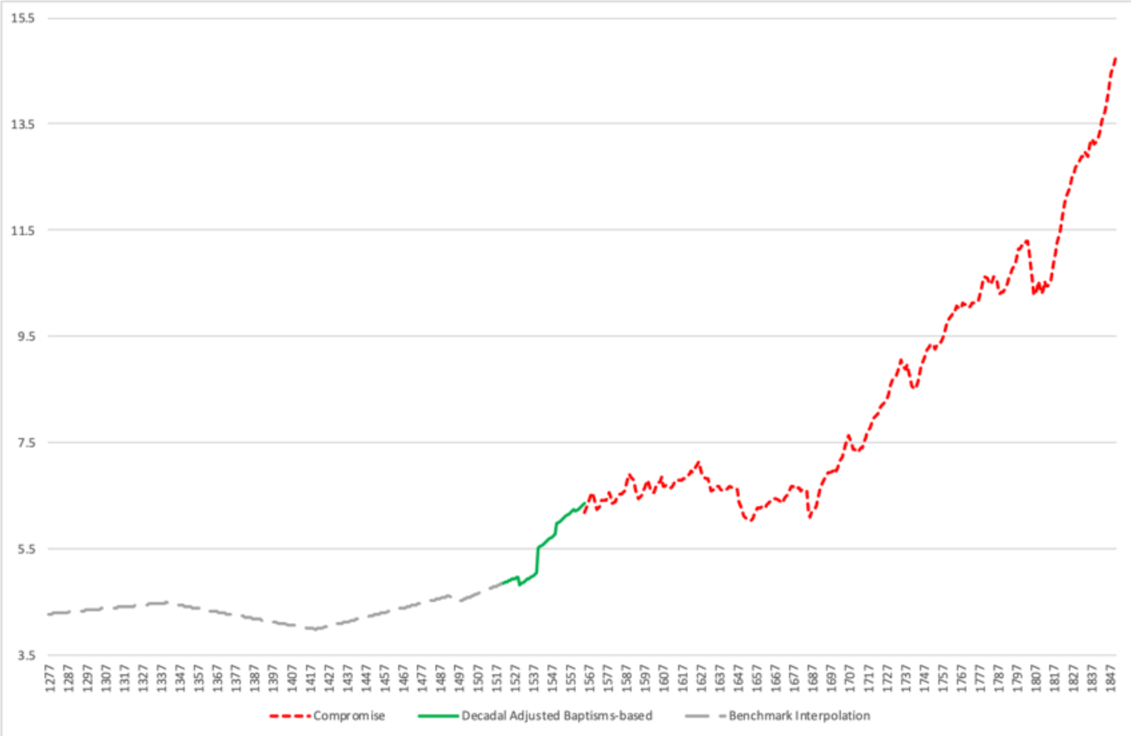

Figure 5. Population Conjectures, 1277-1850 (million)

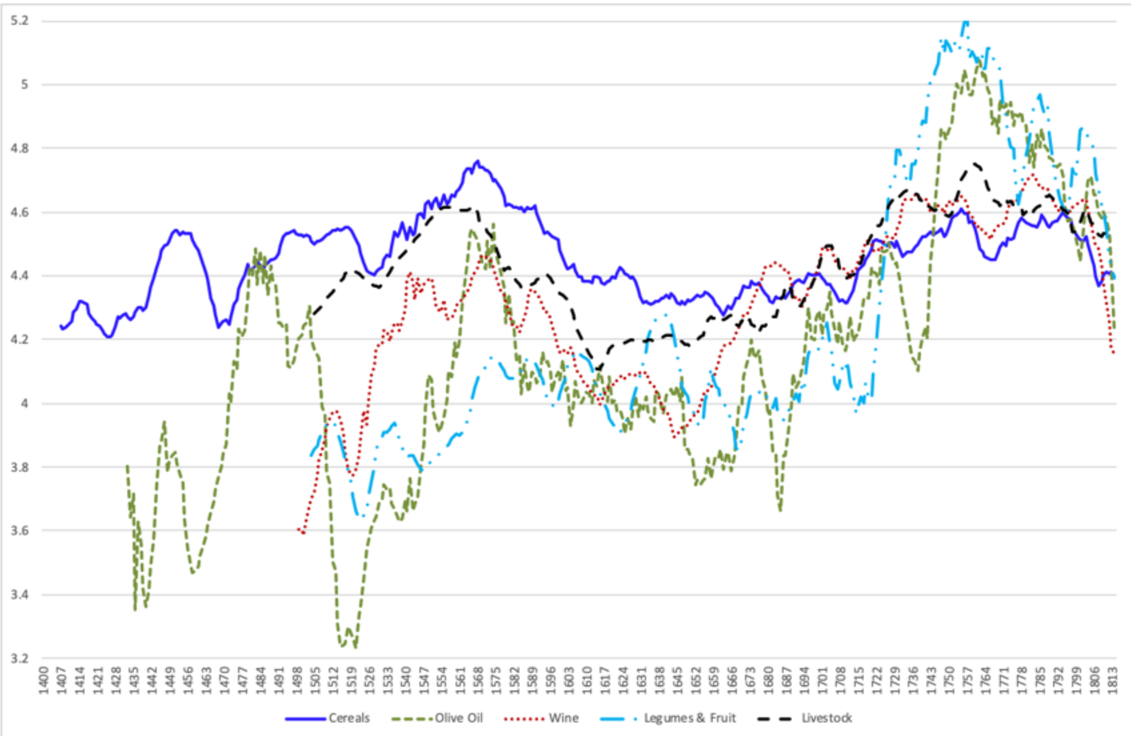

Figure 6. Output by Main Produce, 1407-1814 (1790/9=100). 11-year centred moving average (logs)

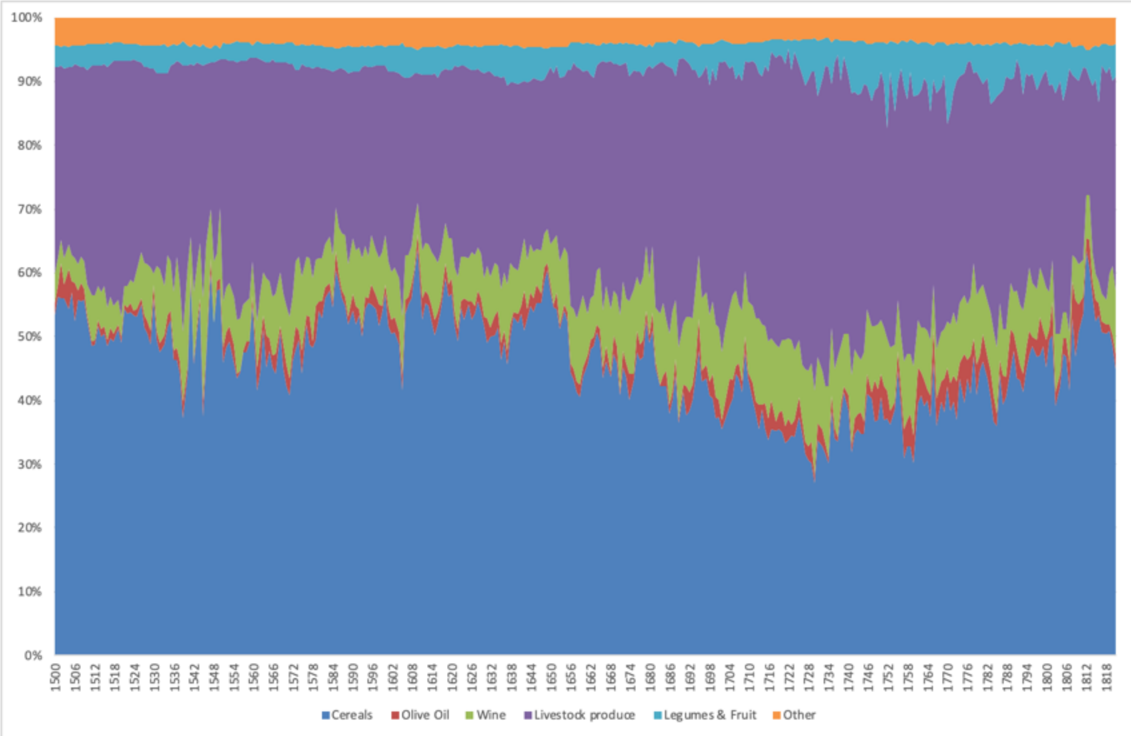

Figure 7. Output Composition, 1500-1820 (%) (Current Prices)

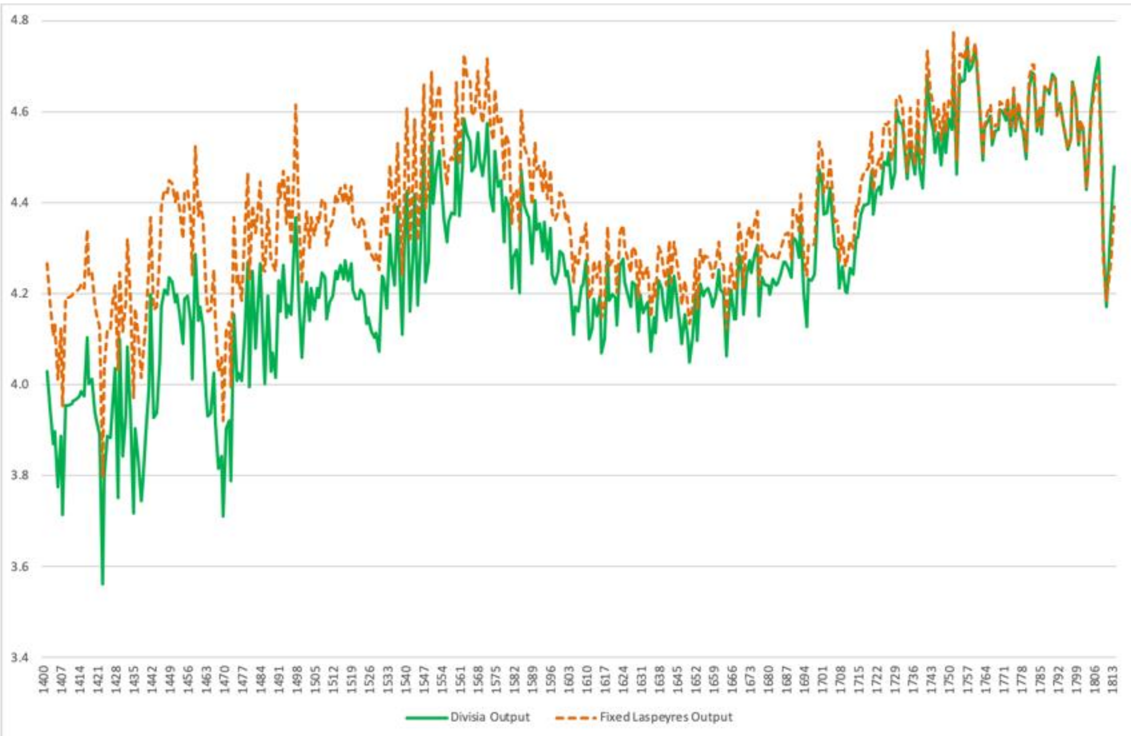

Figure 8. Agricultural Output, 1402-1814: Divisia and fixed Laspeyres Indices (1790/99=100) (logs)

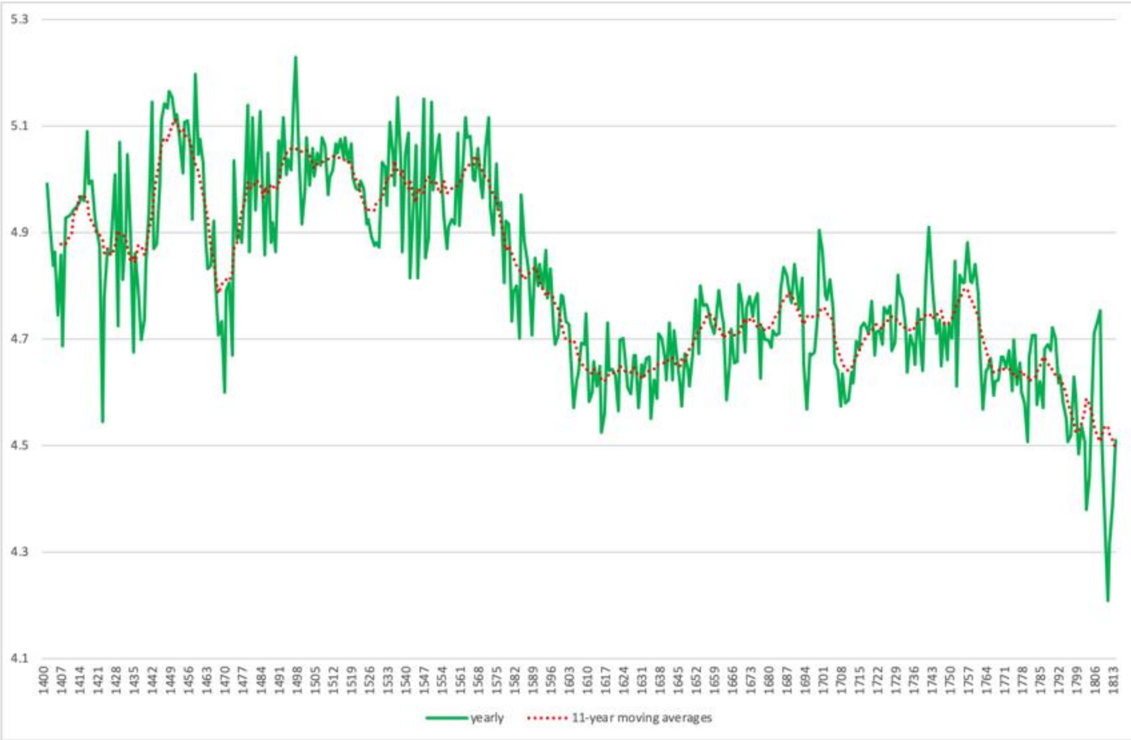

Figure 9. Divisia Index of Agricultural Output per Head, 1402-1814: yearly and 11-year centred moving averages (1790/99=100) (logs).

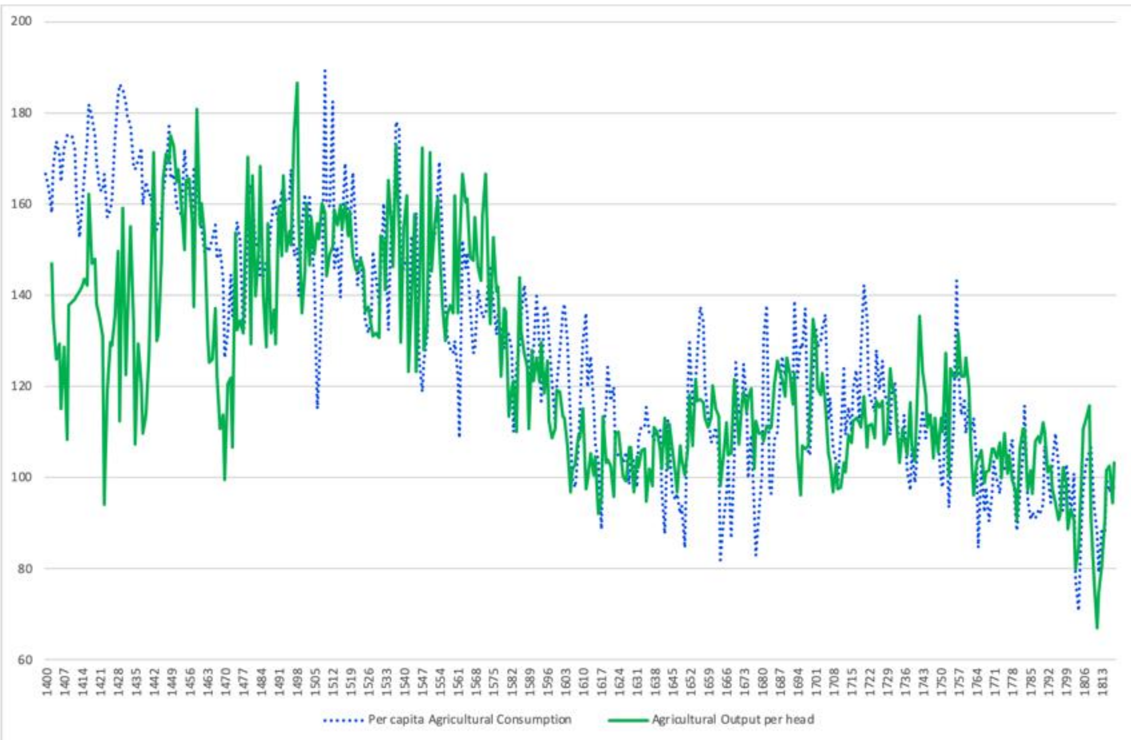

Figure 10. Agricultural Output and Consumption per Head, 1402-1818: Divisia Indices (1790/99=100) (logs). *Sources*: text and Álvarez-Nogal and Prados de la Escosura (2013).

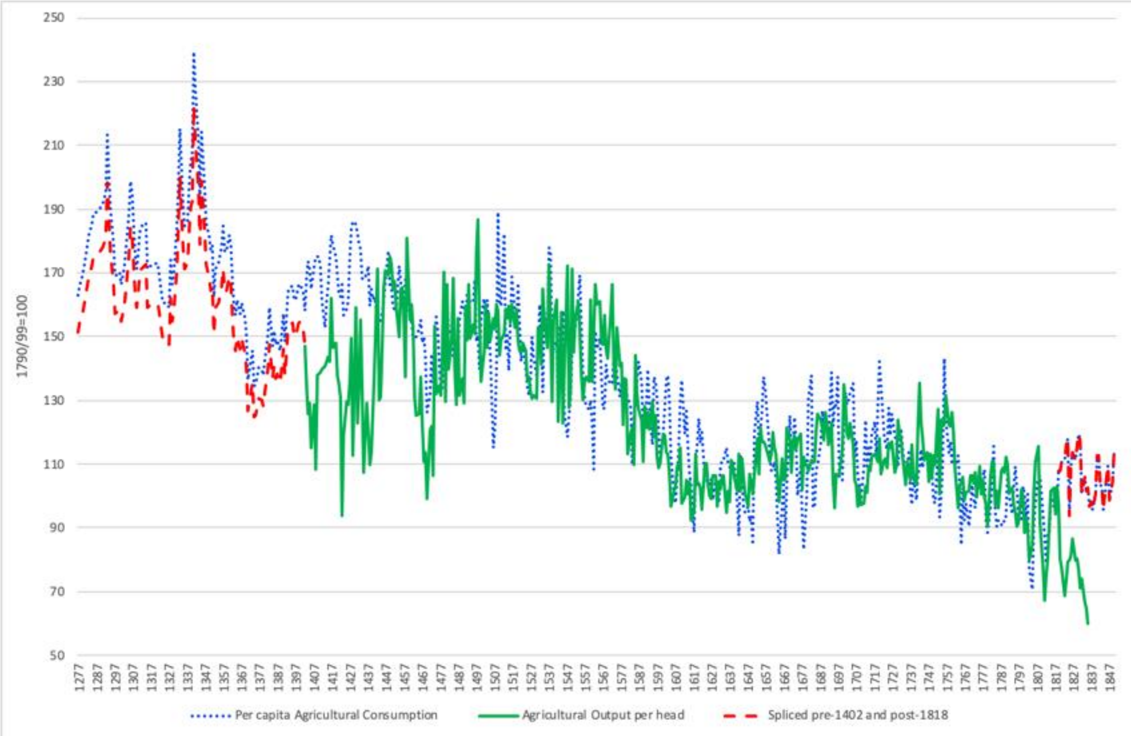

Figure 11. Agricultural Consumption and Output per Head (spliced), 1277-1850: Divisia Indices (1790/99=100) (logs).
Sources: text and Álvarez-Nogal and Prados de la Escosura (2013).

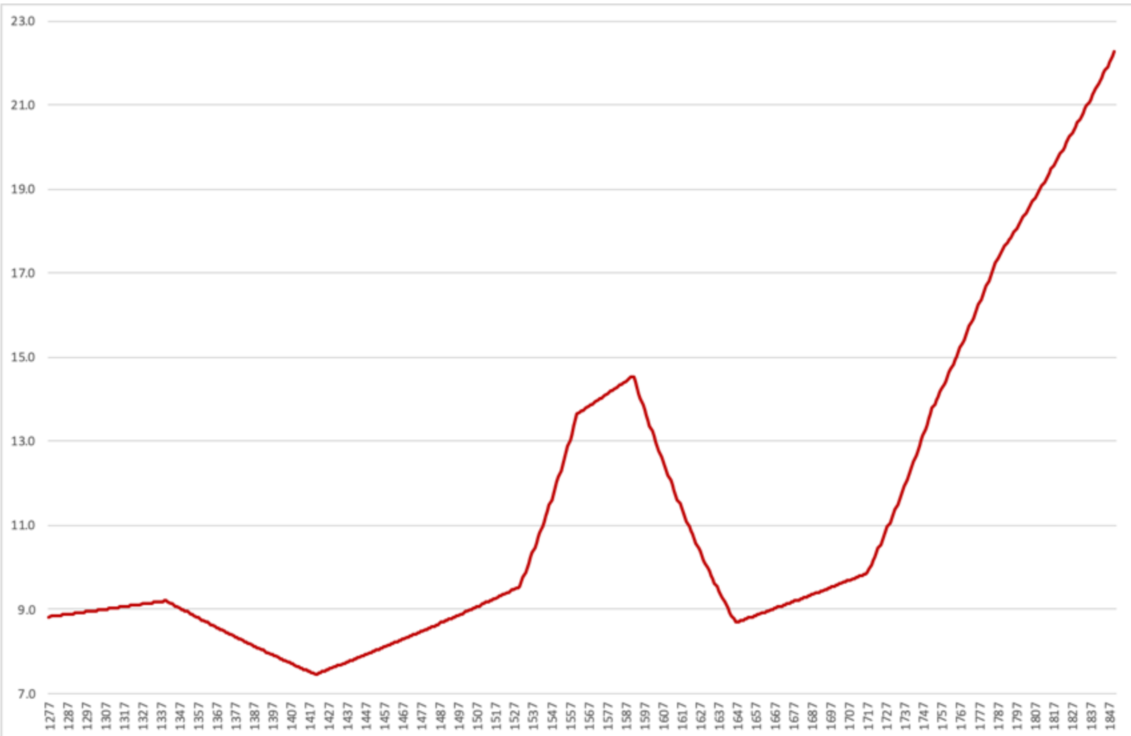

Figure 12. Adjusted Urbanization Rate, 1277-1850 (%)
Sources: See the text

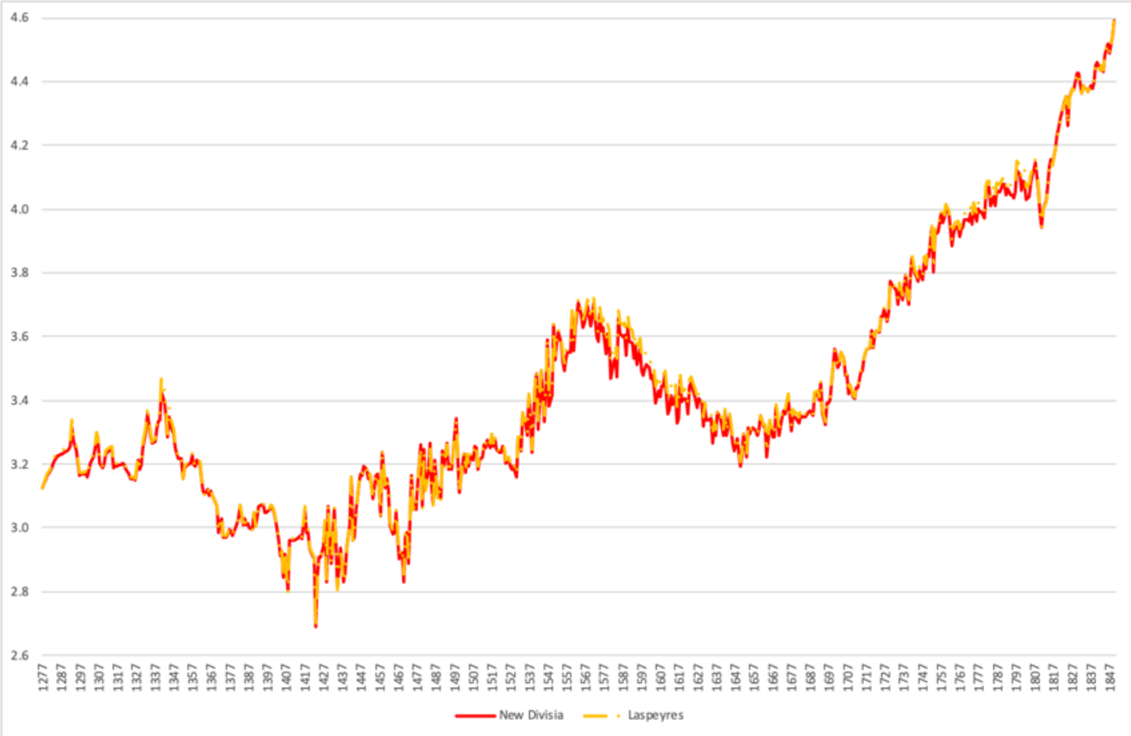

Figure 13. Real GDP, 1277-1850: New Divisia and Fixed Lapeyres Indices (1850/9=100) (logs)
Sources: See the text

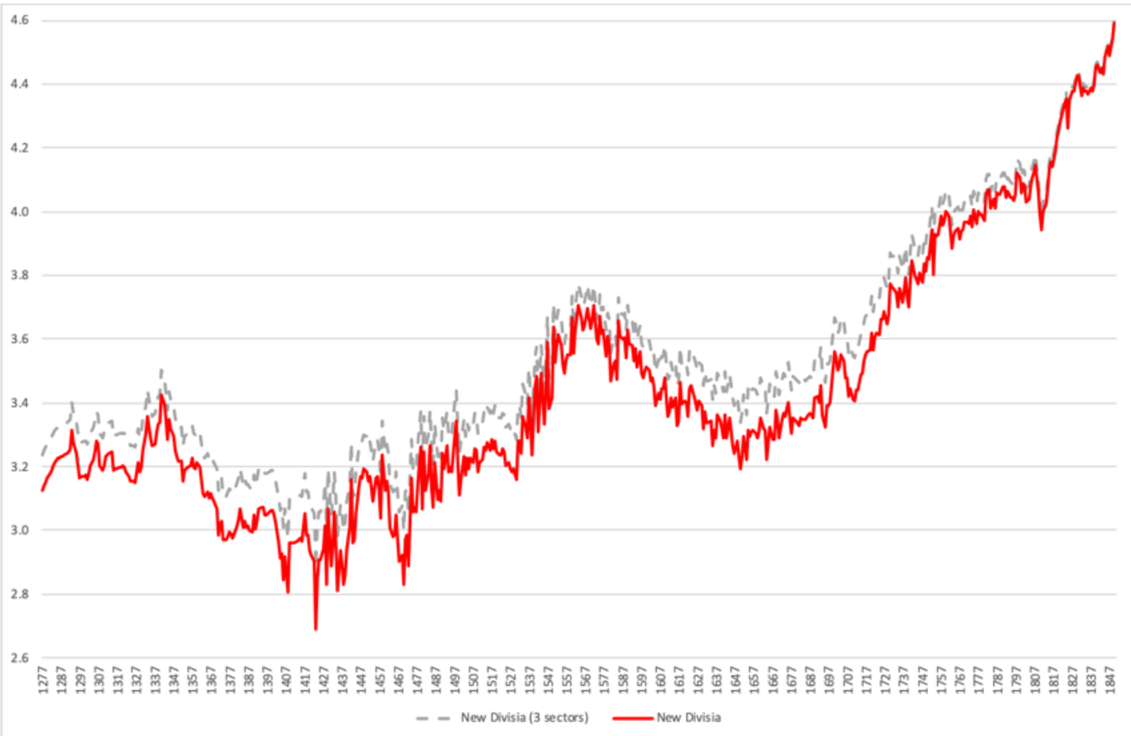

Figure 14. Real GDP, 1277-1850: New Divisia Two- and Three-Sector Indices (1850/9=100) (logs)
Sources: See the text

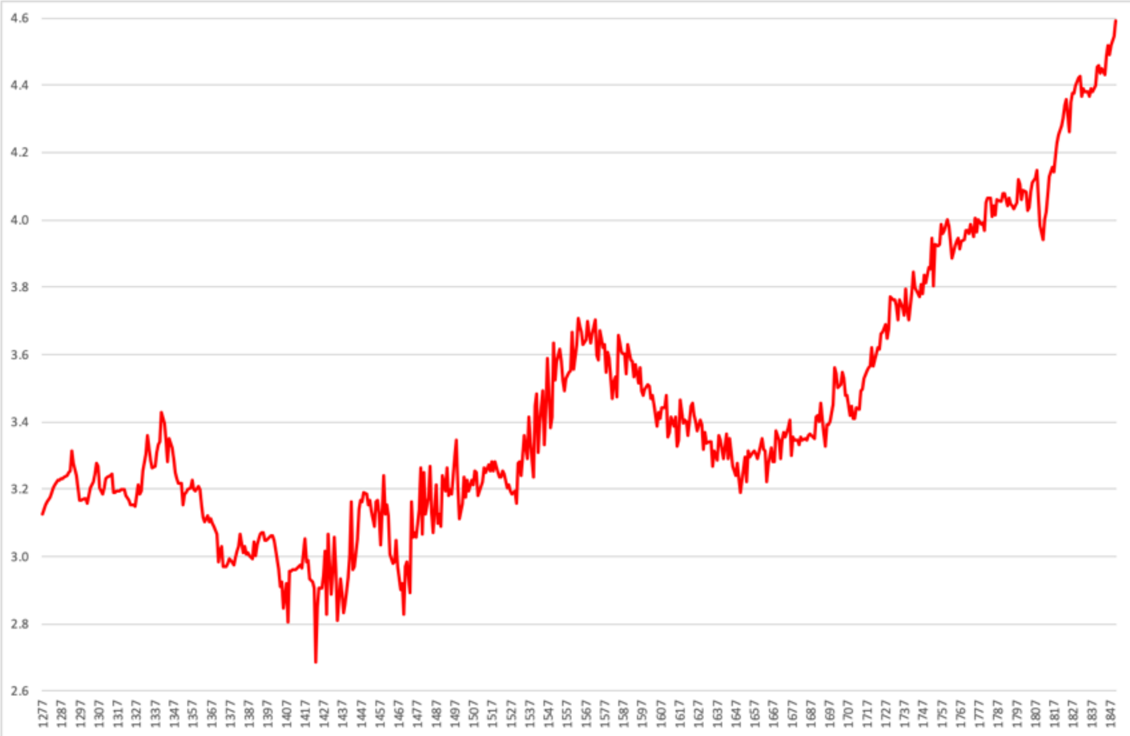

Figure 15. Real GDP, 1277-1850: New Divisia Index (1850/9=100) (logs)
Sources: See the text

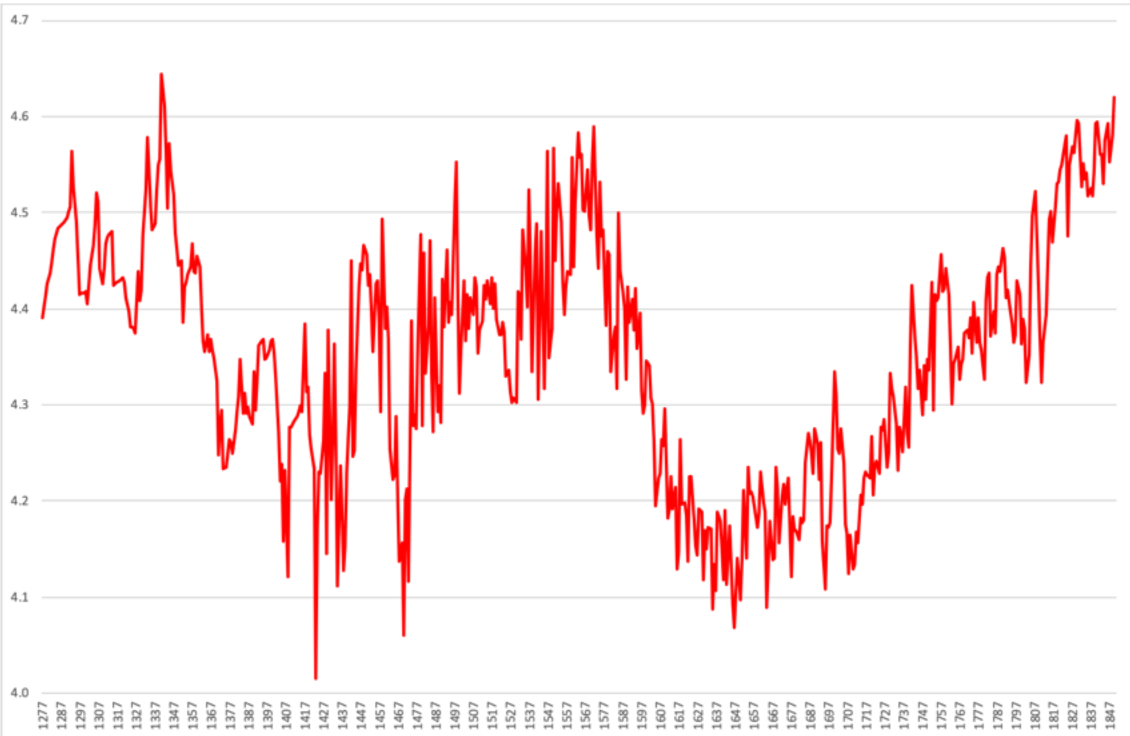

Figure 16. Real GDP per Head, 1277-1850: New Divisia Index (1850/9=100) (logs)
Sources: See the text

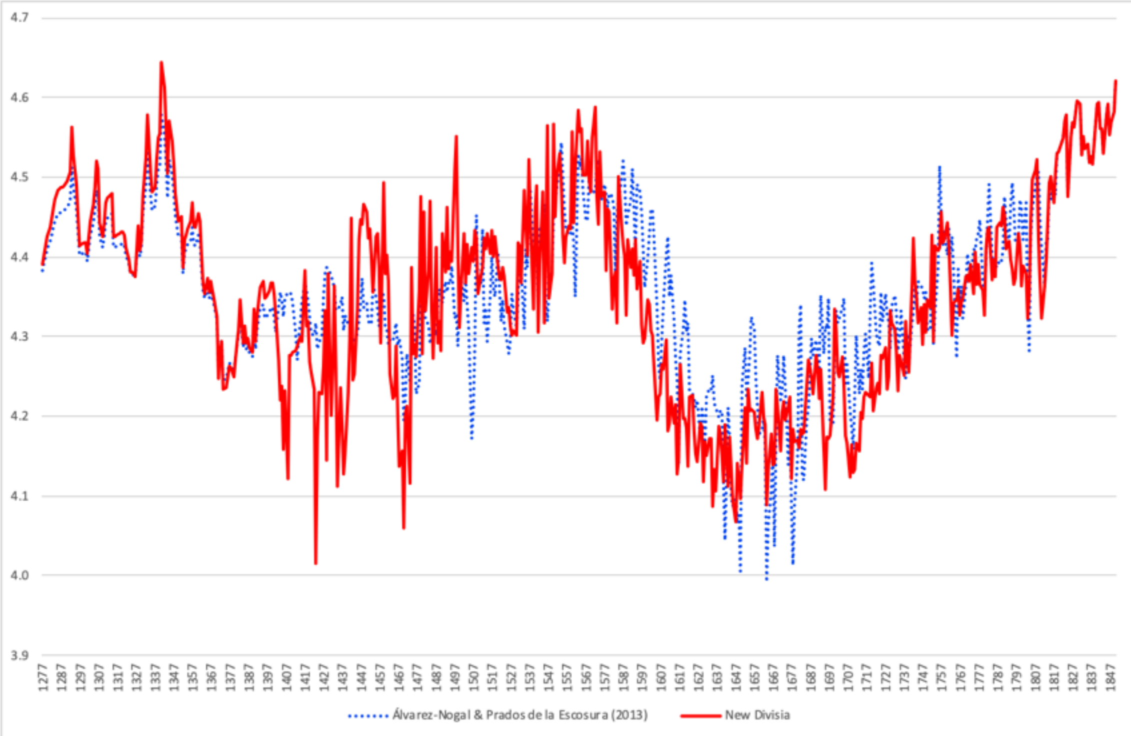

Figure 17. Real GDP per Head, 1277-1850: Alternative Estimates. Divisia Indices (1850/9=100) (logs)
Sources: See the text and Álvarez-Nogal and Prados de la Escosura (2013)

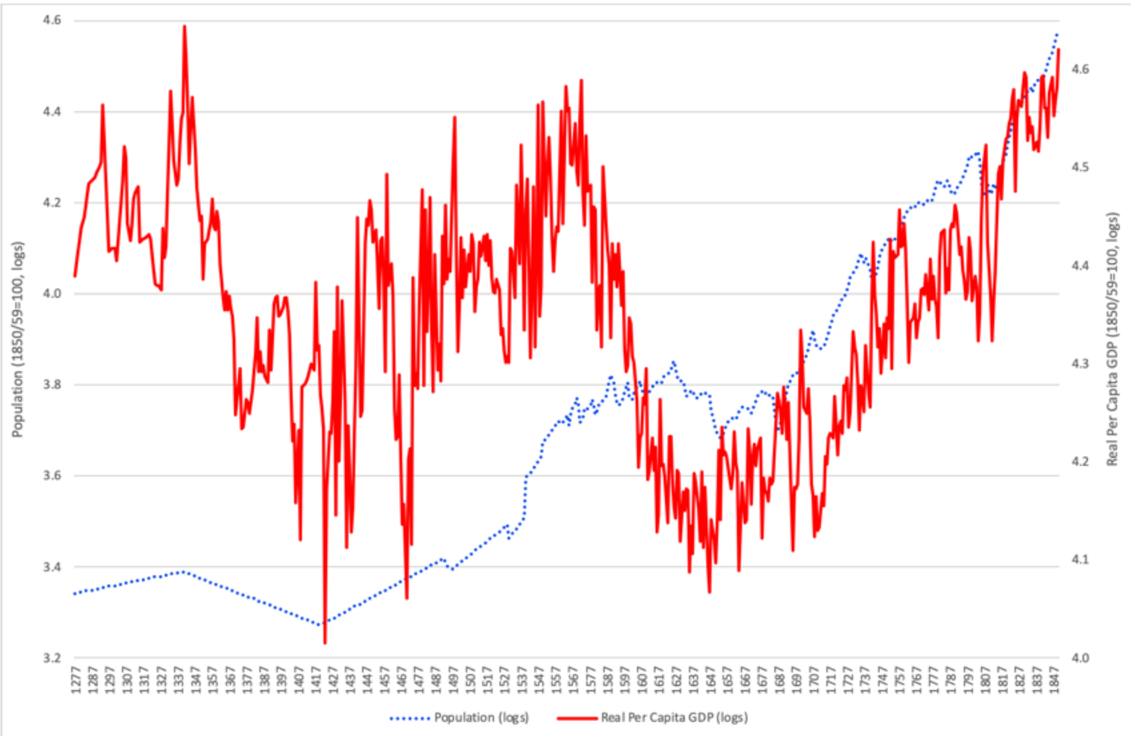

Figure 18. Was Preindustrial Spain a Malthusian Economy: GDP per Head and Population, 1277-1850 (1850/9=100) (logs)
Sources: See the text

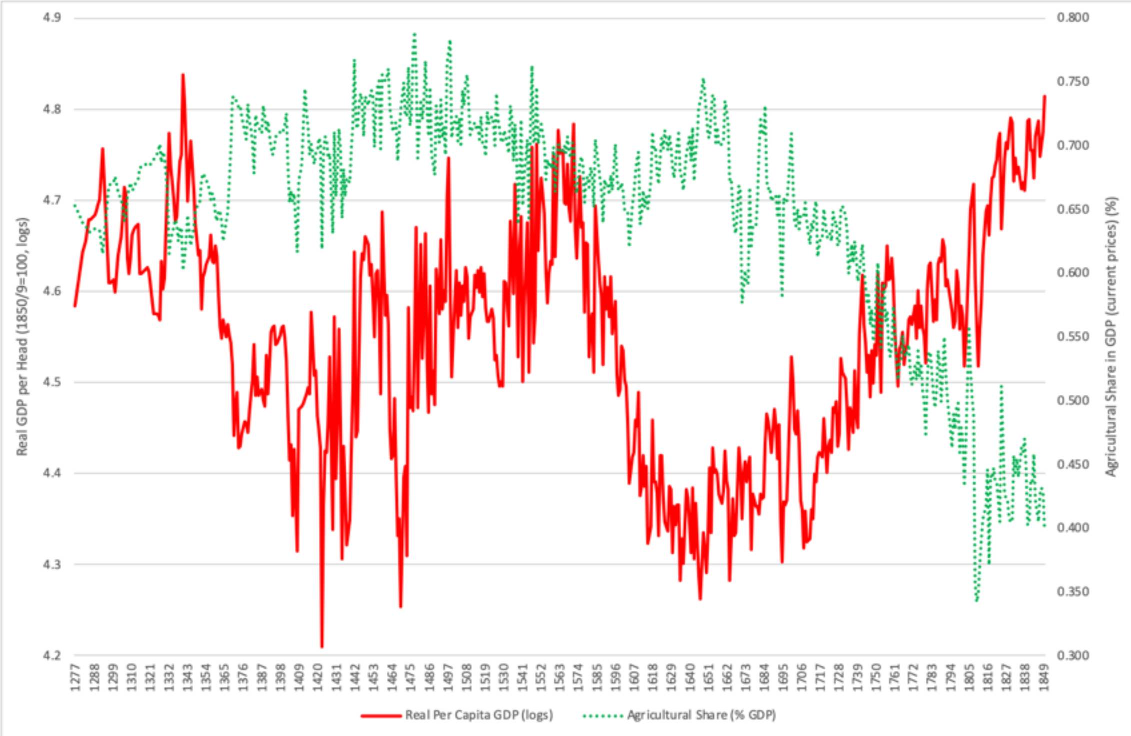

Figure 19. Real GDP per Head (1850/9=100) (logs) and Agriculture's Share in GDP (current prices) (%), 1277-1850.
Sources: See the text

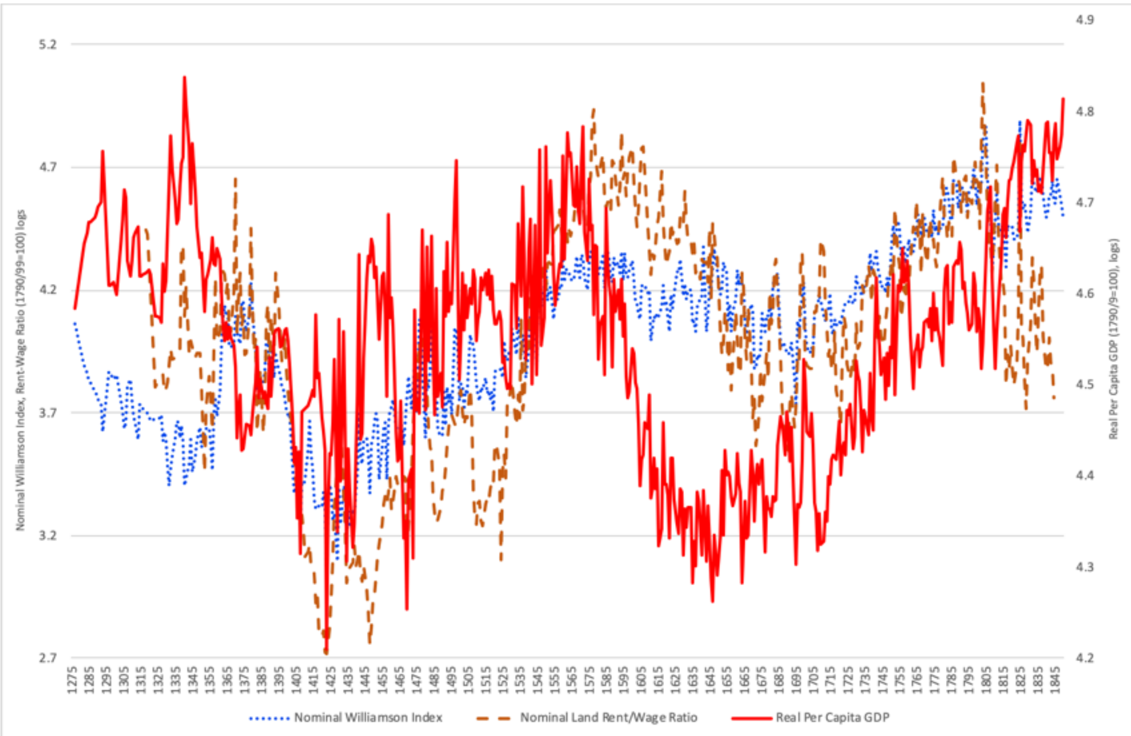

Figure 20. Inequality and Real GDP per Head , 1277-1850 (Nominal Williamson Index and Rent-Wage Ratio 1790/99=100) (logs)
Sources: See the text

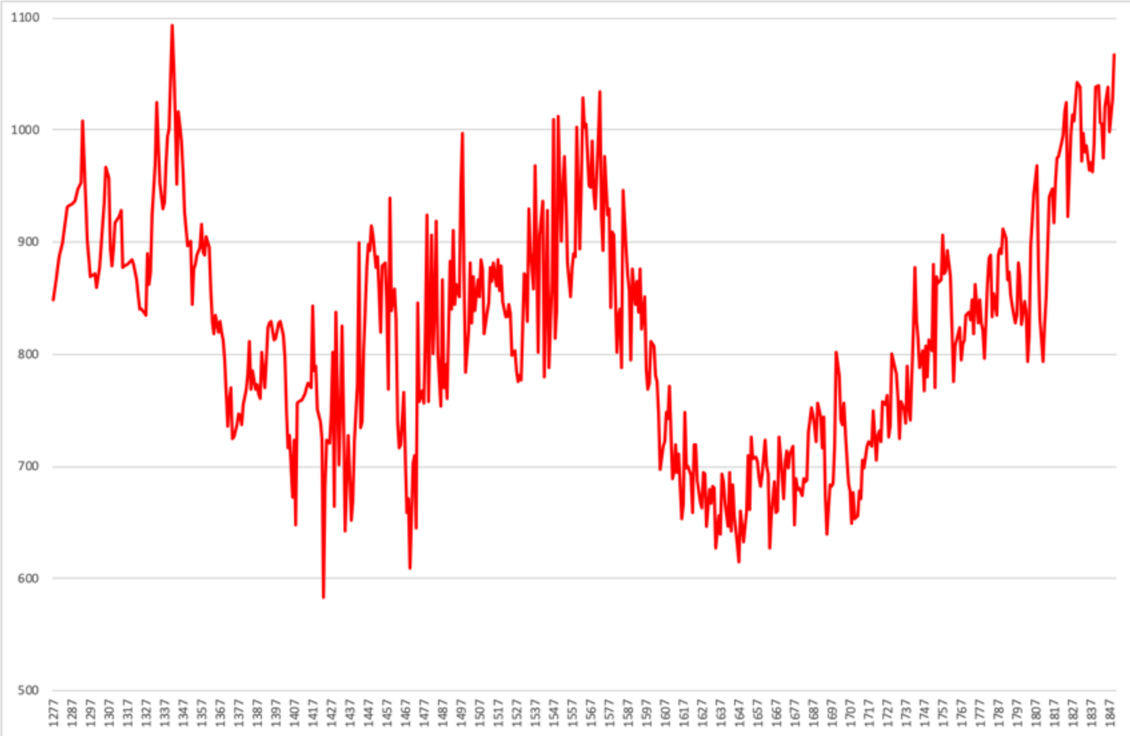

Figure 21. Real Per Capita GDP, 1277-1850 (Geary-Khamis $1990 (logs).

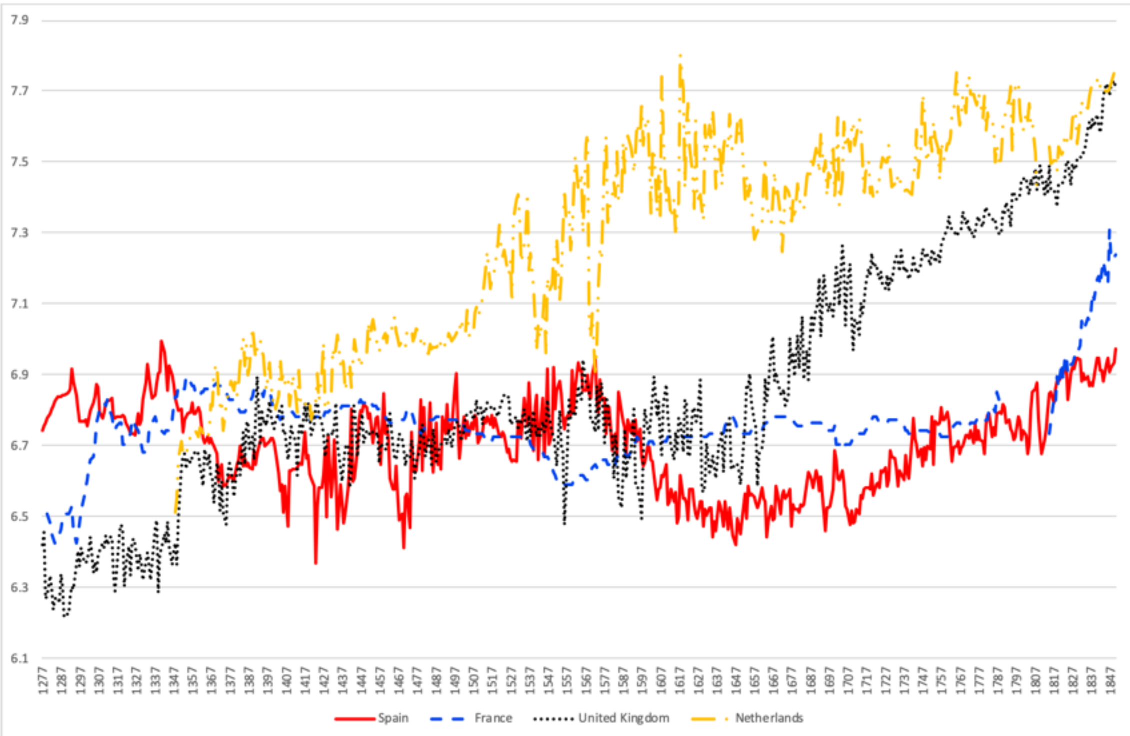

Figure 22. Real Per Capita GDP , 1270-1850: Spain in Western European Perspective (G-K $1990) (logs)
Sources: Spain, see the text; France, Ridolfi (2016); Netherlands, van Zanden and van Leeuwen (2012); United Kingdom, Broadberry et al. (2015).

Data Appendix

	Agriculture Output (1850/9=100)	Urban Pop. (1850/9=100)	Output (1850/9=100)	Population (1850/9=100)	Output per Head (1850/9=100)	Per Capita GDP (G-K $1990)
1277	40	11	23	28	81	848
1278	41	11	23	28	82	858
1279	42	11	23	28	83	868
1280	42	11	24	28	84	879
1281	43	11	24	28	85	889
1282	44	11	24	28	86	899
1283	45	11	25	28	87	910
1284	46	11	25	28	88	921
1285	46	11	25	28	89	931
1286	47	11	25	28	89	933
1287	47	11	25	28	89	934
1288	47	11	25	29	89	935
1289	47	11	25	29	89	937
1290	47	11	26	29	90	942
1291	48	11	26	29	90	947
1292	48	11	26	29	91	952
1293	53	11	27	29	96	1008
1294	50	11	26	29	92	972
1295	47	11	26	29	89	937
1296	45	11	25	29	86	903
1297	42	11	24	29	83	869
1298	42	11	24	29	83	870
1299	42	11	24	29	83	871
1300	42	11	24	29	83	872
1301	42	12	24	29	82	860
1302	43	12	24	29	83	878
1303	44	12	25	29	85	896
1304	46	12	25	29	87	915
1305	47	12	26	29	89	935
1306	50	12	27	29	92	966
1307	49	12	26	29	91	957
1308	44	12	25	29	85	893
1309	43	12	24	29	84	878
1310	44	12	25	29	85	893
1311	46	12	25	29	87	917
1312	46	12	25	29	88	922
1313	47	12	26	29	88	925
1314	47	12	26	29	88	928
1315	43	12	24	29	83	878

1316	43	12	24	29	84	879
1317	43	12	24	29	84	880
1318	44	12	24	29	84	882
1319	44	12	25	29	84	883
1320	44	12	25	29	84	884
1321	44	12	24	29	84	880
1322	43	12	24	29	82	866
1323	42	12	24	29	81	853
1324	41	12	23	29	80	840
1325	41	12	23	29	80	840
1326	41	12	23	29	80	839
1327	40	12	23	29	79	835
1328	44	12	25	29	85	890
1329	42	12	24	29	82	863
1330	43	12	24	29	83	874
1331	47	12	26	29	88	923
1332	51	12	27	29	92	970
1333	55	12	29	30	97	1024
1334	52	12	28	30	94	989
1335	49	12	27	30	91	954
1336	47	12	26	30	88	930
1337	48	12	26	30	89	935
1338	51	12	27	30	92	969
1339	53	12	28	30	95	995
1340	53	12	28	30	95	1000
1341	61	12	31	30	104	1093
1342	58	12	30	30	101	1059
1343	54	12	28	30	96	1011
1344	49	12	27	29	90	951
1345	55	12	28	29	97	1016
1346	52	12	28	29	94	990
1347	50	12	27	29	92	964
1348	47	12	26	29	88	927
1349	46	12	25	29	87	911
1350	45	12	25	29	85	896
1351	45	11	25	29	86	901
1352	41	11	23	29	80	845
1353	43	11	24	29	83	875
1354	44	11	24	29	84	880
1355	44	11	24	29	84	888
1356	45	11	25	29	85	895
1357	46	11	25	29	87	916
1358	44	11	24	29	85	891

1359	44	11	24	29	85	889
1360	45	11	25	29	86	905
1361	45	11	24	29	85	895
1362	42	11	23	29	82	858
1363	40	11	23	29	79	829
1364	39	11	22	29	78	818
1365	40	11	23	29	79	834
1366	39	11	22	29	78	819
1367	40	11	22	29	79	830
1368	39	11	22	28	78	820
1369	39	11	22	28	77	813
1370	37	11	21	28	76	794
1371	34	11	20	28	70	735
1372	35	11	20	28	72	759
1373	36	11	21	28	73	771
1374	33	10	19	28	69	725
1375	33	10	19	28	69	726
1376	34	10	20	28	70	737
1377	34	10	20	28	71	747
1378	34	10	20	28	71	745
1379	34	10	20	28	70	737
1380	35	10	20	28	72	755
1381	36	10	20	28	73	769
1382	36	10	21	28	74	782
1383	38	10	21	28	77	812
1384	35	10	20	28	73	768
1385	37	10	21	28	75	785
1386	35	10	20	28	73	768
1387	36	10	20	28	74	773
1388	35	10	20	28	73	765
1389	35	10	20	28	72	760
1390	38	10	21	28	76	802
1391	35	10	20	28	73	770
1392	37	10	21	27	76	795
1393	39	10	21	27	78	824
1394	39	10	22	27	79	828
1395	39	10	22	27	79	830
1396	38	10	21	27	77	813
1397	38	10	21	27	77	814
1398	39	9	21	27	78	821
1399	39	9	21	27	79	828
1400	39	9	21	27	79	829
1401	38	9	21	27	78	817

1402	37	9	21	27	76	798
1403	34	9	19	27	71	751
1404	32	9	18	27	68	716
1405	33	9	19	27	69	728
1406	29	9	17	27	64	673
1407	32	9	19	27	69	724
1408	27	9	17	27	62	648
1409	34	9	19	27	72	757
1410	35	9	19	27	72	758
1411	35	9	19	27	72	759
1412	35	9	19	27	72	762
1413	35	9	19	27	73	765
1414	35	9	19	27	73	770
1415	36	9	20	27	74	775
1416	35	9	19	27	73	770
1417	40	9	21	26	80	842
1418	36	9	20	26	75	785
1419	36	9	20	26	75	789
1420	34	9	19	26	71	751
1421	33	9	19	26	70	741
1422	32	9	18	26	69	725
1423	23	9	15	27	55	583
1424	30	9	17	27	65	681
1425	32	9	18	27	69	723
1426	32	9	18	27	69	721
1427	34	9	19	27	71	746
1428	37	9	20	27	76	801
1429	28	9	17	27	63	664
1430	40	9	21	27	80	838
1431	31	9	18	27	67	702
1432	34	9	19	27	71	745
1433	39	9	21	27	79	826
1434	34	9	19	27	71	746
1435	27	9	17	27	61	642
1436	33	9	19	27	69	727
1437	31	9	18	27	66	695
1438	28	9	17	27	62	652
1439	29	9	17	27	64	670
1440	33	9	19	27	69	722
1441	36	9	20	28	74	774
1442	44	10	24	28	86	900
1443	34	10	19	28	70	734
1444	34	10	19	28	70	739

1445	38	10	21	28	76	803
1446	43	10	23	28	83	876
1447	44	10	24	28	85	898
1448	44	10	24	28	85	892
1449	46	10	24	28	87	914
1450	45	10	24	28	86	906
1451	43	10	23	28	83	877
1452	44	10	24	28	84	887
1453	42	10	23	28	81	856
1454	40	10	22	28	78	820
1455	44	10	24	28	84	879
1456	44	10	24	28	84	881
1457	41	10	23	28	80	843
1458	36	10	21	28	73	769
1459	48	10	26	29	89	940
1460	41	10	23	29	80	839
1461	43	10	23	29	82	858
1462	41	10	23	29	79	830
1463	35	10	20	29	70	740
1464	34	10	20	29	68	717
1465	34	10	20	29	68	720
1466	37	11	21	29	73	766
1467	33	11	19	29	67	706
1468	30	11	18	29	63	658
1469	31	11	19	29	64	671
1470	27	11	17	29	58	610
1471	33	11	20	29	67	703
1472	33	11	20	29	68	710
1473	29	11	18	29	61	645
1474	42	11	24	29	80	846
1475	36	11	21	29	72	758
1476	37	11	22	30	73	767
1477	36	11	21	30	72	756
1478	40	11	23	30	78	821
1479	47	11	26	30	88	924
1480	36	11	21	30	72	758
1481	46	11	26	30	86	907
1482	39	11	23	30	76	800
1483	42	11	24	30	80	842
1484	47	11	26	30	87	919
1485	39	11	23	30	76	801
1486	36	11	22	30	72	754
1487	44	12	25	30	82	867

1488	37	12	22	30	73	769
1489	39	12	23	30	75	790
1490	37	12	22	30	72	761
1491	45	12	26	30	84	883
1492	42	12	24	31	80	840
1493	47	12	26	30	87	911
1494	42	12	24	30	80	844
1495	43	12	25	30	82	862
1496	42	12	24	30	81	852
1497	49	12	27	30	91	953
1498	52	12	28	30	95	997
1499	44	12	25	30	83	868
1500	38	12	22	30	75	784
1501	41	12	24	30	78	821
1502	45	12	25	30	84	881
1503	42	12	24	30	79	828
1504	45	12	25	30	83	870
1505	43	12	24	31	80	838
1506	45	12	25	31	82	866
1507	44	12	25	31	81	851
1508	46	12	26	31	84	885
1509	46	12	26	31	83	876
1510	42	12	24	31	78	818
1511	43	12	25	31	80	838
1512	44	12	25	31	80	845
1513	46	12	26	31	83	877
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1515	47	13	26	31	84	882
1516	45	13	26	32	82	861
1517	47	13	27	32	84	885
1518	45	13	26	32	81	856
1519	47	13	27	32	84	878
1520	44	13	26	32	80	846
1521	44	13	25	32	79	834
1522	44	13	25	32	79	833
1523	45	13	26	32	80	845
1524	44	13	26	32	79	836
1525	41	13	25	32	76	799
1526	42	14	25	33	76	803
1527	41	14	24	33	75	785
1528	40	14	24	33	74	776
1529	40	14	24	33	74	781
1530	39	13	24	32	74	776

1531	46	14	27	32	83	871
1532	46	14	27	32	83	869
1533	43	14	26	32	79	829
1534	50	14	29	33	88	930
1535	47	15	28	33	85	892
1536	45	15	27	33	82	859
1537	53	15	30	33	92	969
1538	48	15	28	33	85	896
1539	40	16	25	33	76	802
1540	53	17	31	36	86	906
1541	55	17	33	37	89	936
1542	42	18	27	37	74	780
1543	48	18	30	37	81	848
1544	55	18	33	37	88	929
1545	43	19	28	37	75	788
1546	49	19	31	38	82	865
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1549	47	20	30	38	80	839
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1551	54	21	34	40	86	901
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1554	57	22	36	40	89	938
1555	52	23	34	40	84	881
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1559	52	24	35	41	84	887
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1562	58	25	38	41	91	958
1563	65	25	41	42	98	1029
1564	63	25	40	42	95	1002
1565	61	25	39	41	96	1006
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1567	58	26	38	42	90	948
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1569	59	27	39	43	90	943
1570	57	26	38	43	88	930
1571	60	25	39	41	94	994
1572	64	25	41	41	98	1034
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1574	53	26	36	42	85	893
1575	60	26	39	42	93	977
1576	56	26	37	42	88	924
1577	56	27	38	43	88	929
1578	49	27	35	43	80	842
1579	55	27	37	43	86	909
1580	53	26	36	42	86	907
1581	45	26	32	42	76	802
1582	48	27	34	43	79	833
1583	48	27	34	43	80	840
1584	44	27	32	43	75	788
1585	58	27	39	43	90	946
1586	54	28	37	43	85	892
1587	53	28	37	44	83	870
1588	52	29	37	45	81	856
1589	47	29	34	46	76	795
1590	54	29	38	45	83	875
1591	51	29	36	45	80	845
1592	51	28	36	44	82	865
1593	48	27	34	43	80	838
1594	52	27	35	43	83	875
1595	48	27	34	43	78	822
1596	51	27	35	43	81	852
1597	46	27	33	44	75	787
1598	45	27	32	44	73	768
1599	46	27	33	45	74	774
1600	48	26	34	43	77	812
1601	48	25	33	43	77	807
1602	46	25	32	43	74	781
1603	46	25	32	44	74	776
1604	44	25	32	44	71	746
1605	40	25	30	45	66	698
1606	43	25	31	45	68	718
1607	42	24	30	44	69	722
1608	45	24	31	44	71	748
1609	45	24	31	44	71	743
1610	47	24	32	44	73	771
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1612	41	23	29	44	66	695
1613	44	23	30	44	68	719
1614	42	23	30	45	66	695
1615	44	23	30	45	68	711
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1618	48	22	32	45	71	748
1619	43	22	30	45	66	699
1620	44	22	30	45	67	699
1621	44	22	30	46	66	691
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1624	48	22	32	46	68	719
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1626	44	22	30	47	64	669
1627	43	21	29	46	63	662
1628	45	21	30	46	66	695
1629	45	20	30	45	66	693
1630	41	20	28	45	61	646
1631	44	20	29	45	65	680
1632	42	19	28	44	63	667
1633	43	19	28	44	65	682
1634	43	19	28	44	65	681
1635	39	19	26	44	60	627
1636	42	19	28	44	62	657
1637	40	18	27	44	61	639
1638	45	18	29	44	66	693
1639	45	18	28	43	65	686
1640	43	18	28	43	63	667
1641	42	18	27	44	61	646
1642	46	17	29	44	66	694
1643	42	17	27	44	61	643
1644	46	17	29	44	65	683
1645	43	17	27	44	62	657
1646	41	17	26	44	60	631
1647	40	17	26	44	58	614
1648	42	16	27	42	63	661
1649	40	16	25	41	62	647
1650	38	16	24	40	60	632
1651	40	16	25	40	63	660
1652	44	15	27	40	67	709
1653	40	15	25	40	63	661
1654	45	15	28	40	69	726
1655	44	16	27	40	67	706
1656	44	16	27	41	67	708
1657	45	16	27	41	67	705
1658	44	16	27	41	66	690
1659	43	16	27	41	65	682

1660	44	16	27	42	66	692
1661	47	16	29	41	69	723
1662	45	16	28	41	67	700
1663	44	16	28	42	66	693
1664	38	17	25	42	60	627
1665	41	17	26	42	62	656
1666	44	17	28	43	65	686
1667	42	17	27	43	63	659
1668	42	17	27	42	63	661
1669	48	17	29	42	69	726
1670	46	17	28	42	68	710
1671	42	17	27	42	64	671
1672	46	17	28	42	67	705
1673	47	17	29	43	68	714
1674	46	17	29	43	66	699
1675	48	18	29	44	68	710
1676	49	18	30	44	68	718
1677	42	18	27	44	62	648
1678	46	18	29	44	66	689
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1682	45	18	29	44	66	689
1683	45	18	28	44	65	686
1684	45	18	28	44	65	687
1685	46	17	28	41	69	730
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1687	47	17	29	41	71	746
1688	47	17	29	41	70	736
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1690	50	18	30	42	72	756
1691	50	18	31	43	71	743
1692	48	18	30	44	68	717
1693	51	19	32	45	71	745
1694	44	19	29	45	64	672
1695	41	19	28	46	61	640
1696	46	19	30	46	65	683
1697	45	19	30	46	65	682
1698	46	19	30	46	65	685
1699	50	19	32	46	68	718
1700	58	19	35	46	76	802
1701	56	20	35	46	74	781
1702	52	20	33	47	70	741

1703	53	20	33	48	70	737
1704	56	21	35	48	72	756
1705	53	21	34	49	69	730
1706	49	21	32	50	65	685
1707	49	21	32	50	64	678
1708	45	21	31	49	62	650
1709	47	21	31	49	64	676
1710	44	21	30	49	62	654
1711	44	21	30	48	62	656
1712	47	21	31	48	65	678
1713	46	21	31	49	64	671
1714	50	21	33	49	67	705
1715	50	21	33	50	66	699
1716	52	22	34	50	68	718
1717	54	22	35	51	69	722
1718	54	23	35	51	68	720
1719	54	23	35	52	68	718
1720	58	23	37	52	71	749
1721	52	24	35	53	67	706
1722	55	24	37	53	69	727
1723	56	25	37	54	70	731
1724	55	25	37	54	69	722
1725	59	25	39	54	72	757
1726	59	26	39	54	72	754
1727	60	26	40	55	73	764
1728	56	27	38	56	69	726
1729	58	28	40	56	70	736
1730	66	28	43	57	76	801
1731	64	29	43	57	75	788
1732	64	29	43	58	74	782
1733	61	30	42	58	72	760
1734	57	30	41	59	69	724
1735	62	31	43	60	72	757
1736	60	31	42	59	71	751
1737	57	31	41	59	70	738
1738	64	31	44	59	75	790
1739	58	31	42	58	72	752
1740	56	31	41	57	71	741
1741	64	31	44	56	78	821
1742	71	31	47	56	83	877
1743	65	31	45	56	79	831
1744	63	32	44	57	77	814
1745	60	33	43	58	75	788

1746	63	34	45	59	76	803
1747	58	35	44	60	73	767
1748	64	35	46	60	77	807
1749	60	36	45	61	74	779
1750	65	37	47	61	77	812
1751	63	37	47	62	76	803
1752	73	37	52	62	84	880
1753	57	37	45	61	73	771
1754	71	38	51	61	83	869
1755	70	38	51	62	82	864
1756	70	38	51	62	82	866
1757	77	39	54	62	86	906
1758	72	40	52	63	83	872
1759	73	41	53	64	83	874
1760	76	41	55	64	85	893
1761	73	42	54	65	83	869
1762	66	42	51	65	78	824
1763	59	43	49	66	74	776
1764	64	43	51	66	77	808
1765	64	44	51	66	77	812
1766	65	44	52	66	78	823
1767	61	44	50	66	76	796
1768	63	45	51	67	77	809
1769	63	45	51	67	77	813
1770	66	46	53	67	79	835
1771	66	46	53	66	80	837
1772	65	46	52	66	79	831
1773	67	47	54	67	81	848
1774	62	47	52	67	78	818
1775	68	47	55	67	82	862
1776	63	48	53	67	79	828
1777	66	48	55	68	81	848
1778	64	49	54	69	79	827
1779	63	50	54	69	78	821
1780	59	51	53	70	76	796
1781	69	51	57	70	82	864
1782	72	51	58	69	84	885
1783	71	51	58	69	84	888
1784	63	52	55	70	79	833
1785	66	53	57	70	81	854
1786	63	53	55	70	79	835
1787	69	52	58	69	84	888
1788	69	52	58	68	85	894

1789	68	53	58	68	85	890
1790	71	53	59	68	87	911
1791	71	53	59	69	86	903
1792	65	54	57	69	82	866
1793	67	55	58	70	83	873
1794	64	55	57	70	81	853
1795	63	56	57	71	80	843
1796	61	57	56	72	79	828
1797	62	58	58	72	79	834
1798	70	59	62	74	84	881
1799	68	59	61	73	83	869
1800	61	59	58	74	79	826
1801	64	60	60	74	81	847
1802	63	60	59	75	80	838
1803	55	61	56	74	75	793
1804	58	60	57	73	78	816
1805	66	57	59	70	85	896
1806	70	56	61	68	90	943
1807	72	56	62	68	91	955
1808	74	57	63	69	92	968
1809	59	58	58	69	83	877
1810	49	57	54	68	79	831
1811	43	57	52	68	75	793
1812	49	59	55	70	79	826
1813	52	58	56	69	81	852
1814	58	59	59	69	85	896
1815	66	59	62	70	89	940
1816	68	61	64	71	90	947
1817	63	62	63	72	87	917
1818	70	63	66	73	91	953
1819	75	64	69	74	93	975
1820	76	66	70	76	93	976
1821	79	67	72	77	94	989
1822	81	69	74	78	95	995
1823	86	70	77	79	97	1016
1824	88	71	78	80	97	1024
1825	71	72	71	81	88	923
1826	83	73	77	82	95	995
1827	88	74	80	83	96	1013
1828	86	75	79	83	96	1007
1829	90	75	81	84	98	1026
1830	94	76	83	84	99	1042
1831	93	77	83	85	99	1038

1832	80	78	79	85	92	973
1833	84	78	81	85	95	996
1834	81	79	80	86	93	981
1835	81	79	80	85	94	986
1836	78	80	79	86	92	964
1837	80	81	80	87	92	971
1838	78	81	80	87	92	963
1839	81	81	81	87	94	987
1840	91	82	86	87	99	1038
1841	92	83	86	87	99	1040
1842	85	84	84	88	96	1006
1843	86	85	85	89	96	1006
1844	81	87	84	91	93	975
1845	90	88	89	91	97	1021
1846	94	89	91	93	99	1038
1847	87	91	89	94	95	998
1848	90	93	92	95	96	1013
1849	94	94	94	96	98	1027
1850	104	95	99	97	102	1067

Appendix 1 Computing Agricultural Output Indices from Tithes

Unlike most studies we have chosen national rather than a regional or local approach. Thus, aggregates for main crops have been constructed on the basis of an extensive dataset of tithe series at regional and local levels. We have been able to gather tithe records from as early as the fourteenth century.[34]

The choice of a procedure to aggregate multiple series into homogenous and continuous series was a key decision.[35] When the sources made it possible, our favoured approach has been working on the series at a local level. The first step has been establishing whether the series are complete on an annual basis. In most of the cases we found gaps in the records that ranged from just one year to longer periods of time. The way in which we have dealt with missing values depended on the amount of information lost and on the availability of sources. If the number of missing observations was small, we derived them by extrapolating the results from series in the same region that presented a similar behaviour due to analogous climatic and soil conditions. In order to obtain the best estimation, we used as proxy the series that were geographically close to the one to be estimated. Missing years were interpolated using the available series that showed a higher correlation in the years around the missing values.[36] In our opinion, when the amount of years to be estimated was manageable, this procedure offers the most reliable way to filling the gaps in the series and provides the best possible estimations.

If the number of missing values was large or the existence of alternative local series scarce, we have relied on alternative methods. In these cases, we filled the missing values using the average weight that the local series to be estimated did represent in the aggregate provincial sample.[37] However, we were aware of the fact that the weights of the series within the sample changed over time and, therefore, that we had to make adjustments to calculate missing years in the same location that were separated by long periods of time. For that reason we decided to re-calculate the weight of the municipality around each gap. The periods used to estimate the weights therefore varied within the same municipality depending on the years that had to be

[34] Given the lack of consistent data no adjustment has been made for crops partially or totally exempt from paying the tithe (i.e., "Excusado" and "diezmos privativos") as it would have required applying an arbitrary correction. Moreover, until 1761, "Excusado" was collected through a distribution of a yearly lump-sum payment among bishops and other ecclesiastical institutions, and such distribution was estimated using tithes.

[35] We considered that an advanced statistical manipulation of the original series would imply loosing important information about local trends that would be diluted into the aggregate figures while rendering the resulting series useless for econometric treatment.

[36] When we found missing values, we interpolated them using other tithe series in the same region that presented a high correlation with the incomplete one. However, our experience shows that series that presented high correlations in the very long run do not have to necessarily have high correlations in the short term. For that reason we estimated the correlation of the incomplete series with the complete ones around the missing years and not for the whole sample. For instance, if for the same region we had several series between 1500 and 1800 but one of them had missing values between 1550-1555, we proxied those missing values using the most similar series in the region around that period (1530-1580 for example) and not for the whole 300 years.

[37] For example, if we had a study with ten local series and the one with the missing years represented a 20 per cent of the total production, we used that percentage to estimate the gaps from the information contained in the other nine.

estimated, a fact that adds robustness to our estimation. Once we had estimated the missing years for all the local series, we simply aggregated them in order to generate the provincial series. When local series from different authors for the same province and period were available, we used the overlapping periods in order to splice them and derive a single series. We also followed the same process in those cases in which the series came from the same source but different local series were available for different periods of time, and we spliced them through on the basis of the overlapping years.

As a result of a long and detailed process we derived series at provincial or regional level that were, then, combined in order to obtain national aggregates for the main crops: cereals, wine, olive oil, legumes, fruit, and animal produce (including wool and silk).

It is for cereals for which the availability of data is wider over space and time with different series covering Andalusia (three out of four provinces, Seville –which included also Cadiz and Huelva-, Cordoba, and Granada, which included Malaga), Extremadura, Murcia, New Castile, Old Castile-Leon (including Burgos –which also included Rioja and Santander-, Leon –which included Asturias-, Palencia, Segovia, Soria, Valladolid, and Zamora), Galicia, Basque Provinces, and the Canaries, within the Kingdom of Castile; plus Aragon, Balearics, Catalonia, and Valencia, in the Kingdom of Aragon; plus the Kingdom of Navarre.

As for wine, tithes information was restricted to Andalusia (Seville, Cadiz, Huelva, and Cordoba), Murcia, Old Castile (Rioja, Segovia, and Santander), Basque, Navarre, Aragon, and Catalonia). These regions represented, nonetheless, the main producing areas.

In the case of olive oil information only related to Andalusia (Seville and Cordoba), Extremadura, Balearics, Catalonia, and Navarre. Again, these were the main producers in early modern Spain.

Information about tithes on legumes and fruit is scant and we only managed to get tithes for Balearics and Catalonia, Valencia, and Navarre. These areas represent, nonetheless, above 40 per cent of the value of production in the 1799 Census.

In the case of animal produce, tithes for livestock and wool, are available for Old Castile (Segovia and Soria), Extremadura, Murcia, Navarre, Aragon, and Valencia.

In all cases, we had to interpolate missing values with the help of the geographically closer series. We then constructed regional series by assuming that series for missing provinces evolve alongside those for which data were available. Alternatively, missing values for odd years were log-linearly interpolated.

Weighting provincial series for each crop poses a major challenge. The 1799 *Census of Fruits and Manufactures* provides the only available estimate of quantities and values of agricultural and industrial goods for early modern Spain. It has a poor reputation largely due to Josep Fontana's (1967) severe critique. Nonetheless, Fontana largely exonerated cereal production from his criticism and suggested a correction for olive oil output. Unfortunately there is no alternative to the 1799 Census. A possibility would be to derive weights from the highly reputed Cadastre of Ensenada for the 1750s, but only covers the Kingdom of Castile, leaving aside the Kingdom of Aragon (including Aragon, Balearics, Catalonia, and Valencia) and the Kingdom of Navarre. Furthermore, no distinction is made in the Cadastre's "respuestas generales" (aggregate results) by crops, only between crops and animal produce (Matilla Tascón, 1947; Grupo ’75, 1977).

We have re-computed the value of total output for the 1799 benchmark by, firstly, correcting olive oil production, as suggested by Fontana (1967); then, valuing each crop at a single price derived as the weighted average of provincial prices. Using a single set of prices helps to correct for the risk of spurious provincial prices (as pointed out by Fontana), while provides us with consistent estimates. Furthermore, it implies a purchasing power parity adjustment across Spanish provinces. The value of agricultural output c. 1799 resulted from aggregating the value of each crop obtained by multiplying its quantity by the average national price. We used, then, provincial (regional) shares in the value of each main crop in 1799 as weights to construct national volume indices for each of them, expressed using 1790/99 as 100.

The valuation of livestock output in the 1799 Census raises a problem as the livestock total (number of different type of cattle) is mixed with animal produce (i.e., wool). The total value of animal output should then be reduced, in principle, to offset this exaggeration. However, livestock figures are grossly underestimated in the 1799 Census. The data from the 1750s Cadastre of Ensenada for the Kingdom of Castile roughly doubles the 1799 Census figures for the Castilian provinces (García Sanz, 1985, 1994). Since there no evidence of a major decline in Castilian livestock during the late eighteenth century exists, such a discrepancy evidences under-reporting in the 1799 Census.[38]

[38] It is worth noting that the share of animal produce in agricultural final output was 25.3% in 1890 and 29.3% in 1909/13 (Prados de la Escosura, 2017: 69). Given the expansion of crops, largely at the expense of livestock, throughout the nineteenth century, a share of 31 per cent for animal produce in 1799 does seem reasonable, so we have accepted it. Agricultural historians coincide in pointing to a decline in livestock output simultaneous to a rise in crop output over the late 19th century. See GEHR (1978/79).

Appendix C. Sources and procedures

KINGDOM (Years)		
MAIN REGION (Years)		
Sub Region (Years)		
Years	Source	Location

CEREALS

KINGDOM OF ARAGON (1466-1835)		
ARAGON (1610-1827)		
1610-1827	Latorre Ciria (2007)	
BALEARIC ISLANDS (1466-1819)		
1466-1819	Vidal (1978)	
CATALONIA (1508-1835)		
1508-1601	Dantí I Riu (1987)	Palaudaries
1602-1658	Dantí I Riu (1987) Serra (1988)	Palaudaries and Sentmena
1658-1729	Serra i Puig (1978)	Sentmenat
1730-1756	Badosa i Coll (1978)	Sans-Mataró
1756-1835	Fradera (1978)	Mataró
VALENCIA (1501-1835)		
1501-1565	Casey (1979)	
1566-1700	Casey (1979) Ardit Lucas (1987) Palop Ramos (1982)	
1701-1835	Ardit Lucas (1987) Palop Ramos (1982)	

NAVARRE (1569-1840)		
1569-1634	Belascoain Cemborain (2011)	
1693-1840	Garde Garde (2016)	

KINGDOM OF CASTILE (1402-1839)		
ANDALUSIA (1408-1839)		
Seville (1408-1836)		
1408-1503	Ladero Quesada (1979)	Archbishopric of Seville
1469-1503	Ladero Quesada (1979)	Seville, Carmona, Jerez and Niebla
1515-1579	Ponsot (1986)[39]	Albaida Alcala del Rio, Cazalla de la Sierra, Coria, Marchena and Mairena del Alcor, los Molares, la Campana, Moron, Osuna and Utrera
1580-1605	Ponsot (1986)	Albaida, Alcala del Rio, Cazalla de la Sierra, Coria, Marchena, Mairena del Alcor, Los Molares, La Campana, Moron, Osuna, Utrera, Seville and Carmona
1606-1836	Ponsot (1986)	Montemayor
Cadiz (1493-1835)		
1493-1835	Ponsot (1986	Conil, Jerez, Chiclana, Vejer, Medina Sidonia and Trebujena

[39] We used series for Cadiz and Huelva from Ladero Quesada (1979) that overlap with the Seville series to splicing the pre-1503 and post-1515 series.

Huelva (1451-1835)		
1451-1490	González Gomez (1980)	Trigueros
1490-1605	Ponsot (1986)	Niebla, Aljaraque, Almonte, Hinojosos, Moguer, Aracena and la Palma
1606-1800	Ponsot (1986)	Niebla, Aljaraque, Almonte, Hinojosos
1800-1835	Ponsot (1986)	Niebla, Hinojosos
Cordoba (1580-1837)		
1580-1837	Ponsot (1986)	Baena, Bujalance, Cabra, Castro y Espejo, Espiel, Fernan Nuñez, Montoro, Palma del Rio, Posadas, la Rambla, Santaella and Cordoba
Granada (1690-1839)		
1690-1839	Garzon Pareja (1974, 1982)	
Malaga (1555-1800)		
1555-1800	Benitez Sanchez-Blanco (1982)	Cartama, Borge, Setenil, Antequera, Marbella and Casares.
EXTREMADURA (1500-1813)		
1500-1599	Pereira Iglesias (1990) [40]	Caceres
1739-1744	Llopis Agelán (1979)	Cortijo de San Isidro
1745-1781	Llopis Agelán (1979)	Casa de Madrigalejo, Casa de la Burquilla, Casa de la Vega, and Casa del Rincon
1782-1788	Llopis Agelán (1979)	Casa de la Vega and Casa del Rincon
1744-1764	Rodriguez Cancho et al. (2004)	Plasencia
1797-1813	Rodriguez Cancho et al. (2004)	Plasencia
CANARY ISLANDS(1613-1819)		
1613-1819	Macias Hernandez (1984)	Arucas, Teror, Telde, Matanza, Realejos, Icod, Arico, Tirajana, and Fuerteventura
MURCIA (1580-1836)		
1580-1836	Lemeunier (1982)	
NEW CASTILE (1463-1800)		
1463-1699	López-Salazar Perez and Martín Galán (1981)	Alcala de Henares, Alcaraz, Alcolea de Torote, Brihuega, Buitrago, Calatrava, Canales, Escalona, Guadalajara, La Guardia, Hita, Illescas, Madrid, Montalban, Ocaña, Rodillas, Santa Olalla y Maqueda, Talamanca, Talavera de la Reina, La Puebla de Alcocer, Zorita de los Canes, and Almoguera
1700-1800	Santiago-Caballero (2014)	Guadalajara
OLD CASTILE (1402-1837)		
Burgos (1402-1800)		
1402-1520	Casado Alonso (1991)	
1590-1800	Hernández García and Pérez Romero (2008) [41]	
La Rioja (1550-1819)		
1550-1819	Ibañez Rodriguez and Alonso Castrobiejo (1996)	
Santander (1607-1805)		
1607-1805	Lanza García (1991)	Rozas, Piasca, San Mames de Meruelo, Abionzo, and Gajano
Leon (1569-1835)		
1569-1835	Sebastian Amarilla (1992)	Monastery of Sandoval
Palencia and Valladolid (1550-1800)		

[40] Tithes paid in cash that were deflated.

[41] Tithes paid in cash that were deflated.

1550-1800	García and Pérez Romero (2008) [42]	
Salamanca (1701-1778)[43]		
1701-1778	Garcia Figuerola (1986)	
Segovia (1550-1814)		
1550-1800	García and Pérez Romero (2008) [44]	
1800-1814	Garcia Sanz (1977)	
Soria (1550-1837)		
1550-1800	García and Pérez Romero (2008) [45]	
1800-1837	Andrés Gallego (1973)	
Zamora (1523-1803)		
1523-1803	Álvarez Vázquez (1984)	
BASQUE PROVINCES (1537-1829)		
1537-1829	Bilbao Bilbao and Fernandez de Pinedo (1984)	
GALICIA (1594-1837)		
1594-1837	Erias Roel (1982)	

WINE

KINGDOM OF ARAGON (1502-1839)		
ARAGON (1502-1600)		
1502-1600	Latorre Ciria (1989)	Liesa, Floren, and Huesca
CATALONIA(1666-1839)		
1666-1712	Serra i Puig (1978)	Martorelles
1713-1725	Vicedo i Rius (1982)	Lleida
1726-1781	Vicedo i Rius (1982) Badosa i Coll (1978) Fradera (1978)	Lleida Gracia-Sant Geivasi Mataró
1782-1800	Vicedo i Rius (1982) Fradera (1978)	Lleida Mataró
1800-1839	Fradera (1978)	Mataró

NAVARRE (1569-1840)		
1569-1625	Belascoain Cemborain (2011).	
1693-1840	Garde Garde (2016)	

KINGDOM OF CASTILE (1490-1838)		
ANDALUSIA (1490-1835)		
Seville (1490-1801)[46]		
1490-1601	Ponsot (1986)	Albaida, Alcala del Rio, Cazalla de la Sierra, Coria, El Copero, Lebrija, Marchena, Mairena del Alcor, Moron, and Utrera
1602-1641	Ponsot (1986)	Montemayor
1642-1678	Ponsot (1986)	Alcala del Rio, Cazalla de la Sierra, Lebrija, Marchena, Montemayor, and Osuna
1679-1801	Ponsot (1986)	Alcala del Rio, Cazalla de la Sierra, Lebrija, Marchena, and Osuna

[42] Decadal estimates.

[43] Series were in cash and were deflated using the Price series from the same paper.

[44] Decadal estimates.

[45] Decadal estimates.

[46] Series were in cash and were deflated using the prices in Ponsot (1986).

Cadiz (1494-1835)[47]		
1494-1835	Ponsot (1986)	Jerez and Chiclana
Huelva (1579-1800)[48]		
1579-1641	Ponsot (1986)	La Palma
1642-1800	Ponsot (1986)	La Palma and Almonte
Cordoba (1580-1819)[49]		
1580-1819	Ponsot (1986)	Baena, Cabra, Castro y Espejo, Espiel, Montoro, Posadas, and La Rambla
OLD CASTILE (1550-1838)		
La Rioja (1550-1819)		
1550-1819	Ibañez Rodriguez and Alonso Castrobiejo (1996)	
Santander (1624-1838)		
1624-1838	Lanza García (1991)	Piasca, Santiago de Heras, Valle de Ruesga, Gajano, and Rubayo
Segovia (1610-1814)		
1610-1814	García Sanz (1977)	
BASQUE PROVINCES (1537-1829)		
1537-1829	Bilbao & Fernandez de Pinedo (1984)	

OLIVE OIL

KINGDOM OF ARAGON (1716-1809)		
BALEARIC ISLANDS (1750-1809)		
1750-1809	Daviu y Pons (1978)	Majorca
CATALONIA (1716-1769)		
1716-1751	Serra i Puig (1978)	Santa Creu dUlorda
1752-1769	Serra i Puig (1978) Badosa i Coll (1978)	Santa Creu dUlorda Gracia-Sant Gervasi

NAVARRE (1693-1839)		
1693-1839	Garde Garde (2016)	

KINGDOM OF CASTILE (1428-1821)		
ANDALUSIA (1428-1821)		
Seville (1428-1801)		
1428-1510	González Arce (2015)[50]	Aljarafe Shire
1494-1560	Ponsot (1986)	Albaida, Alcala de Guadaira, Santa Maria de Carmona, Cazalla de la Sierra, El Coronil, Lebrija, Marchena, Mairena del Alcor, Moron, Osuna, and Utrera
1561-1567	Ponsot (1986)	Santa Maria de Carmona and El Coronil

[47] Series were obtained by deflating tithes in cash paid with prices in Ponsot (1986).
[48] Series were obtained by deflating tithes in cash paid with prices in Ponsot (1986).
[49] Series were obtained by deflating tithes in cash paid with prices in Ponsot (1986).
[50] Combine both tithes in quantity and value. For those years for which we only had values, we deflated them with the average price of olive oil between 1478 and 1490, as suggested by the author. We carried out a robustness check using those years when we had both quantity and value. The results indicate that the use of the average price for the period 1478-1490 is a valid way of estimating the quantity produced from the value taxed.

1568-1598	Ponsot (1986)	Albaida, Alcala de Guadaira, Santa Maria de Carmona, Cazalla de la Sierra, El Coronil, Lebrija, Marchena, Mairena del Alcor, Moron, Osuna, and Utrera
1599-1641	Ponsot (1986)	Santa Maria de Carmona, and El Coronil
1642-1769	Ponsot (1986)	Santa Maria de Carmona, Marchena, and Osuna
1770-1801	Ponsot (1986)	Cazalla de la Sierra, Lebrija, Marchena, and Osuna
Huelva (1494-1801)[51]		
1494-1608	Ponsot (1986)	Moguer, Aracena and, la Palma
1609-1641	Ponsot (1986)	Hinojosos
1642-1801	Ponsot (1986)	Moguer and la Palma
Cordoba (1581-1821)[52]		
1581-1821	Ponsot (1986)	Baena, Bulajance, Cabra, Castro y Espejo, Fernan Nuñez, Montoro, Palma del Rio, Posadas, La Rambla, and Santaella
EXTREMADURA (1697-1788)		
1697-1788	Llopis Agelan (1979)	Casa del Rincon

VEGETABLES AND FRUITS

KINGDOM OF ARAGON (1499-1835)		
BALEARIC ISLANDS (1649-1819)		
1649-1819 (Legumes)	Vidal (1978)	Majorca
CATALONIA (1658-1835)		
1658-1670 (Legumes)	Serra i Puig (1978)	Martorelles
1671-1715 (Legumes)	Serra i Puig (1978)	Martorelles and Sentmenat
1716-1729 (Legumes)	Serra i Puig (1978) Badosa i Coll (1978)	Sentmenat and Badosa Sants/l'Hospitalet
1730-1770 (Legumes)	Badosa i Coll (1978)	Sants/l'Hospitalet and Gracia-Sant Geivasi
1770-1835 (Legumes)	Fradera (1978)	Mataró
VALENCIA (1499-1700)		
1553-1700 (Fruits)	Casey (1979)	
1499-1602 (Vegetables)	Salvador Esteban (2004)	

NAVARRE (1693-1840)		
1693-1840 (Legumes)	Garde Garde (2016)	

LIVESTOCK PRODUCE

KINGDOM OF ARAGON (1501-1800)		
ARAGON (1610-1827)		
1610-1827	Latorre Ciria (2007)	
VALENCIA (1501-1800)		

[51] The series in cash were deflated d with prices in Ponsot (1986).
[52] Series in cash deflated with prices in Ponsot (1986).

1501-1565	Casey (1979)	
1566-1700	Casey (1979) Ardit Lucas (1987)	
1701-1800	Ardit Lucas (1987)	

NAVARRE (1569-1837)		
1569-1625	Belascoain Cemborain (2011).	
1693-1837	Garde Garde (2016)	

KINGDOM OF CASTILE (1500-1837)		
MURCIA (1591-1810)		
1591-1810	Pérez Picazo and Lemeunier (1984)	
EXTREMADURA (1500-1800)		
1500-1599	Pereira Iglesias (1990)	
1692-1800	Llopis Agelán (1979) Melón Jiménez (1998)	Monastery of Guadalupe
OLD CASTILE (1575-1837)		
Santander (1744-1837)		
1744-1837	Lanza García (1991)	Carmona
Segovia (1575-1800)		
1575-1800	Garcia Sanz (1977)	
Soria (1682-1837)		
1682-1837	Andrés Gallego (1973)	

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Appendix 2. *Commodity and Factor Price Indices*

Agricultural prices

For each main crop, prices for 1402-1500 derive from Argilés (1998), for Catalonia (Lérida), Zulaica (1994) an Hamilton (1936), for Aragon, and Hamilton (1936) for Valencia and Navarre, Izquierdo Benito (1983), for Toledo, and Alonso Casado (1991, 2009), for Burgos. Prices for 1501-1800, come from Felíu (1991), for Catalonia, and from Hamilton (1934, 1947), and Hamilton's unpublished manuscript working sheets (kindly provided by Robert Allen) for Andalusia, New and Old Castile, and Valencia. From 1800, prices comes from Felíu (1991), for Catalonia, up to 1808; Morilla (1972) and Ponsot (1986) for Andalusia; and Llopis Agelán (1982) for wool in Guadalupe. Prices for each produce have been weighted by the regional shares in each main produce's production by 1799 in order to derive prices at national level.

Industrial Prices

An unweighted Divisia index of manufacturing prices (building materials –timber, plaster, lime, tiles, nails-, fuel -coal, wood-, paper, parchment, textiles –cloth, linen, silk-, wax,) for 1276-1500 was constructed on the basis of those we had previously built on the basis of original data, for Aragon, 1276-1429 (Zulaica Palacios, 1994), and 1429-1500 (Hamilton, 1936); Toledo, 1401-1475 (Izquierdo Benito, 1983); and Burgos, 1390-1500 (MacKay, 1981; Casado Alonso, 1985, 1991). For the period 1501-1860, we have used an aggregate manufacturing price index kindly supplied by Joan Rosés (Rosés et al., 2007).

Consumer Price Index

A CPI for 1276-1501 was constructed as a weighted average of agricultural (0.75) and industrial (0.25) Divisia price indices, except for Valencia (Allen, 2001). For 1501-1860, a Divisia index was derived from regional CPIs: Catalonia, 1501-1807 (Felíu, 1991), and 1830-1860 (Maluquer de Motes, 2005); Valencia, 1501-1785 (Allen, 2001); New Castile (Reher and Ballesteros, 1993), Old Castile, 1518-1650 (Llopis Agelán et al., 2000) and 1751-1860 (Moreno Lázaro, 2002).

Wage Rates

Unweighted Divisia indices of nominal wage rates for masons, bricklayers, tilers, and carpenters were computed from the following sources: Aragon, 1277-1423 (Zulaica Palacios, 1994) and 1423-1497 (Hamilton, 1936); Lérida, 1361-1500 (Argilés, 1998); Valencia, 1413-1500 (Allen, 2001) in the Kingdom of Aragon; Toledo, 1401-1475 (Izquierdo Benito, 1983); and Burgos, 1390-1500 (MacKay, 1981; Casado Alonso, 1985, 1991) in the Kingdom of Castile. For 1501-1860, the sources used were: Catalonia (Felíu, 1991; Maluquer de Motes, 2005), New Castile (Reher and Ballesteros, 1993), Old Castile (Moreno Lázaro, 2002), and Valencia (Allen (2001).

Land Rent

Unweighted Divisia indices for land rents were built from data in the following sources: Aragon, 1318-1416 (Zulaica Palacios, 1994); Catalonia, Gerona, 1520-1800 (Duran i Pujol, 1985) in the Kingdom of Aragon; Burgos, 1320-1520 (Casado Alonso, 1987, 2009); Andalusia, western, 1504-1845 (Ponsot, 1986), and Jaen, 1520-1672 (Coronas Vida, 1994); Old Castile, Leon, 1569-1835 (Sebastián Amarilla, 1990); Segovia, 1651-1690, 1780-1817 (García Sanz, 1986); Avila, 1790-1841 (Llopis, private communication); and Zamora, 1683-1840 (Álvarez Vázquez, 1987) in the Kingdom of Castile.

Appendix 3 Adjusting Urban Population

In order to distinguish those in the urban population who depended on industrial and service activities, an arithmetical exercise has been carried out. Wrigley (1985) assumed that, in pre-industrial Europe, all agricultural population lived in rural areas so to derive the population related to non-agricultural activities, to those living towns, the rural population not involved in agricultural activities should be added. Therefore, the crucial distinction to make was between the agricultural and non-agricultural shares of rural population. However, in preindustrial Spain, the existence of 'agro-towns' (namely, towns in which a sizable share of the population was dependent on agriculture) is assumed. Hence, the challenge is to establish which share of rural and urban population lived on agriculture.

In order to distribute rural and urban population into agricultural and non-agricultural we start by comparing the share of the economically active population (***L***) occupied in agriculture (L_{ag}/L), and the share of total population (***N***) living in rural areas (N_{rur}/N). If the ratio between these two shares [(L_{ag}/L):(N_{rur}/N)] is above one, this would mean that part of the population living in towns worked in agriculture. Conversely, a ratio below one suggests that part of those living in the countryside work for industry and services.

However, deriving the ratio between the agricultural, L_{ag}, and the rural economically active populations , L_{rur} (L_{ag}/L_{rur}) requires further adjustment which allows for urban-rural differences, firstly, in the proportion of total population (***N***) in working age, or potentially active population (***PAP***), and, then, in the share of the working age population (***PAP***), which is economically active (***L***).

Fortunately, we have information on the ***PAP/N*** ratio in both rural and urban areas by region for 1787 (Marcos Martín, 2005). This ratio (computed –due to the census distribution by age cohorts – as population ages 16 to 50 over total population) differs by region (***i***) between urban $(PAP/N)_{urb\ i\_1787}$ and rural $(PAP/N)_{rur\ i\_1787}$ areas, being larger in urban areas, but showing low dispersion in both cases.[53]

The implication is that using rural and urban population without previously adjusting for age composition biases the results against agricultural employment, as, on average, the rural $(PAP/N)_{rur}$ ratio is 87.5 percent of the urban one. Unfortunately, no yearly data on the ***PAP/N*** ratio are available for Spain, except for New Castile, for which Reher (1991) computed it from the late sixteenth century onwards.[54] Thus, we are forced to proxy long-run changes in Spain's ***PAP/N*** by those in New Castile's (***NC***) $(PAP/N)_{NC\_t}$.[55]

[53] They were, on average, 55.7 and 48.8 percent in urban and rural areas, respectively. The urban and rural coefficients of variation are 0.056 and 0.023, respectively and are computed from Marcos Martín (2005). The regional dispersion in the activity rate (EAP/PAP) is also low, 0.113.

[54] The sample used by Reher (1991) consists of 26 villages, from which only five belong to the province of Madrid.

[55] Regional dispersion was low for *PAP/N* in 1787 but we do not really know if this was the case in previous epochs. In New Castile, the *PAP/N* ratio, computed for the share of population between 15 and 50 years old, was rather stable over time, with less than a 5 percent variation around the 1787 ratio (Reher, 1991: 70:74).

Thus, we derived the urban and rural working age at each benchmark year ***t*** as follows[56],

$$PAP'_{urb\ it} = N_{urb\ it} * (PAP/N)_{urb\ i\_1787} * ((PAP/N)_{NCt} / (PAP/N)_{NC\_1787}) \quad [1]$$

$$PAP'_{rur\ it} = N_{rur\ it} * (PAP/N)_{rur\ i\_1787} * ((PAP/N)_{NCt} / (PAP/N)_{NC\_1787}) \quad [2]$$

Then, in order to arrive to figures for economically active urban ($L_{urb\ it}$) and rural ($L_{rur\ it}$) populations at each benchmark we needed to derive the relevant ***L/PAP*** ratios. Alas, we were only able to compute the ***L/PAP*** ratio for 1787 without being able to distinguish between urban and rural ratios. Hence, we estimated figures of urban and rural ***EAP*** for every benchmark year as

$$L'_{urb\ it} = PAP'_{urb\ it} * (L/PAP)_{i\_1787} \quad [3]$$

$$L'_{rur\ it} = PAP'_{rur\ it} * (L/PAP)_{i\_1787} \quad [4]$$

Next, we compared the economically active population occupied in agriculture (L_{ag}), with that living in rural areas (L'_{rur}). If $L_{ag} > L'_{rur}$ it can be presumed that part of the population living in towns worked in agriculture. Conversely, if $L_{ag} < L'_{rur}$ the implication is that those living in the countryside allocated part of their working time to industry and services. This way, we distributed the rural (L'_{rur}) and urban (L'_{urb}) economically active populations into agricultural ($_{ag}$) and non-agricultural ($_{nonag}$) occupations and reached a figure for urban non-agricultural labour ($L'_{urb\text{-}nonag\ it}$).

$$L'_{rur\text{-}nonag\ it} = L'_{rur\ it} - L_{ag\ it} \quad \text{if } L'_{rur\ it} > L_{ag\ it}\text{, 0 otherwise} \quad [5]$$

$$L'_{rur\text{-}ag\ it} = L'_{rur\ it} - L'_{rur\text{-}nonag\ it} \quad [6]$$

$$L'_{urb\text{-}ag\ it} = L_{ag\ it} - L'_{rur\ it} \quad \text{if } L_{ag\ it} > L'_{rur\ it}\text{, 0 otherwise} \quad [7]$$

$$L'_{urb\text{-}nonag\ it} = L'_{urb\ it} - L'_{urb\text{-}ag\ it} \quad [8]$$

Thus, economically active population outside agriculture is obtained as

$$L'_{nonag\ it} = L'_{rur\text{-}nonag\ it} + L'_{urb\text{-}nonag\ it} \quad [9]$$

Moreover, we can estimate the adjusted urban population in towns of 5,000 or more inhabitants (excluding those living on agriculture), by re-scaling the resulting figures for urban economically active population outside agriculture with the activity rate (***L/N***),

$$N'_{urb\text{-}nonag\ it} = L'_{urb\text{-}nonag\ it} / (L'_{urb\ it} / N_{urb\ it}), \quad [10]$$

Thus, we can obtain an adjusted rate of urbanization (Ua_{it}) that partly offsets at least the upward biased effect of the agro-towns:

$$Ua_{it} = 100 * N'_{urb\text{-}nonag\ it} / N_{it} \quad [11]$$

Regrettably, though, we lack data to compute the share of labour in agriculture (L_{ag}/L) at each benchmark year. For L_{ag} evidence can only be obtained for 1857 and 1787, from population census and for 1752, restricted to the Kingdom of Castile, from the Cadastre of Ensenada (Grupo '75, 1977).[57] Wrigley (1985) and Allen (2000) also faced this shortcoming, and Wrigley assumed that, in early sixteenth century England and France, up to 80 percent of the rural labour force was in agriculture and reduced arbitrarily this figure over the three following centuries. Allen (2000) accepted the same percentage for most European countries *circa* 1500 and interpolated the years up to the first one (1800) for which he had estimates. In the

[56] In expressions [1] to [11] ´ means an approximated estimate, as opposed to the actual value, since some simplifying assumptions were needed in order to facilitate the computation.

[57] The Kingdom of Castile covered nowadays Spain excluding the Kingdom of Aragon (Aragon, Catalonia, Valencia, and Balearics) and the Kingdom of Navarre.

case of Spain, we assumed a fixed 80 percent share of EAP in agriculture and interpolated log-linearly the shares between 1530 and 1787 and 1787 and 1857.[58]

However, efficiency changes resulting from variations in the composition of labour by economic sectors and in the dependency rate could affect our proposed measure. Thus, we have carried out a sensitivity test by estimating the intersectoral shift effect that results from changes in the shares of industry and services in non-agricultural employment and in the productivity gap between industry and services. Furthermore, we have allowed for changes in the potentially active to total population ratio (PAP/N) that could also affect our index. Fortunately trends in the proposed index of output outside agriculture do not appear to be significantly altered by either demographic or output composition changes during the early modern era.[59]

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[58] The share of EAP in agriculture in the Kingdom of Castile is systematically higher in the Floridablanca Census (1787) than in the Cadastre de Ensenada (1752). Choosing the 1787 Census provides an upper bound for our L_{agr} estimates and, hence, biases downwards the adjusted urbanization rates. We have carried out a sensitivity test assuming that the *Lag/L* in 1787 remained unchanged for the entire time span considered. The results exhibited the same trends for the adjusted urbanization rates but differ for the sixteenth century (12.0 rather than 9.9 in 1530 and 16.5 instead of 14.5 in 1591).

[59] Services increased relative to manufacturing in terms of output and employment in early modern Spain (García Sanz, 1991; López-Salazar, 1986; Reher, 1990) probably as a consequence of the Dutch disease provoked by the inflow of American silver (Forsyth and Nicholas, 1983; Drelichman, 2005). Given the lack of national data, we arbitrarily assumed that the evolution of the internal composition of non-agricultural employment in Spain was captured by the shares in non-agricultural economically active population (L_{i+s}) of industry (L_i/L_{i+s}) and services (L_s/L_{i+s}) in a New Castile town, Cuenca (Reher, 1990). As regards the productivity ratio between industry and services, lack of data forced us to accept a fixed ratio (1.4) derived from the Cadastre de Ensenada for the Kingdom of Castile c. 1750. The resulting intersectoral shift effect [$IS = (L_s/L_{i+s}) + (1.4^* (L_i/L_{i+s}))$] shows a mild decline over time. If alternatively the productivity gap for the 1850s were used (Prados de la Escosura, 2017) the productivity index would rise slightly over 1750-1850. Changes in the potentially active to total population ratio (PAP/N) can also affect our index of output outside agriculture. Alas, we only know the evolution of the PAP/N ratio for the case of New Castile from 1586 onwards which does not exhibit major changes over time (Reher, 1991).