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Agriculture in Europe's Little Divergence: The Case of Spain

Carlos Álvarez-Nogal, Leandro Prados de la Escosura and Carlos Santiago-Caballero

Abstract
This paper explores the role of agriculture in Spain's contribution to the little divergence in Europe. On the basis of tithes collected by historians over the years, long-run trends in agricultural output are drawn. After a long period of relative stability, output suffered a severe contraction during 1570-1590, followed by milder deterioration to 1650. Output per head moved from a relatively high to a low path that persisted until the Peninsular War. The demand contraction, resulting from the collapse of domestic markets, monetary instability, and war in Iberia, helps to explain a less intensive use of labour and land as incentives to produce for the market sharply diminished. Agricultural output per head moved along population up to 1750. This finding confirms the view of Spain as a land abundant frontier economy. Only in the late eighteenth century a Malthusian pattern emerged.

Keywords: agriculture, little divergence, early modern Spain, tithes, output per head.

JEL Classification: N53, O13, Q10.

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This paper explores the role of agriculture in Spain's contribution to the *little divergence* in Europe. On the basis of tithes collected by historians over the years, long-run trends in agricultural output are drawn. After a long period of relative stability, output suffered a severe contraction during 1570-1590, followed by milder deterioration to 1650. Output per head moved from a relatively high to a low path that persisted until the Peninsular War. The demand contraction, resulting from the collapse of domestic markets, monetary instability, and war in Iberia, helps to explain a less intensive use of labour and land as incentives to produce for the market sharply diminished. Agricultural output per head moved along population up to 1750. This finding confirms the view of Spain as a land abundant frontier economy. Only in the late eighteenth century a Malthusian pattern emerged.

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[1] To Gonzalo Anes and Ángel García Sanz, in memoriam.

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Introduction

In recent years, quantitative research has shed new light on the economic performance of early modern Spain (Yun-Casalilla, 1994; Carreras, 2003; Álvarez-Nogal and Prados de la Escosura, 2007, 2013). At the same time, comparative history has expanded adding a new concept, the *little divergence* in Europe between the North Sea and the Mediterranean areas, with north-western countries (Britain and the Netherlands) forging ahead and southern countries (Italy and Spain) falling behind (Broadberry, 2013). Sir John Elliott's old plea, "'to compare Spanish conditions with those of other contemporary societies" (Elliot, 1961: 55) has, thus, been finally answered. However, why Spain fell behind remains elusive. Explanations are highly speculative, including recent interpretations that stress the insecurity of property rights and the impact of absolutism on trade and colonial institutions in a context of extractive institutions (Acemoglu and Robinson, 2012: 218-222), and institutional fragmentation, that hindered market integration (Grafe, 2012). Regardless the extent to which these grand interpretations stand the test of historical evidence, a precise description of the mechanisms that drove Spain's falling behind is needed. Public finance, trade and credit, urban activities, and agricultural performance need to be quantified and their interconnections established before an overall assessment can be provided. Only then it would be possible, as Elliott suggested, isolating any features unique to Spain.

"The conditions of the soil and the nature of land-holding" (Elliott, 1961: 56) captured historians' attention during the late twentieth century. Economic historians of early modern Spain have used indirect information on religious taxes -the tithe, in particular- to derive trends in output. Studies of main crops' output, most of them dating from the 1970s and early 1980s, are abundant. Although regional agricultural output has occasionally been computed, monographs were mainly carried out at local or provincial level.[3] The daunting effort required to unifying and analysing dozens of studies for different products in different regions and at different periods of time has

[3] The 2008 conference of the Spanish economic association represented a turning point, as there were attempts at providing aggregate estimates of agricultural output on the basis of tithes for some regions.

probably discouraged historians from attempting to provide a wider spatial picture.[4] The only attempt at assessing the evolution of agricultural output in Spain on the basis tithe series was provided by Gonzalo Anes and Ángel García Sanz (1982) in an overview grounded on Ricardo's theory of differential rent (Ricardo, 1817, 1951). They argued that, during the sixteenth and eighteenth centuries, foodstuff relative prices rose in response to increasing urban demand -a consequence of demographic expansion-, leading to an expansion of land under the plough, at the expense of pasture and forest. Yields per seed and per hectare declined, as less fertile land was cultivated and technological change was mainly absent (mules substituting for oxen was one of the few innovations). As a result, land rent increased and labour productivity fell. Conversely, during the seventeenth century, as population stagnated and urban demand contracted, relative prices for foodstuffs fell and marginal lands were reverted to pasture and forest. Yields and labour productivity recovered while land rents declined. Anes and García Sanz nuanced their interpretation by emphasising wide regional disparities in agricultural performance during the early modern era.

More recently, indirect estimates of regional and national output have been derived using a demand function approach (Allen, 1999, 2000; Malanima, 2011; Álvarez-Nogal and Prados de la Escosura, 2007, 2013) in which agricultural consumption per head is estimated and, then, adjusted for net food imports, to derive output per head and, times population, absolute output. Real consumption per head of agricultural goods (***C***) can be expressed as,

$$C = a\, P^{\varepsilon}\, Y^{\mu}\, M^{\gamma} \qquad [1]$$

In which P and M respectively denote agricultural, and non-agricultural prices relative to the consumer price index, 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.

[4] Difficulties to interpreting the information provided by archival records on tithes have also led historians to avoid using data not collected directly by themselves.

The main results obtained from the demand approach for early modern Spain suggest that output per head declined from mid-fifteenth to mid-seventeenth century –although its level remained high until the 1550s- and, then, stabilized at a low level, before another episode of decline occurred in the late eighteenth century (Álvarez-Nogal and Prados de la Escosura, 2013).

These findings may be considered, to some extent, explicit conjectures as they are based upon limited empirical evidence on real wage rates and land rent –used as proxies for disposable income per head-, and hypothetical values for income- and own price elasticities.[5]

As constructing direct estimates of aggregate output seems so far unfeasible, information on tithes provides an alternative procedure to derive output measures that, although also indirect, requires less stringent assumptions than those involved in the demand approach. Thus, it is our purpose to present estimates of agricultural output in early modern Spain on the basis of tithes that will be compared to the results from the demand approach.

Grain was, by far, the most important component of agricultural output in late medieval and early modern Spain, and although it lost some ground in some regions (coastal areas, in particular), it still kept its predominance in agriculture by 1800, amounting to about two-thirds of all crops and nearly half of agricultural final output in the 1790s (Polo y Catalina, 1803). Continuous series for grain tithes can be traced back to the early fifteenth century in Old Castile or Andalusia, for many regions in the sixteenth century and for practically all of them from the seventeenth to the early nineteenth century. However, it is generally accepted that the reliability of tithes as a proxy for agricultural output decreased significantly after the Napoleonic invasion, so we set 1800 as the end year for our estimates. In addition to cereal, tithes for major agricultural crops: wine (must) and olive oil but also legumes, fruit, and animal produce are available for the main producing regions.

[5] This approach has been criticised on the grounds that by using wage rates as a proxy for disposable income a considerable margin of error can be introduced in the estimates (Llopis Agelán and González Mariscal, 2010).

On the basis of tithes it can be shown that agricultural output was at a high level over 1440-1570. Then, a decline took place in two phases, a sharp but short one between 1570 and 1590, followed by a milder and steady one to 1650. A recovery followed up to the mid-eighteenth century, when the absolute level of the mid-sixteen century was recovered. Then, another phase of decline started lasting to 1800.

Our estimates of agricultural output per head reinforce the view of a dramatic change in the late sixteenth century, in which an affluent agriculture with relatively high levels of per capita consumption was replaced by another one of low consumption levels that persisted to the Napoleonic Wars.

Moreover, the relative stability of output per head while population expanded rapidly between 1500 and 1570, and the parallel evolution of output per head and population, declining over 1570-1650 and growing thereafter until the mid-eighteenth century, suggest that the depiction of Spain as a frontier economy can be extended up to the mid-eighteenth century. After the 1750s Spain's agricultural conformed to the Western European Malthusian pattern. Thus, our results expand and nuance the findings from the indirect demand approach (Álvarez-Nogal and Prados de la Escosura, 2013).

On the basis of the new findings an explanatory hypothesis of the role of agriculture in Spain's decline can be put forward. Fiscal conflict between cities and the King led to the destruction of local markets from 1570 onwards (Álvarez-Nogal and Chamley, 2014, 2015), as evidenced by the collapse of the Medina del Campo fair since the 1560s, and the interruption of trade flows with northern Europe as a by-product of the revolt in Flanders (Espejo and Paz, 1908). The financial collapse of the early 1570s had deleterious effects on small firms in trade and finance while war prevented wool exports that never recovered pre-1570s levels (Ruiz Martín, 1968: 133-135). Monetary alterations, especially the devaluation of vellón –a copper currency that up to 1602 included a lower proportion of silver (García Guerra, 1999)- prevented markets recovery (Álvarez Nogal, 2005). A second wave of wars (including military conflict in the Iberian Peninsula) and systematic tax increases (especially on basic foodstuffs, the so-called *millones*) impeded economic recovery and deepened the depression to the mid-seventeenth century. Thus, agricultural decline appears a result of the tax-induced

contraction in urban and international demand, together with war with France and revolts in Portugal and Catalonia, which prevented cultivation and reduced incentives to produce for the market leading to a less intensive use of labour and land.

Tithes as a Proxy for Agricultural Production

Tithes have been traditionally considered a major tax in the pre-industrial era, particularly during the Middle Ages when most of the European population lived on agriculture and centralized fiscal systems had not been developed (Pöschl, 1927). The tithe was an ecclesiastical tax, imposed on all farming production including the incomes obtained from livestock. The tithe was normally estimated on total production in the same field right after the harvest had been collected, before deducting the seeds to be used in the following season or the product that had to be used to pay rents. The tithe was nominally 10 per cent of total production but, in practice, its share fluctuated and remained below this percentage. In Mediterranean Europe the most important products taxed were grains (wheat, barley, oats and rye), wine (must), and olive oil.

Tithe records can be traced back in time to the High Middle Ages but the survival of written sources reduces the time span in which they are available. Although wars and epidemics made difficult their collection, in Roman Catholic countries the tithes did not vanish or disappear altogether until the French Revolution and the Napoleonic Wars, providing continuous series for several centuries. However, researchers did not exploit the abundance of tithe records in most of Europe until the twentieth century. Earlier studies focused on explaining the existence of the tithe, the methods used for its collection, or the tax legislation (Viard, 1909-14; Borah, 1941; Boyd, 1952). It was only since the 1960s when a quantitative approach was adopted for the study of tithes with the main objective of reconstructing fiscal time series that would capture the long run evolution of agricultural output.

The new methodology introduced by the *Annales* School, allowed to exploit the potential of tithes to analyse economic and social change in early modern France, as well as shedding light on other economic and social variables (prices, yields, productivity, types of cultivation, living standards) (Goubert, 1960; Baehrel, 1961). Labrousse (1962) initiated a systematic analysis of agricultural production in pre-

industrial France using the tithes as the main source that was soon extended to regional studies (Le Roy Ladurie, 1966; Morineau, 1970; Deyon, 1967; Le Roy Ladurie and Goy, 1972). Tithe series collection became a collective effort that in 1969 materialised in a publication including more than 20 studies at local level. Together with France, the volume also included regions such as Andalusia (Spain) and Sicily (Italy). Later, in 1977, Goy and Le Roy Ladurie hosted an international conference on tithes with the participation of more than 60 historians from 17 countries. The new studies allowed the extension of the available data set in both chronological (from the fourteenth to the nineteenth centuries) and geographical terms (Europe and Latin America) (Goy and Le Roy Ladurie, 1982). The wide geographical coverage of tithes opened the debate about the homogeneity of the data and the possibility of carrying out comparative studies. Difficulties concerning the direct conversion between tithes and agrarian output, as collection methods changed over time and varied across regions; the resistance of peasants to pay the tax; the way tithes were collected (directly or rented out to private agents) and paid (in kind or cash), were main issues in the debate.[6]

The impulse given to tithes in France (Neveux, 1980; Bois, 1984; Derville, 1987), also encouraged the research in other countries in Europe: Belgium (Ruwet, 1964), Spain (Cabo Alonso, 1955; Anes and Le Flem, 1965; Anes, 1970; Ponsot, 1986), Hungary (Kirilly and Kiss, 1968), and Latin America (Borah, 1949). More recently, research on tithes has extended to Sweden (Leijonhufvud, 2001) and England (Evans, 1976; Dodds, 2004, 2007).[7]

Spain is, perhaps, the country in which research on tithes has been as widespread as in France, thanks to the records kept in the ecclesiastical and national archives. In addition to the wealth of the archival records, it is worth highlighting that tithes provide the same information for all Spanish regions and kingdoms regardless their different fiscal systems. After the research effort carried out in the 1970s and

[6] See the discussion in Goy and Le Roy Ladurie (1982) and Le Roy Ladurie and Goy (1982).

[7] Due to the abundance of alternative sources such as manors' accounting records, tithes have been largely neglected in England.

1980s, a wide sample of tithe records at local is available for most regions.[8] However, although the study of regional tithes series has continued in Spain, an aggregate view of agricultural performance on the basis of tithes is, with the exception of the early attempt by Anes and García Sanz (1982), still missing at national level.

In Spain, tithe receipts were divided into three components: one accruing to the bishop, another to the local priest, and a third one that was divided between the king and the parish. The diversity of beneficiaries multiplied the accounting records available and allowed a direct comparison between different sources. The "tazmía" books, for instance, were kept in each parish and recorded the amounts that were paid by each peasant. The data from this source can be compared to the records that were kept in private, ecclesiastical, or national archives.

How reliable are tithes as a proxy for agricultural output has been widely debated. Due to its fiscal nature, tithes have been questioned as they may bias output downwards. Also, tithes cover main products with new crops such as maize and potatoes often escaping them, at least in the early years of cultivation. Furthermore, as the Church land expanded (entailment) tithes would tend to decline. Tithes were sometimes paid in cash, instead of in kind, so deflation is required to draw long run trends in output. In some cases, institutions leased tithe collection to private agents who bid for the right to collect them. In these cases, records do not reflect actual production but the value of the winning bid. Moreover, tax evasion could vary overtime. For example, as the production diversified the opportunities for evasion increased. As with all taxes, producers could hide part of the harvest depending on the degree of coercion and enforcement. In Spain, religious authorities imposed controls to prevent peasants from hiding the harvest partially (Santiago-Caballero, 2011), a fact

[8] Including Andalusia (Granada, Garzón Pareja, 1974, 1982; Malaga, Benítez Sánchez-Blanco, 1982; Seville, Ladero Quesada, 1979; Ponsot, 1986), Extremadura (Pereira Iglesias, 1990; Llopis Agelán, 1979), Murcia (Lemeneunier, 1982), New Castile (Toledo, López-Salazar, Pérez and Martín Galán, 1981), Old Castile-Leon (Segovia, García Sanz, 1982; Leon, Sebastián Amarilla, 1992; Zamora, Álvarez Vázquez, 1984), Basque Country (Bilbao and Fernández de Pinedo, 1982), Galicia (Eiras Roel, 1982), Aragon (Latorre Cria, 2007), Balearics (Mallorca, Vidal, 1978), Catalonia (Badosa, 1978; Fradera, 1978), and Valencia (Ardit Lucas, 1989, and Palop Ramos, 1982).

that improves the reliability of the source. Nonetheless, tithes are considered to represent roughly a fixed proportion of total production (García Sanz, 1979). As the time limit for tithes as a proxy for agricultural output, it has been argued that the social and political turmoil caused by the French invasion in 1808 facilitated peasants' passive resistance to pay the tithe rendering the tithe untenable as a trustworthy source in Spain (Anes and García Sanz, 1982).

We can conclude that, even if tithes do not capture accurately agricultural production, they provide reliable output trends over the long run and constitute a unique source for the study of agriculture's performance in early modern Spain.

Method

Unlike most Spanish studies that use a regional and, often, a local approach, in this paper a national perspective has been chosen. Thus, aggregates for main crops have been constructed on the basis of an extensive dataset of tithe series at regional and local levels. Making a wide array of a heterogeneous set of series into relatively homogeneous and comparable series across space has been a painstaking and time-consuming process. We have been able to gather tithe records from as early as the fourteenth century. However, given the sketchy nature of the early records and the difficulty to link them to later series, our agricultural output estimates only cover from 1500 onwards. However, on the basis of information restricted to cereals and olive oil we have been able to establish some conjecture output trends back to the early fifteenth century.

The choice of a procedure to aggregate multiple series into homogenous and continuous series was a key decision. One of the available choices at our disposal was the utilization of econometric techniques such as panel data regression or principal components analysis that could have help us to derive standardised series (Clark, 2002). However, 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. When the sources made it possible, our favoured approach was working on the series at a local level. The first step was establishing whether the series were 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 dealt with missing values depended on the amount of information lost and on the availability of sources. When 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.[9] In our opinion, when the amount of years to be estimated was manageable, this process was the most reliable in the calculation of the gaps in the series and provides the best estimations.

When the amount of missing values was larger or the existence of alternative local series more scarce, we had to rely on alternative methods. In these cases, we estimated the missing values using the average weight that the local series to be estimated represented in the aggregate provincial sample.[10] 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

[9] 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.

[10] 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.

years that had to be 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 we counted on local series from different authors for the same province and period, we used the overlapping periods between them in order to re-escalate them to create aggregated series. We also followed the same process in the cases where the series proceeded from the same study but had different local series available in different periods of time, unifying them through rescaling taking advantage of the overlapping years.

As a result of a long and detailed process we derive at provincial or regional series for main crops: cereals, wine (must), olive oil, legumes, fruit, and animal produce (including wool and silk).

Combining provincial series into regional and national aggregates was the next step. 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; and Aragon, Balearics, Catalonia, and Valencia, in the Kingdom of Aragon; plus the Kingdom of Navarre. As in the case of individual series, we had to interpolate missing values with the help of geographically close series. We then constructed regional series by assuming that series for missing provinces evolve alongside those for which data were available.[11] Alternatively, missing values for odd

[11] Thus, for example, series for Cadiz (1408-1493) and Huelva (1408-1450), in the province of Seville, in the 15th century were complete by assuming a similar evolution to that for Seville. Likewise, Cordoba pre-1580 series were assumed to evolve alongside those for Seville. In the case of East Andalusia, series for Malaga were used completed for missing years with those for Granada (1790-1800). In the absence of tithe data, Extremadura was assumed to evolve alongside New Castile over 1595-1738. This assumption is warranted by the correlation (about 0.6) between the two region series for the periods in which both are available. In the case of Burgos, the series for 1402-1519 were spliced with those for 1590 onwards with the available series for Rioja that was largely part of the Burgos province before the

years were log-linearly interpolated. We finally derived estimates for the kingdoms of Castile, Aragon, and Navarre from which a national index was derived as a weighted average.

As for wine (must), tithes information was restricted to Andalusia (Cadiz, Huelva, and Seville, in the province of Seville, and Cordoba), Old Castile (Burgos -Rioja and Santander- and Segovia), and Basque Provinces in the Kingdom of Castile, plus Aragon and Catalonia, in the Kingdom of Aragon, and Navarre.[12] These regions represented, nonetheless, the main producing areas. Indices for the kingdoms of Aragon, Castile, and Navarre were constructed and, then, aggregated as a weighted average into a single index for Spain.

In the case of olive oil information only related to Andalusia (Seville, including also Huelva and Cordoba provinces) and Extremadura in the Kingdom of Castile, and Balearics and Catalonia, only for the eighteenth century, in the Kingdom of Aragon. Again, these were the main producers in early modern Spain. A weighted index of Aragon and Castile was built to represent the whole of Spain. As information on Aragon is missing before 1716, it was assumed that Spain's index evolved along that of the Kingdom of Castile.

Information about tithes on legumes and fruit is scant and we only managed to get tithes for Balearics and Catalonia from 1649 onwards, and for Valencia since 1499. These areas represent, nonetheless, more than one-third of the value of production in the 1799 Census. An aggregate index for the Kingdom of Aragon was, then, obtained and we assumed it captures the evolution of the whole of Spain.

Tithes on animal produce are available for Extremadura, Murcia, Old Castile (including Segovia and Soria), Aragon, and Valencia. Weighted indices were

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1833 reform. The Burgos series were considered representative for Old Castile before 1520. Segovia, 1550-70, assuming its evolution was similar to that of Valladolid and Palencia; 1523-50, along Zamora; pre-1523, Burgos. Series for Zamora were assumed to represent the evolution of the series for Segovia, León, and over 1523-1550. For Navarre, we completed the series by assuming it moved along the Basque Provinces since 1639.

[12] Navarre was assumed to evolve along Rioja from 1626 onwards.

constructed for the kingdoms of Aragon and Castile and, then, an index for Spain was derived as their weighted average.

How to weight the series for different provinces and regions poses a major challenge. The 1799 Census of Fruits and Manufactures is the only available estimate of quantities and values for agricultural and industrial goods for early modern Spain. Its reputation is poor largely due to a devastating but sound critique published by Josep Fontana in 1967. Nonetheless, Fontana (1967) largely exonerated cereal production from his harsh criticism and suggested a correction for olive oil output in Majorca. Unfortunately there is no alternative to the 1799 Census. Using as an alternative population weights from scattered population census in the eighteenth century would imply assuming that all provinces produced the same crops in the same proportion, something definitively mistaken. Another 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.[13]

In addition to following Fontana's advice to correct olive oil output, we re-computed the value of total output using a single price for each product derived as the weighted average of its provincial prices. In addition to correct for the risk of spurious provincial prices, as suggested by Fontana, this procedure allow us to provide consistent estimates -that implies a purchasing power parity adjustment- for Spain as a whole.

Thus, in order to get a quantity index for each crop we have used the provincial shares in total production for 1799 as weights. An aggregate figure for farm output resulted from weighting each crop by its share in national farm output in 1799. We computed farm and livestock output independently and, then, added them up. The valuation of livestock output in the 1799 Census raises a problem as the stock of livestock (number of different type of cattle) is mixed up with livestock produce (i.e., wool). Therefore, the total value of livestock output should be reduced, in principle, to

[13] 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).

offset its over-exaggeration. However, the livestock output is grossly underestimated in the 1799 Census, as a comparison for the Kingdom of Castile between the 1799 Census and the 1750s Cadastre of Ensenada suggests. Cadastres of Ensenada figures roughly double those of the 1799 Census. Since there is no evidence of a major catastrophe in Castilian livestock during the second half of the eighteenth century, such disparity evidences the 1799 Census downward bias. Thus, we have accepted the 31 per cent share for livestock. Nonetheless, we have computed agricultural output with a lower (20 per cent) share, the one that would correspond to livestock output excluding cattle, with no significant disparities in its long trends.[14]

Trends in agricultural output

Trends in main crops are presented in Figure 1. It can be observed that their tendencies are highly coincidental from 1500 onwards. Output appears to have grown across the board from the early fifteenth century to 1560s. Then, it fell to the 1640s. From the 1660s to the mid-eighteenth century output recovered and, then, stagnated until 1800 (Table 1). However, a closer look shows distinctive behaviour among different crops. Thus, the expansion of wine production appears remarkable during the first two-thirds of the sixteenth century. As a high-income elastic good, the increase in wine output seems consistent with the progress experienced by the Spanish economy. This depiction also fits olive oil that appears as a volatile product showing intense contractions in the 1510s and in the 1580s. The behaviour of fruits and legumes conveys–with reservations due its poor coverage in terms of tithes- the view of a product whose demand was raising over time, as did not contract between mid-sixteen and mid-seventeenth century, grew faster than average until 1750 and continued growing up to 1800 amid general stagnation. Livestock produce evolved along cereals and presented a stronger recovery between the 1680s and the 1730s, a fact possibly associated to the increasing weight acquired by stabled (*estante*) livestock throughout the eighteenth century relative to the transhumant livestock that had leading role in previous centuries (Phillips and Phillips, 1997).

[14] In the Kingdom of Castile livestock also represented one-fifth (19.8%) of agricultural output in the 1750s according to Cadastre of Ensenada (Grupo ’75 (1977), pp. 177 and 186.

Total output shows mild long term growth that can be divided into four distinctive phases (Figure 2), the first one, of sustained growth to 1570, which can be conjectured goes back, at least, to the early fifteenth century, accelerating during central decades of the sixteenth century (Table 1). A contraction occurred since 1570, more dramatic up to the 1610s and at a slower pace during the first half of the seventeenth century. The recovery peaked in 1750, when the highest level in four centuries was achieved. Then, output stabilised, short-run fluctuations aside, until 1800.

During the first two-thirds of the sixteenth century the increase in output catered a raising urban demand. The rise in relative foodstuffs prices generated incentives to expand production over new land, including the King's *baldíos* (literally, waste lands, but depicting non-previously cultivated land). From 1560 onwards the King's lands were on sale and it was in the surroundings of main cities (Madrid, Seville, Valladolid) where the demand for land was more intense (Vassberg, 1975; Álvarez-Nogal, 2003).

Regional variance was substantial according to partial and qualitative evidence. It resulted not only from differences in factor endowments or soil quality but from trade opportunities and institutional changes. Thus, while the contraction in Castile's agricultural output is associated to falling urban demand from 1570 onwards, in Andalusia the fall in colonial trade from 1610 to the end of the seventeenth century can be suggested as another main reason (García Fuentes, 1980).

How do production trends compare to those of population? Annual population series are lacking and all we have are point estimates from scattered *vecindarios* (local censuses) up to 1700 and scattered censuses in the late eighteenth century (Pérez Moreda, 1988). Historians have drawn population trends on the basis of baptism records (Nadal, 1988). This procedure implies assuming that deaths rates kept a stable relationship with birth rates and that net migration flows are negligible over time. Nonetheless, it seems a superior alternative to a simple interpolation between scattered benchmark estimates. In order to derive total population, the Census figure for 1787 has been accepted as representative for the 1780s and projected back and

forth with decadal baptism indices.[15] Alternative population estimates through benchmark estimates interpolation and baptisms are offered in Figure 3. Although they share trends, a more nuanced pictured is obtained from the baptism series. From baptism indices it can be suggested that population grew at an annual compound rate of 0.3 per cent over 1500-1800. After a phase of mild expansion in the early sixteenth century, growth accelerated to 1.0 per cent between 1540 and 1580. On the whole, the rate of growth amounted to 0.6 per cent over 1500-1590. Then, population declined during 1590-1650. From 1660 onwards population growth resumed at an average 0.3 per cent annually and, by the first decade of the eighteenth century, the 1580s level had been recovered. Demographic expansion from 1720 to 1800 proceeded at faster pace (0.45 per cent per year).

Trends in agricultural output per person can, now, be drawn (Figure 4). A first phase of relative stability at high level of output per head lasted to 1570. Actually, if our crude estimates for the fifteenth century were accepted, the high plateau would have covered more than a century (Figure 4). A decline took place between the 1560s and 1640s with output per person shrinking to two-thirds, at a cumulative growth rate of -0.5 per cent per year, and a phase of deeper contraction during the years 1570-1590 (at -1.5 per cent) (Table 2). Output per head stabilised at low levels during the seventeenth century. The first half of the eighteenth century witnessed recovery, with a positive but mild growth rate (0.2 per cent). Another contraction phase occurred between 1750 and 1800 (at a yearly rate of 0.45 per cent). On the whole, by 1800, agricultural output per inhabitant would have been shrunk to 60 per cent of its level at the beginning of the sixteenth century. It is worth noting that, as a consequence of the late sixteenth century dramatic decline, output per head evolved along a new, lower path until the end of the Napoleonic Wars.

[15] The idea of using the 1787 level as a benchmark comes from David Reher who kindly supplied us decadal estimates from 1520s onwards. For 1610s-1790s we have used Llopis Agelán and Sebastián Amarilla (2007) baptism decadal series. As for the pre-1520s decades, we had to rely on log-linear interpolation of Pérez Moreda (1988) benchmark estimates.

A fact to be highlighted is that the relative stability of agricultural output per inhabitant was achieved while population experience a fast expansion, especially over 1550-1570 (Figure 4). Furthermore, output per head and population evolved alongside between 1580 and 1750, shrinking during the first half of the seventeenth century and, then, expanding in the early eighteenth century. It is only in the second half of the eighteenth century when population evolves inversely to output per inhabitant. These findings imply that, before 1750, Spain far from being a Malthusian society, was an economy in which the frontier continued expanding not just to the late sixteenth century -as previously claimed (Álvarez-Nogal and Prados de la Escosura, 2013)- but to the mid-eighteenth century. By then, agriculture satisfied the increasing demand of food of a growing population at the extensive margin, as large areas of the country were put into cultivation. Landowners who controlled substantial amounts of land put them into cultivation taking advantage of the abundant labour force (Santiago-Caballero, 2013). Only from 1750 onwards an inverse relationship emerged between changes in production per person and in population, which could be deemed as Malthusian.

How do the new estimates compare to those derived through the demand approach? As it can be observed (Table 2 and Figure 4), both tithe-based and demand approach estimates provide roughly the same trends for agricultural output per head. A major difference between the two sets of estimates is that while in the demand approach consumption per head is directly computed[16], in the case of the tithe-based estimate the results are very sensitive to the population estimates used to derived output per head. Although the two regimes mentioned above, of pre-1580s high and post-1580s low output per head levels are confirmed in both estimates, the demand approach presents a more gradual decline that also reached a trough in the 1640s and a shorter recovery to the 1720s.

[16] A shortcoming of the estimates for the case of Spain is net imports of foodstuffs were assumed to be negligible, so consumption and output per head were considered equivalent (Álvarez-Nogal and Prados de la Escosura, 2013).

How does the experience of Spanish agriculture compare to those of north-west Europe? Does the view of a reversal of fortune between the North Sea and Mediterranean areas find any support in it? A comparison of long-run trends in agricultural output per head and population between Spain and Britain is most revealing. In Spain, levels of output per head are significantly lower after 1570, falling during the late eighteenth century (Figure 4); in Britain, the evolution of output per head exhibits a wide and mild U shape with the peak in the 1450s recovered in the 1770s and overcome by 1800 (Figure 5). An additional element to be considered is that while in Spain agriculture employed about two-thirds of the male labour force by the late eighteenth century (and can be hypothesised that about four-fifths by 1500) (Pérez Moreda, 1999: 54; Álvarez-Nogal and Prados de la Escosura, 2007), in Britain it represented just over one-third in 1801, from an initial share of two-thirds in 1522 (Broadberry et al., 2014: 362). The implication is that labour productivity experienced a long-run decline in Spain throughout the early modern era while it exhibited a sustained improvement in Britain (Figure 6).[17] From these opposite trends it can be concluded that agriculture played a significant part in the *little divergence* between north-western and southern Europe.

Spanish Agriculture in the 'Little Divergence'

Between the early sixteenth century and 1570 a great economic expansion took place driven by urban growth. Commerce, both domestic and international (including colonial), expanded. Wool exported to North-Western Europe was, aside silver, the most important staple. This expansion increased the demand for agricultural goods, some of them of high-income elasticity (i.e. wine), which led to a rise in the relative

[17] Measuring labour productivity levels for early modern Spain is a real challenge. As regards the denominator (labour input), all that can be crudely estimated is economically active population (EAP). EAP has been obtained in two stages. Firstly, working age population (WAP) estimates were derived by computing the working age/total population ratio at national level from the 1797 population census and projecting it backwards to 1586 on the basis of David Reher (1991) shares in total population of those aged 16-50 for New Castile (we assumed the late sixteenth century WAP share was acceptable for the entire century). Then, the EAP/WAP ratio for 1797 was applied to the resulting series to derive EAP shares in total population. EAP shares were, then, multiplied by our total population estimates. Lastly, agricultural EAP figures were derived by applying the ratio from Álvarez-Nogal and Prados de la Escosura (2007) (for 1530, 1591, 1700, 1750, and 1787)- to total EAP estimates. In the case of Britain, labour productivity estimates correspond to benchmark estimates for 1522, 1700, 1759, and 1801, and come from Broadberry et al. (2014: 365).

price agricultural goods and to an expansion of land under the plough. The extension of cultivation, including the so-called *baldíos*, was its result (Álvarez-Nogal, 2001). During this period, population increased at a fast pace, while agricultural output per head remained stable. Such behaviour differs from the expected a Malthusian scenario, in which these variables would evolve in opposite directions. As a result of a higher demand of land and an increase in both population and agricultural labour force, the relative price of land rose relative to that of labour, raising income inequality in so far returns to land are more concentrated than returns to raw labour (Figure 7).

After 1570 a more complex scenario appeared. The king did not collect taxes directly but through cities and cities rejected the king's demand to increase consumption taxes (*alcabalas*). This led the king to defaulting on its debt payments to the Genoese bankers, a decision that trickled down, affecting the credit of small traders and merchants (fairs, for example, also declined since 1568). As a result, the economy entered into recession. *Alcabalas* doubled, opening the way to successive tax increases that would be levied on cities up to the 1660s and 1670s (including additional taxes on consumption goods, the so called *millones*). Meanwhile, different military conflicts took place in a short time span: the Low Countries rebellion of 1567 and open war after 1573, the Moorish uprising in the Alpujarras in 1569, and the Lepanto battle in 1571, all required a substantial increase in military expenditure. Spain's wars extended to England and peaked with the Armada expedition in 1588. War destroyed trade networks and wool exports would never recover pre-1570 levels. Urban decline implied that wool was not diverted to the domestic industry as domestic markets were shrinking. Moreover, population declined up to 1650. Along shrinking population a deeper contraction happened in agricultural output per head. A two-phase reduction in output per head took place: a short and intense period of economic collapse in the 1570s and 1580s that was followed by steady decline to mid-17th century.

Environmental degradation also had an effect on agricultural performance. Between 1570 and 1620 temperatures fell significantly, along with an intense increase in the number of catastrophic floods, sea storms and cold spells (Rodrigo, 1994). This

deep climatic anomaly, identified as 'the initial oscillation', continued between 1620 and 1640 with severe and long droughts (Barriendos, 1994, 1999).

Our explanatory hypothesis is that the collapse in urban and external demand for agricultural goods, fuelled by monetary instability and military conflict in different parts of Iberia (war with France 1635-1659, and the Portuguese (1640-1668) and Catalan (1640-1652) rebellions) stymied crops and prevented normal agricultural activities in different parts of Iberia reducing incentives to cultivate that resulted in a less intense use of land. As a result, the land rent-wage ratio contracted all the way to the 1670s, even when real wage rates continued to decline until the 1640s, and only recovered in a sustained way since the 1720s (Figure 7).

A recovery started in the late seventeenth century. From the 1660s to the 1740s population grew accompanied by a milder expansion of output per head, a fact suggesting that land was still abundant. Only in the second half of the eighteenth century a more conventional Malthusian scenario emerged with population expanding alongside output per head contraction. This reflects in the land rent-wage ratio that increases sharply from 1750 onwards. Agriculture, that had expanded extensively, in the absence of new inputs of land and capital, was unable to react to growing population by improving its efficiency, so its output per person shrank throughout the second half of eighteenth century. This scenario coincided with another climatic shift known as the 'Maldá Anomaly' (1760-1800), that brought with it an increase in the number of successive climatic disasters (floods, droughts, and sea storms) that made increasingly difficult for agrarian producers the adaptation to the changing weather (Barriendos and Llasat, 2003).

Concluding Remarks

Trends in agricultural output have been estimated on the basis of a large tithe database. Over three and a half centuries, agricultural output per head evolved in parallel with population, supporting the view of Spain as a land abundant frontier economy up to the mid-eighteenth century while a Malthusian pattern only emerged after 1750.

Two different paths are found in agricultural performance. A high path in output per head up the late sixteenth century was broken by a severe contraction over 1570-1590, initiating a low path that lasted to 1800. An affluent agriculture with relatively high levels of per capita consumption and labour productivity was, thus, replaced by another one of low consumption and productivity levels that persisted to the Napoleonic Wars. Thus, agriculture contributed to Spain's falling behind and, hence, to Europe's *little divergence*.

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Table 1

Growth Rates of Agricultural Output and its Main Components, 1420-1800 (%)

	Cereals	Olive Oil	Wine	Legumes & Fruit	Livestock	Crops Output	Total Output
1410/9-1510/9	0.25	-0.60				0.21	*0.20*
1510/9-1560/9	0.48	2.52	0.86	0.24	0.46	0.59	0.55
1560/9-1640/9	-0.56	-0.55	-0.85	0.10	-0.47	-0.56	-0.54
1640/9-1740/9	0.23	0.26	0.89	0.59	0.63	0.33	0.42
1740/9-1790/9	0.16	0.12	-0.15	0.46	0.01	0.14	0.10
1560/9-1580/9	-0.77	-2.77	-0.44	0.84	-1.24	-0.76	-0.88
1580/9-1610/9	-0.70	0.43	-1.12	-0.78	-0.10	-0.70	-0.55
1610/9-1640/9	-0.27	-0.06	-0.84	0.47	-0.33	-0.28	-0.29
1410/9-1790/9	0.09	0.16				0.12	*0.14*
1500/9-1790/9	0.05	0.05	0.30	0.37	0.20	0.10	0.13

Sources: See text.

Table 2

Agricultural Output per Head Growth, 1420-1800 (%)

	Tithes approach	Demand approach
1410/9-1510/9	0.06	-0.08
1510/9-1560/9	-0.16	-0.32
1560/9-1640/9	-0.49	-0.38
1640/9-1740/9	0.14	0.10
1740/9-1790/9	-0.45	-0.17
1560/9-1580/9	-1.48	-0.20
1580/9-1610/9	-0.26	-0.37
1610/9-1640/9	-0.07	-0.51
1640/9-1690/9	0.06	0.44
1690/9-1740/9	0.22	-0.24
1410/9-1790/9	-0.13	-0.14
1500/9-1790/9	-0.18	-0.14

Sources: See text.

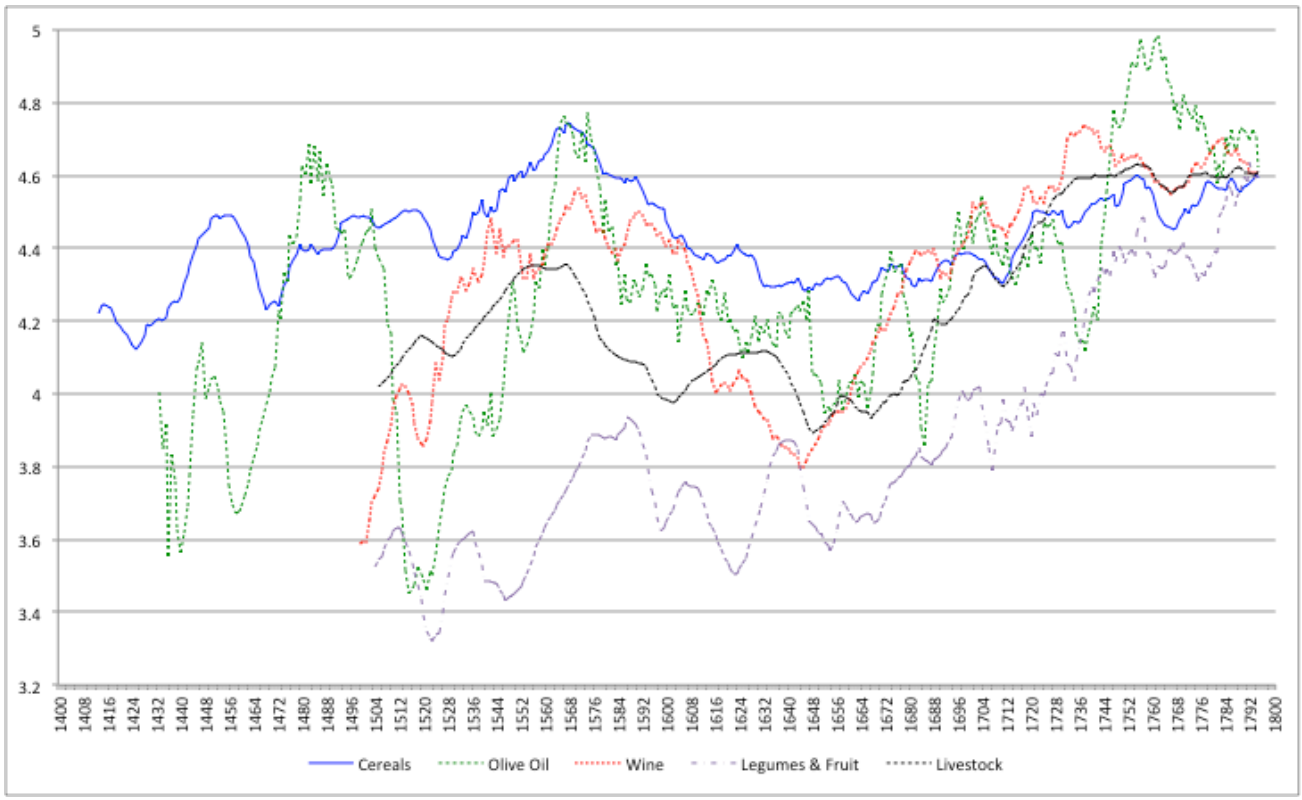

Figure 1. Agricultural Output: Main Components, 1400-1800 (11-year centred moving averages in logs) (1790/99=100). *Source*: See the text.

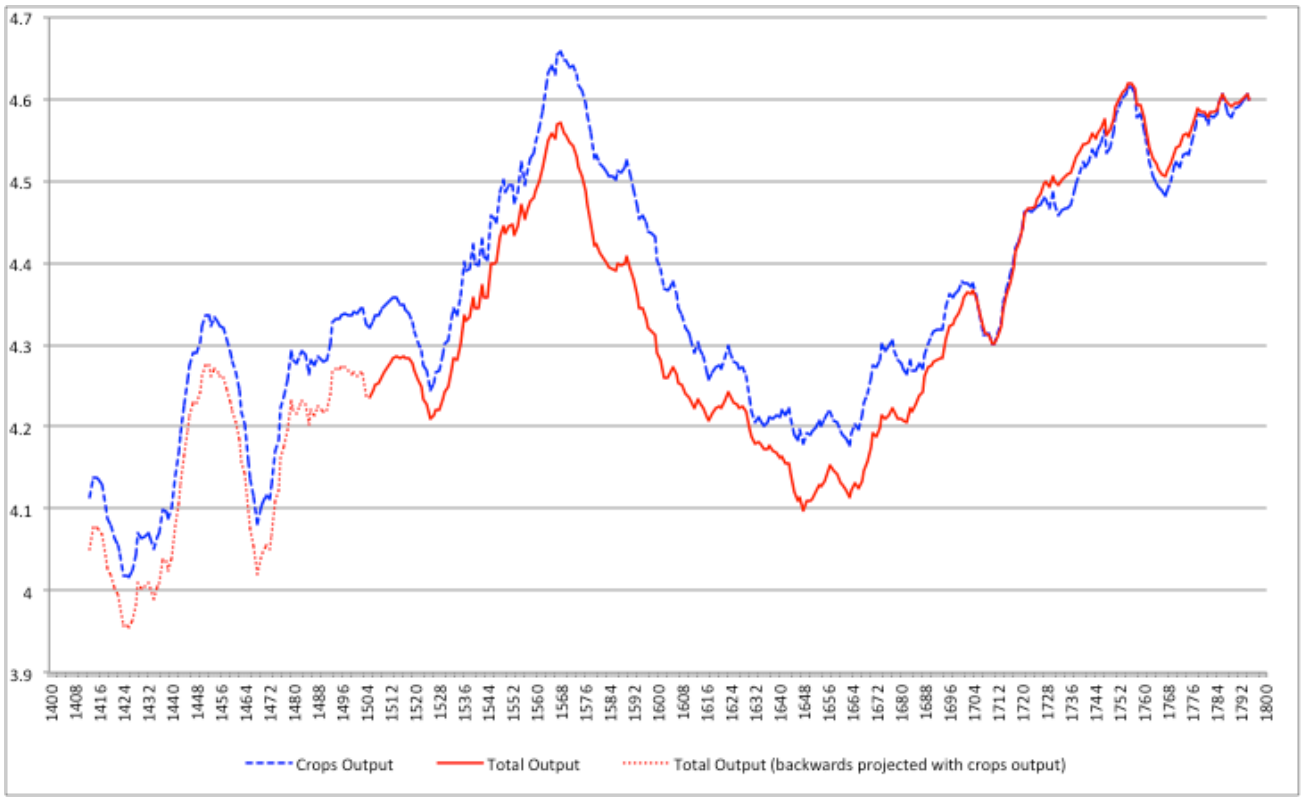

Figure 2. Crops and Agricultural Output, 1420-1800 (11-year centred moving averages in logs) (1790/99=100). *Source*: see the text.

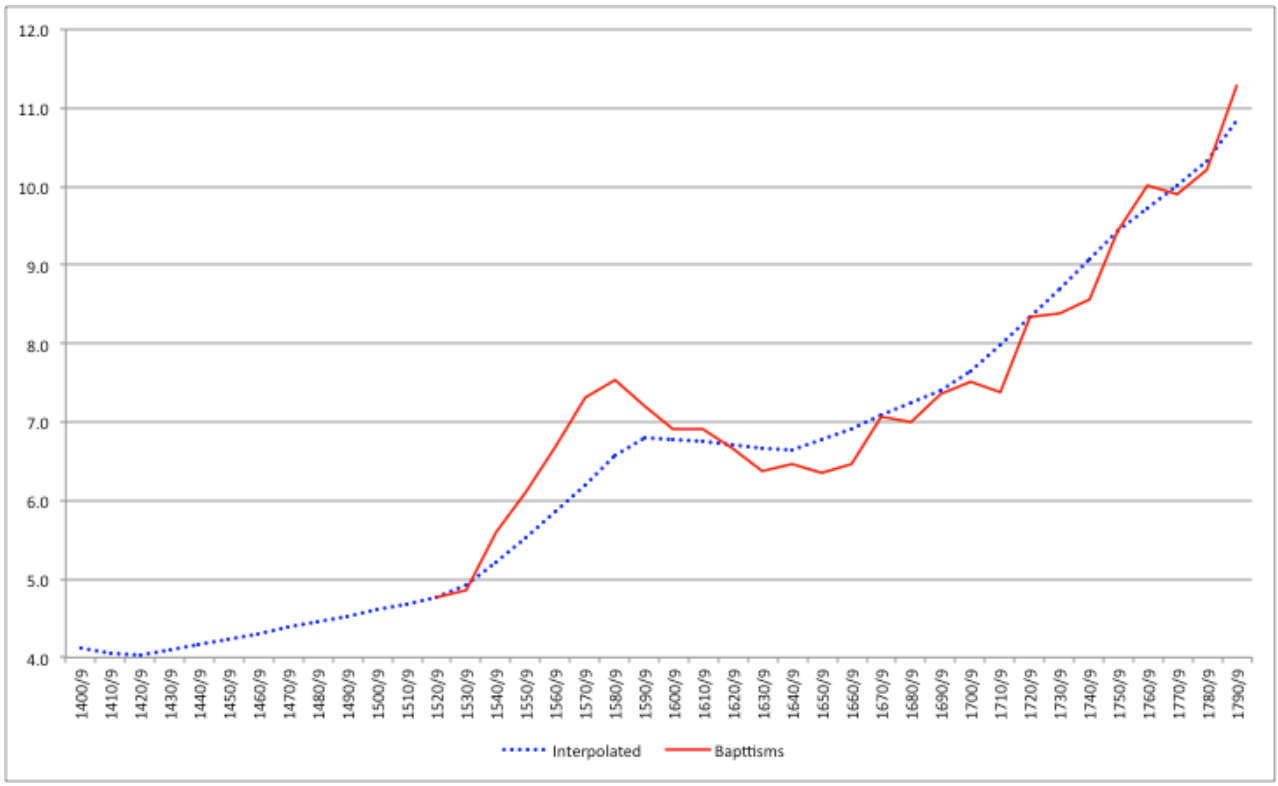

Figure 3. Trends in Population, 1400-1800 (decadal averages) (million)
Sources: Baptisms, Llopis & Sebastián (2007) and Reher (unpublished); Interpolation from Alvarez-Nogal and Prados de la Escosura (2007) and Pérez Moreda (1988).

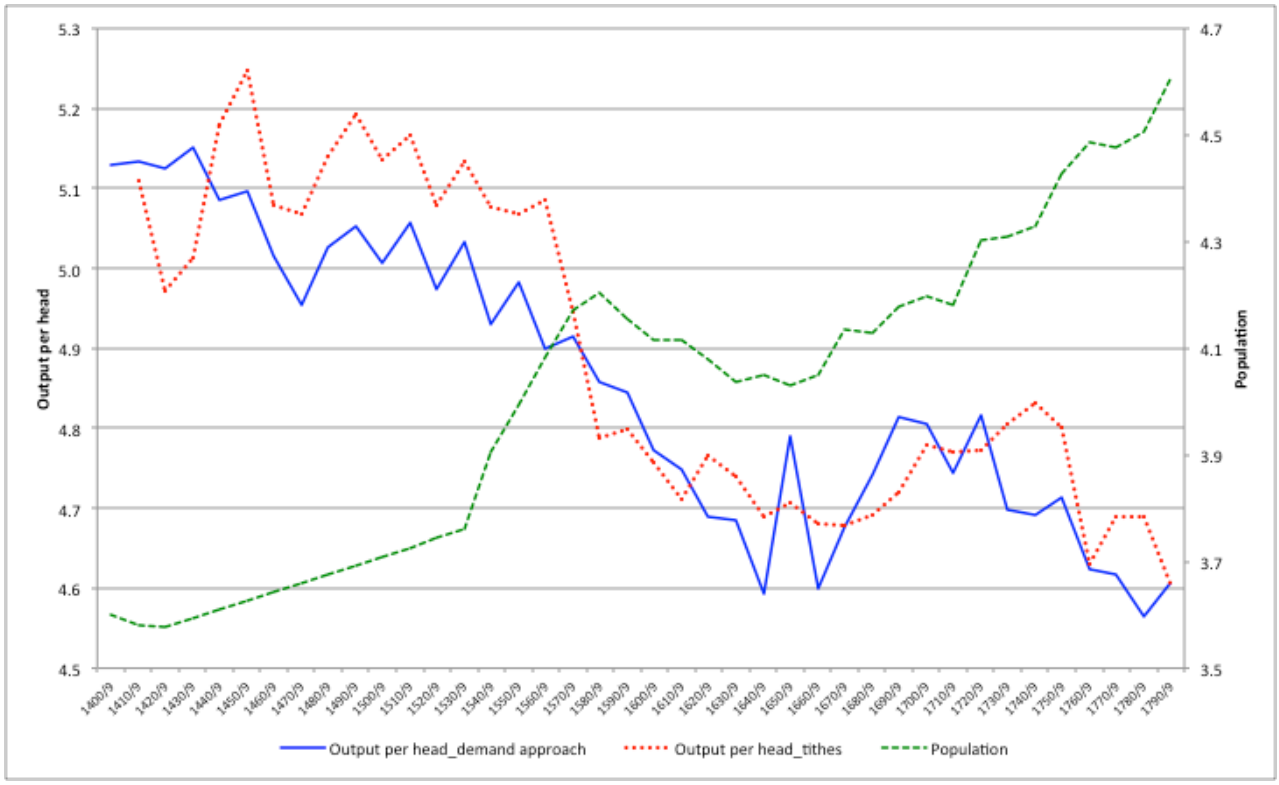

Figure 4. Agricultural output per head (Tithes and Demand approach) and population, 1400-1800 (decadal averages in logs) (1790/99=100). *Sources*: tithes, text; demand approach, Álvarez-Nogal & Prados de la Escosura (2013); population, as Figure 3.

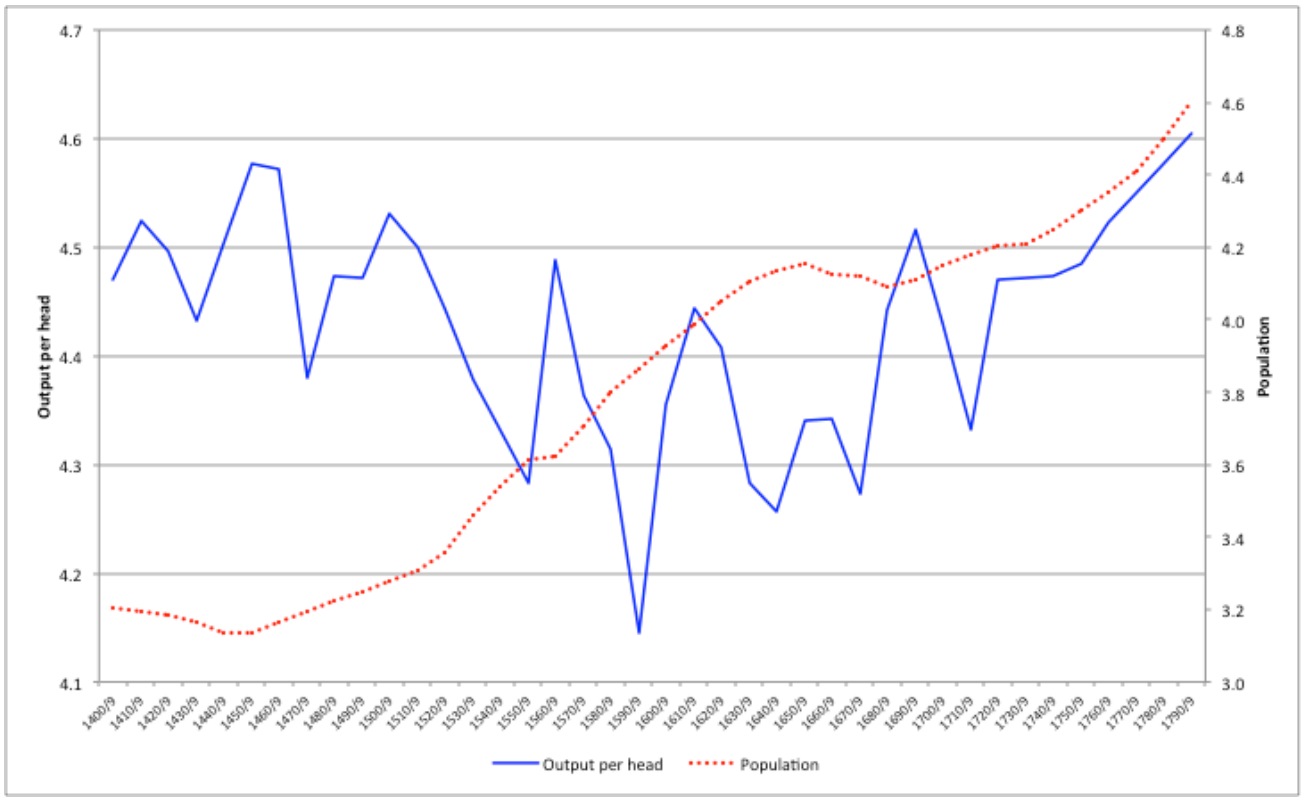

Figure 5. Agricultural output per head and population trends in Britain, 1400-1800 (decadal averages in logs) (1790/99=100). *Source*: Broadberry et al. (2014)

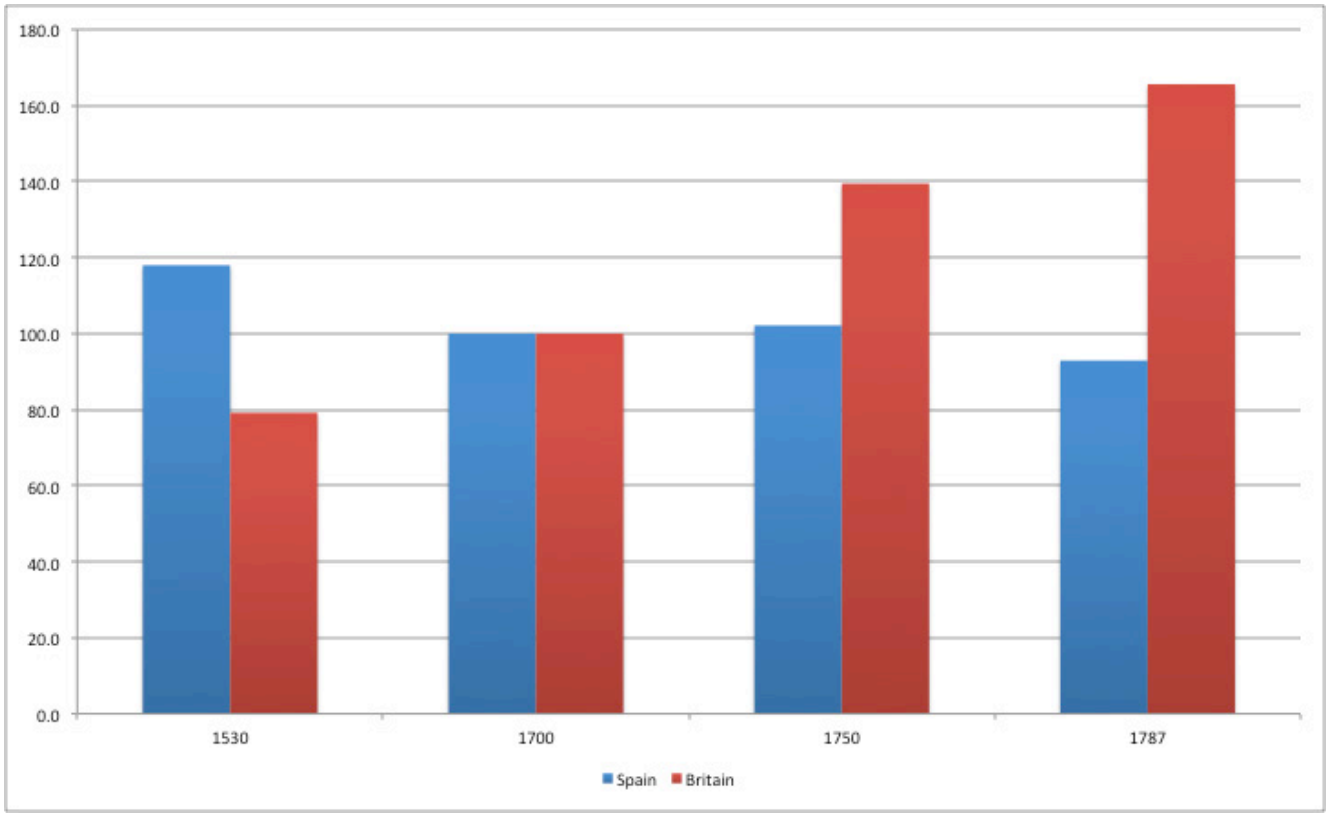

Figure 6. Agricultural labour productivity in Spain and Britain, 1500-1800 (1700=100) Sources: Britain, Broadberry et al. (2014: 365). Spain, Appendix, Table A.2 and Álvarez-Nogal and Prados de la Escosura (2007). See footnote 17.

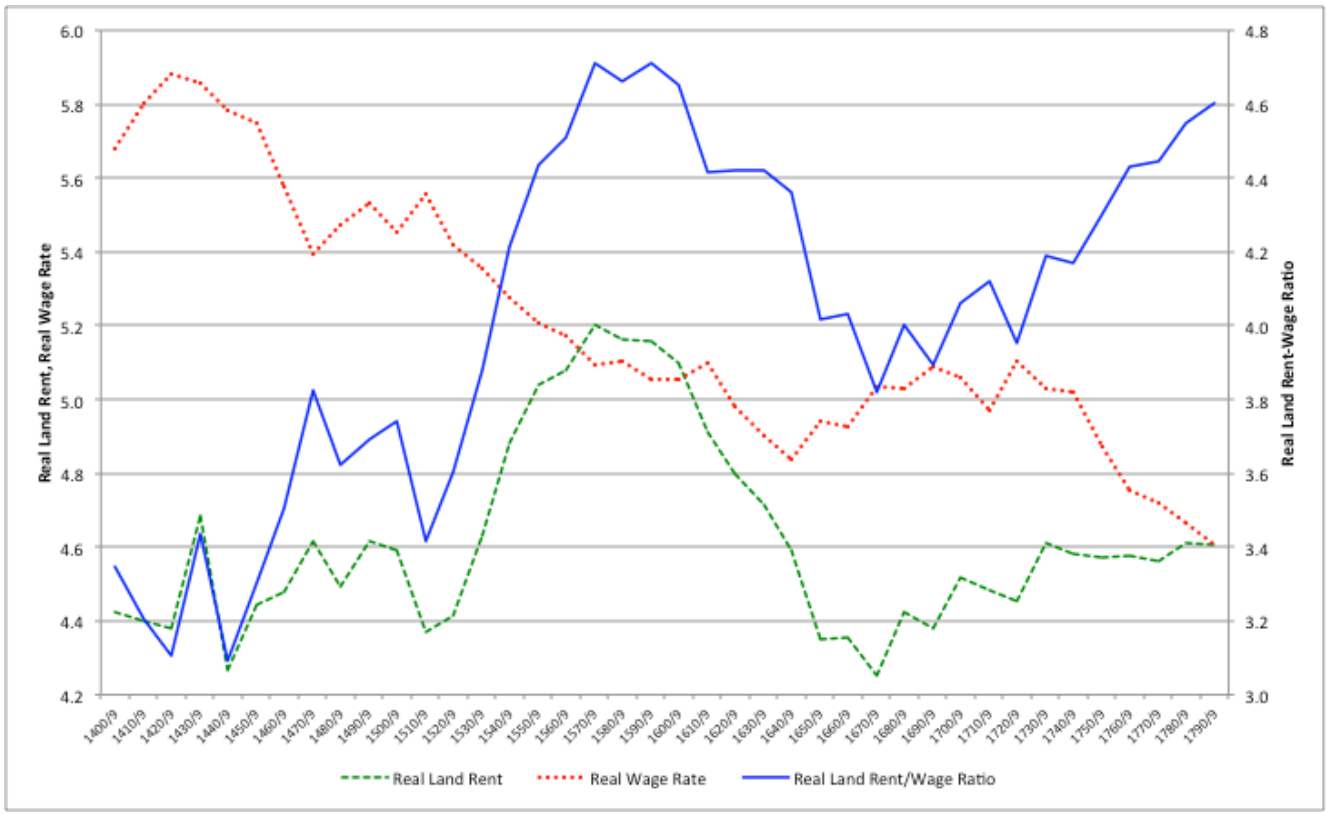

Figure 7. Land Rent-Wage Ratio, 1400-1800 (decadal averages, logs) (1790/9=100)
Source: Álvarez-Nogal and Prados de la Escosura (2013), Online Appendix.

Appendix A.

Table A.1
Main Crops, 1400-1800
(decadal averages) (1790/99=100)

	Cereals	Olive Oil	Wine	Legumes & Fruit	Livestock
1400/9	57.9				
1410/9	70.3				
1420/9	61.5	55.3			
1430/9	67.3	50.1			
1440/9	81.2	56.1			
1450/9	89.3	46.9			
1460/9	76.4	46.4			
1470/9	74.5	78.2			
1480/9	80.1	103.5			
1490/9	89.3	78.3	34.3	33.4	
1500/9	86.6	85.3	41.4	34.0	55.5
1510/9	90.3	32.1	56.6	36.2	61.4
1520/9	79.9	36.0	61.0	28.0	62.2
1530/9	85.1	53.0	68.6	37.3	63.9
1540/9	93.0	48.5	82.2	32.1	70.5
1550/9	101.0	62.2	79.8	33.7	77.7
1560/9	114.9	113.3	86.9	40.7	77.1
1570/9	108.3	114.8	92.0	48.3	69.7
1580/9	98.5	65.1	79.6	48.2	60.1
1590/9	92.1	78.8	88.2	43.0	57.5
1600/9	83.6	65.2	82.7	42.6	54.5
1610/9	79.7	74.1	56.9	38.2	58.4
1620/9	81.6	62.2	58.9	33.8	60.9
1630/9	72.7	63.7	49.2	45.3	61.0
1640/9	73.5	72.8	44.1	44.0	52.8
1650/9	74.9	52.2	51.5	36.0	51.8
1660/9	71.9	54.2	59.4	39.1	52.0
1670/9	77.4	79.8	69.1	42.8	54.4
1680/9	73.7	48.5	80.2	46.2	61.2
1690/9	78.9	81.4	76.4	49.5	66.8
1700/9	79.6	92.2	92.9	52.7	78.0
1710/9	79.3	71.7	87.5	50.8	76.4
1720/9	89.6	89.7	92.6	55.1	88.3
1730/9	87.8	61.8	112.9	57.4	99.4
1740/9	92.2	94.3	107.9	79.6	99.5
1750/9	100.8	133.6	104.9	83.5	102.5
1760/9	85.6	133.9	95.5	79.6	95.8
1770/9	92.3	117.3	102.6	74.7	100.3
1780/9	96.5	108.0	106.8	96.3	98.9
1790/9	100.0	100.0	100.0	100.0	100.0

Sources: See text.

Table A.2
Agricultural Output and Output per Head, 1400-1800
(decadal averages) (1790/99=100)

	Output	Output per Head	Consumption per head
1400/9			168.8
1410/9	*59.4*	*165.7*	169.7
1420/9	*51.6*	*144.3*	168.3
1430/9	*54.6*	*150.4*	172.6
1440/9	*65.7*	*177.8*	161.8
1450/9	*71.4*	*190.0*	163.5
1460/9	*61.4*	*160.8*	150.8
1470/9	*61.7*	*158.9*	141.8
1480/9	*67.4*	*170.7*	152.5
1490/9	*72.3*	*180.1*	156.5
1500/9	69.4	169.9	149.5
1510/9	72.7	175.2	157.3
1520/9	67.9	160.6	144.5
1530/9	72.8	169.5	153.6
1540/9	79.6	160.4	138.3
1550/9	86.2	159.0	145.9
1560/9	95.8	161.7	134.1
1570/9	91.2	140.7	136.4
1580/9	80.4	120.1	128.9
1590/9	77.4	121.3	127.2
1600/9	71.2	116.4	118.2
1610/9	68.2	111.2	115.3
1620/9	69.4	117.4	108.8
1630/9	64.8	114.5	108.4
1640/9	62.4	108.9	98.8
1650/9	62.3	110.7	120.3
1660/9	61.9	107.8	99.5
1670/9	67.4	107.6	107.4
1680/9	67.8	109.1	114.6
1690/9	73.2	112.3	123.2
1700/9	79.2	118.9	122.1
1710/9	77.2	118.0	114.9
1720/9	87.4	118.1	123.5
1730/9	91.0	122.2	109.6
1740/9	95.2	125.5	109.1
1750/9	101.8	121.6	111.3
1760/9	91.1	102.5	101.9
1770/9	95.6	108.8	101.1
1780/9	98.6	108.8	96.0
1790/9	100.0	100.0	100.0

Sources: Output and Output per head, see text; Consumption per head, Álvarez-Nogal and Prados de la Escosura (2013), Online Appendix.
Note: Output and Output per head estimates before 1500 are highly conjectural.

Appendix B. Sources and procedures

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

CEREALS

KINGDOM OF ARAGON (1466-1800)		
ARAGON (1610-1800)		
1610-1800	Latorre Ciria (2007)	
BALEARIC ISLANDS (1466-1800)		
1466-1800	Vidal (1978)	
CATALONIA (1508-1800)		
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
1756-1800	Fradera (1978)	Mataró
VALENCIA (1501-1800)		
1501-1565	Casey (1979)	
1566-1700	Casey (1979) Ardit Lucas (1987) Palop Ramos (1982)	
1701-1800	Ardit Lucas (1987) Palop Ramos (1982)	

NAVARRE (1569-1634)		
1569-1634	Belascoain Cemborain (2011)	

KINGDOM OF CASTILE (1408-1800)		
ANDALUSIA (1402-1800)		
Seville (1408-1800)		
1408-1503	Ladero Quesada (1979)	Archbishopric of Seville
1469-1503	Ladero Quesada (1979)	Seville, Carmona, Jerez and Niebla
1515-1579	Ponsot (1986)[18]	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

[18] 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.

1606-1800	Ponsot (1986)	Montemayor
Cadiz (1493-1800)		
1493-1800	Ponsot (1986	Conil, Jerez, Chiclana, Vejer, Medina Sidonia and Trebujena
Huelva (1451-1800)		
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
Cordoba (1580-1800)		
1580-1800	Ponsot (1986)	Baena, Bujalance, Cabra, Castro y Espejo, Espiel, Fernan Nuñez, Montoro, Palma del Rio, Posadas, la Rambla, Santaella and Cordoba
Granada (1690-1800)		
1690-1800	Garzon Pareja (1974, 1982)	
Malaga (1555-1800)		
1555-1800	Benitez Sanchez-Blanco (1982)	Cartama, Borge, Setenil, Antequera, Marbella and Casares.
EXTREMADURA (1500-1788)		
1500-1599	Pereira Iglesias (1990) [19]	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
1797-1800	Rodriguez Cancho et al. (2004)	Plasencia
CANARY ISLANDS(1613-1800)		
1613-1800	Macias Hernandez (1984)	Arucas, Teror, Telde, Matanza, Realejos, Icod, Arico, Tirajana, and Fuerteventura
MURCIA (1580-1800)		
1580-1800	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 (1402-1800)		
Burgos (1402-1800)		
1402-1520	Casado Alonso (1991)	
1590-1800	Hernández García and Pérez Romero (2008) [20]	
La Rioja (1550-1800)		
1550-1800	Ibañez Rodriguez and Alonso Castrobiejo (1996)	
Santander (1607-1800)		
1607-1800	Lanza García (1991)	Rozas, Piasca, San Mames de Meruelo, Abionzo, and Gajano

[19] Tithes paid in cash that were deflated.
[20] Tithes paid in cash that were deflated.

Leon (1569-1800)		
1569-1800	Sebastian Amarilla (1992)	Monastery of Sandoval
Palencia and Valladolid (1550-1800)		
1550-1800	García and Pérez Romero (2008) [21]	
Segovia (1550-1800)		
1550-1800	García and Pérez Romero (2008) [22]	
Soria (1550-1800)		
1550-1800	García and Pérez Romero (2008) [23]	
Zamora (1523-1800)		
1523-1800	Álvarez Vázquez (1984)	
BASQUE PROVINCES (1537-1800)		
1537-1800	Bilbao Bilbao and Fernandez de Pinedo (1984)	
GALICIA (1594-1800)		
1594-1800	Erias Roel (1982)	

WINE

KINGDOM OF ARAGON (1502-1800)		
ARAGON (1502-1600)		
1502-1600	Latorre Ciria (1989)	Liesa, Floren, and Huesca
CATALONIA(1666-1800)		
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

NAVARRE (1569-1625)		
1569-1625	Belascoain Cemborain (2011).	

KINGDOM OF CASTILE (1490-1800)		
ANDALUSIA (1490-1800)		
Seville (1490-1800)[24]		
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
1679-1800	Ponsot (1986)	Alcala del Rio, Cazalla de la Sierra, Lebrija, Marchena, and Osuna
Cadiz (1494-1800)[25]		

[21] Decadal estimates.
[22] Decadal estimates.
[23] Decadal estimates.
[24] Series were in cash and were deflated using the prices in Ponsot (1986).

1494-1800	Ponsot (1986)	Jerez and Chiclana
Huelva (1579-1800) [26]		
1579-1641	Ponsot (1986)	La Palma
1642-1800	Ponsot (1986)	La Palma and Almonte
Cordoba (1580-1800) [27]		
1580-1800	Ponsot (1986)	Baena, Cabra, Castro y Espejo, Espiel, Montoro, Posadas, and La Rambla
OLD CASTILE (1550-1800)		
Burgos (1550-1800)		
1550-1800	Ibañez Rodriguez and Alonso Castrobiejo (1996)	
Santander (1624-1800)		
1624-1800	Lanza García (1991)	Piasca, Santiago de Heras, Valle de Ruesga, Gajano, and Rubayo
Segovia (1610-1800)		
1610-1800	García Sanz (1977)	
BASQUE PROVINCES (1537-1800)		
1537-1800	Bilbao & Fernandez de Pinedo (1984)	

OLIVE OIL

KINGDOM OF ARAGON (1570-1800)		
ARAGON (1750-1800)		
1750-1800	Daviu y Pons (1978)	Majorca
BALEARIC ISLANDS (1750-1800)		
1750-1800	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

KINGDOM OF CASTILE (1428-1800)		
ANDALUSIA (1428-1800)		
Seville (1428-1800)		
1428-1510	González Arce (2015)[28]	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
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

[25] Series were obtained by deflating tithes in cash paid with prices in Ponsot (1986).
[26] Series were obtained by deflating tithes in cash paid with prices in Ponsot (1986).
[27] Series were obtained by deflating tithes in cash paid with prices in Ponsot (1986).
[28] 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.

1599-1641	Ponsot (1986)	Santa Maria de Carmona, and El Coronil
1642-1769	Ponsot (1986)	Santa Maria de Carmona, Marchena, and Osuna
1770-1800	Ponsot (1986)	Cazalla de la Sierra, Lebrija, Marchena, and Osuna
Huelva (1494-1800)[29]		
1494-1608	Ponsot (1986)	Moguer, Aracena and, la Palma
1609-1641	Ponsot (1986)	Hinojosos
1642-1800	Ponsot (1986)	Moguer and la Palma
Cordoba (1581-1800)[30]		
1581-1800	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 (1649-1800)		
BALEARIC ISLANDS (1649-1800)		
1649-1800	Vidal (1978)	Majorca
CATALONIA (1658-1800)		
1658-1670	Serra i Puig (1978)	Martorelles
1671-1715	Serra i Puig (1978)	Martorelles and Sentmenat
1716-1729	Serra i Puig (1978) Badosa i Coll (1978)	Sentmenat and Badosa Sants/I'Hospitalet
1730-1760	Badosa i Coll (1978)	Sants/l'Hospitalet and Gracia-Sant Geivasi
1761-1800	Badosa i Coll (1978)	Sants/l'Hospitalet
Valencia (1499-1700)		
1553-1700 (Fruits)	Casey (1979)	
1499-1602 (Vegetables)	Salvador Esteban (2004)	

LIVESTOCK PRODUCE

KINGDOM OF ARAGON (1501-1800)		
ARAGON (1610-1800)		
1610-1800	Latorre Ciria (2007)	
VALENCIA (1501-1800)		
1501-1565	Casey (1979)	
1566-1700	Casey (1979) Ardit Lucas (1987)	
1701-1800	Ardit Lucas (1987)	

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

KINGDOM OF CASTILE (1500-1800)		
MURCIA (1591-1800)		
1591-1800	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 (1610-1800)		
Segovia (1610-1800)		
1610-1800	Garcia Sanz (1977)	
Soria (1682-1800)		
1682-1800	Andrés Gallego (1973)	