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LAND-USE PROFILES OF AGRARIAN INCOME AND LAND OWNERSHIP INEQUALITY IN THE PROVINCE OF BARCELONA IN MID-NINETEENTH CENTURY

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Abstract: According to the existing literature, when land remained the most abundant factor an increase in market integration is expected to lead to a greater inequality in wealth or income distribution. However, several case studies on the vineyard specialization experienced in Catalonia during the 18th and 19th centuries suggested another outcome: land ownership and agrarian income became less uneven, not the opposite. The outstanding interpretation posed by Catalan rural historians deserves to be confirmed or rejected by applying different inequality and polarization indices (Gini, Theil and top incomes), and innovative methods (inequality possible frontier and extraction ratios), to the big dataset we have been able to assemble with the information provided for every cadastral taxpayer of each municipality in the *Distribution of Personal Wealth in Real Estate Ownership in the Province of Barcelona* published in 1852 by the Official Gazette, combined with other population and land-use data listed in a *Land-Use Statistics of the Province of Barcelona* compiled in 1858. The results confirm that landownership and income inequality were lower in winegrowing municipalities than in cereal-cropping or forest ones, in spite of the fact that commercial specialization and higher population densities could have meant an extended frontier of possible inequality.

Keywords: agrarian income distribution, land ownership, personal inequality, regional inequality, land-use patterns, tax burden

JEL: N53, D31, H24, Q15

Resumen: Cuando la tierra aún era el factor más abundante, lo esperable es que la integración en el mercado generara una mayor desigualdad en la distribución de la riqueza o los ingresos. Sin embargo, varios estudios de caso sobre la especialización vitícola catalana de los siglos XVIII y XIX sugieren lo contrario. Esa interpretación propuesta por la historiografía rural catalana merece ser confirmada o rechazada con la aplicación de diferentes índices de desigualdad o polarización (Gini, Theil y la porción en manos del % más rico), y nuevos métodos (frontera de desigualdad posible y tasa de extracción), a la base de datos que hemos podido reunir con la información proporcionada para todos los contribuyentes de cada municipio en la *Distribución Personal de la Riqueza Territorial* publicada en 1852 por el Boletín Oficial de la provincia de Barcelona, y por la *Estadística Territorial* de esta provincia confeccionada en 1858. Los resultados confirman que la desigualdad en la propiedad de la tierra y los ingresos agrarios era menor en municipios vitícolas que en los cerealícolas o forestales, pese a que la especialización comercial y una mayor densidad de población podrían haber aumentado la frontera de máxima desigualdad posible.

Palabas clave: distribución del ingreso agrario, riqueza patrimonial de bienes inmuebles, desigualdad personal, desigualdad territorial, usos del suelo, presión fiscal.

LAND-USE PROFILES OF AGRARIAN INCOME AND LAND OWNERSHIP INEQUALITY IN THE PROVINCE OF BARCELONA IN MID-NINETEENTH CENTURY[1]

Enric Tello and Marc Badia-Miró
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I. INTRODUCTION

There exists in the literature on inequality and economic growth a fairly general consensus in considering that the historical processes of commercial specialization and economic globalization lead to more uneven distributions of income or wealth—at least in an early stage when land remained the most abundant factor endowment. This entails a significant point of agreement among many authors that follow mainstream economic approaches (Williamson 1991, 1999 and 2006; O'Rourke and Williamson 1999; Bourguignon and Morrison 2002; Lindert and Williamson 2003; Acemoglu et al. 2002; Milanovic 2005; Acemoglu and Robinson 2006; Piketty et al. 2006; Atkinson and Piketty eds. 2007; Prados de La Escosura 2008; Roine and Waldenström 2009) with other who adopt more heterodox interpretive lines (Hornborg et al. 2007). Moreover, Milanovic, Lindert and Williamson (2007) have recently stressed the point that attaining higher total incomes thanks to these processes of market integration could also mean an upward shift of the inequality possible frontier and a raise in the maximum extraction ratio taken by a small elite.

All that makes a very interesting and somewhat intriguing counterexample the process of agricultural specialization in brandies and wines experienced in Catalonia from mid-17th century up to the Phylloxera plague at the late 19th century (Vilar 1962; Valls 2004). In fact, many existing historical monographs stress the opposite result: the spread of vineyards in this North-eastern corner of the Iberian Peninsula led to a less unequal rural society (Cussó et al. 2006; Tello et al. 2006; Olarieta, et al. 2008; Garrabou et al. 2008; Garrabou et al. 2009).[2] Therefore, we are going to test this hypothesis, put forward by previous comparative local case studies, that the Catalan vineyard specialization was accompanied by a reduction of inequality in access to land and distribution of agrarian incomes.

According to these case studies, there would have been two specific mechanisms through which winegrowing specialization could have led to a reduction of inequality in land ownership and agricultural income, one direct and another indirect. The direct

[1] This work springs from the research project HAR2009-13748-C03-01 on *Environmental History of Mediterranean Agrarian Landscapes* at the University of Barcelona, financed by the Spanish Ministry of Science and Innovation (On-line URL:http://www.ub.edu/histeco/p2/eng/index.php). We thank Yaiza Alemany, Marta Nieto, Julia Ossorio and Alba Pigrau for their care in transferring data from the *Repartimiento Personal de la Riqueza Territorial* of 1852 to excel sheets for this project. We are very grateful to Ricard Garcia Orallo for their valuable assistance in locating this historical source in the library of the University of Barcelona, and clarifying its origin from the corresponding Royal Order issued by Bravo Murillo at the time. We thank the useful comments by Alfonso Herranz and Jordi Guilera at the University of Barcelona, and also to all the assistants to the session 3.4 on "Property rights, social inequality, and agrarian change in southern Europe" at the international conference Rural History 2010 held in the University of Sussex (UK). None of them are responsible for our own mistakes.

[2] Santiago-Caballero (2011) also shows an inequality decrease in the cereal-growing inland Spanish province of Guadalajara during the last third of 18th century due, as it seems, to a successful local land reform.

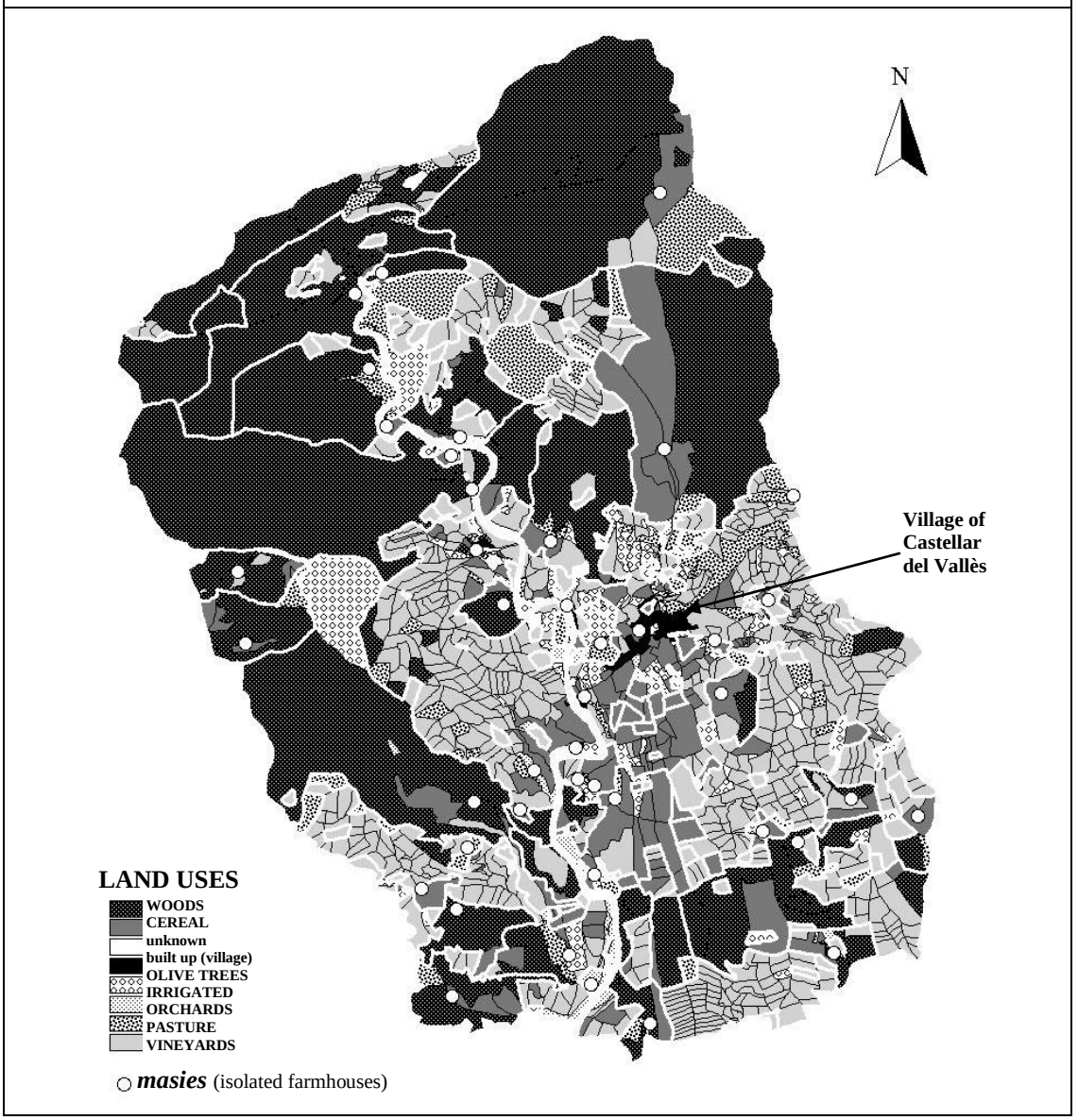
mechanism was the leasing of small plots of land from well-off landowners to landless winegrowers through a traditional sharecropping contract called in Catalan *rabassa morta* (Carmona and Simpson 1999; Badia-Miró et al. 2010). The tenancy established by this peculiar long-lease emphyteutic contract lasted until the death of all vines planted by the tenant. Given that before the Phylloxera plague winegrowers used to bury strains of their old vines in order to keep them alive, the *rabassa* tenants tried to maintain their access to land almost permanently. The duration of the contract, together with the rent share taken by the landowner from the vintage harvested by the winegrower, gave rise to a long-lasting class conflict from the end of the 18th century until the Spanish Civil War in 1936-1939 (Balcells 1980; Tello 1997; Carmona and Simpson 1999). Despite the conflicting social relationship between landowners and tenants it entailed, the fact that this tenancy system became so widespread might also be acknowledged as an achievement by the poorest sections of Catalan rural society by means of their bargaining power and collective action (Garrabou and Tello 2004, Garrabou et al. 2010).

The second indirect mechanism through which vineyard specialization could have led to a reduction in landownership and agrarian income inequalities was the ability of many *rabassa* tenants to subsist from their vines, endure the pressure of the rent taken by the owner, and prosper enough to buy a small house, an adjoining garden and even a plot of their own. It is important to note that many of these landless tenants were immigrants initially coming from the South of France and the mountain villages of the Pyrenees (Nadal and Giralt 1960). Some others, however, came from the non-inheriting progeny of the same class of well-off peasants who offered them a *rabassa* tenancy. Furthermore, as non-heirs they received a legitimate compensation from the first-born brother heir, which was paid either in cash or with a small plot of land. This second mechanism restrained landownership inequality, while the first direct spread of *rabassa* tenancies only reduced the inequality of income distribution. Taken together, both entailed an improvement of access to land and income that the *rabassa* tenants managed to open in wine-growing municipalities. These options were not so available to the poorest sectors of Catalan rural society in cereal-growing or forest and pasture areas. In this sense, we may say that Catalan winegrowing tenants managed to harness the ongoing process of population growth, commercial specialization and agricultural intensification to carry out a genuine process of empowerment.

The complex fabric of this mid-19th century Catalan rural society can be summarized looking at Figure 1, made out of a cadastral map of the small village of Castellar del Vallès drawn by Pedro Ramirez Moreno in 1854—the same topographer who compiled the abovementioned *Land-Use Statistics of the Province of Barcelona* in 1858 (manuscript 1733 of the National Geographic Institute in Madrid). The most apparent feature of agrarian settlement in most of the province was a network of scattered poly-cultural farms called *masies* in Catalan, structured into compact land units around an isolated rural dwelling (see the white dots in Figure 1). Thanks to the late medieval peasant struggles held in Catalonia before and after the Black Death, the well-off landowners who lived in these *masies* gradually gained control of the rights of access to cropped and uncultivated land over a complex and conflictive transition from feudalism to agrarian capitalism (Garrabou et al. 2008). From the 17th century onwards population growth was fostered by increasing French immigrants and higher birth numbers. The owners of the scattered farms saw these immigrants, and the disinherited descendants of the old local families, as a new and frightening landless class that tried to establish itself in the villages or towns between their networks of *masies*.

However, landowners soon discovered new favourable opportunities to take advantage of their lack of land, their labour availability, and the high relative prices of brandy or wine at the time, by leasing to them some marginal lands to plant vineyards. Many landless men became winegrowers through the emphyteutic *rabassa* contract, and a new social geography appeared when a patchwork of small vineyard plots arose among the interstices of the old poly-cultural *masies* (Tello et al. 2006; Olarieta et al. 2008; Marull et al. 2008; Marull et al. 2010). This poorest share of population used to live in the streets of small towns or villages, like Castellar del Vallés. While the shape of the diverse compact fields of every *masia* tended to be higher and be located around a scattered farmhouse, the small plots of vineyards planted by the *rabassers* used to be orientated towards the village following the existing ways and roads (see Figure 1).

Figure 1. *Old poly-cultural* masies, *new vineyard plots and main land-uses in the cadastral map of* Castellar del Vallès *in 1854*



Source: made with GIS by Marc Badia-Miró for the research project HAR2009-13748-C03-01, out of the cadastral map 1:5000 drawn by Pedro Moreno Ramirez in 1854 and kept in the historical archive of the Catalan Cartographic Institute. It has been reproduced in (Garrabou et al. 2010).

The abovementioned local case studies have shown a decrease in the Gini coefficients of landownership distribution from the beginning of the 18th century up to the Phylloxera Plague (Garrabou et al. 2008; Garrabou et al. 2009). Later, when every old vine had been ravaged during the 1880s, all the *rabassa* contracts came to an end and many tenants were evicted or gave up winegrowing. Many old *masia* owners recovered the land, and there was a new increase in landownership inequality—at least in municipalities such as Castellar del Vallés where most dead vines were not replaced by new resistant strains. In other areas, however, vineyards were replanted, many *rabassa* tenancies persisted, and with them the conflicts about the rent shares or vines and land entitlements lasted another half a century up to the Spanish Civil War and Franco's dictatorship (Badia-Miró et al. 2010). Anyway, could this pathway be generalized assuming that the reduction in inequality of the rural Catalan society up to mid-19th century was a general trend triggered by the spread of vineyard specialization?

We might cast some doubts on that, considering the following three points, briefly mentioned earlier. First of all, commercial specialization could attract more immigrants to the municipalities where vineyards were spreading, and also foster population growth in them by increasing birth rates, thus increasing the number of people who owned only very small plots or had no land of their own. Secondly, the spread of vineyards also raised the total income and wealth of the whole rural community. As Milanovic et al. (2007) have pointed out a higher income in a wealthier economy could also mean the possibility to increase the extraction ratio taken by a small elite, thus raising the frontier of maximum inequality. Thirdly, there are many historical examples showing that an increase in market integration and globalization lead to a greater inequality, not the opposite (Hornborg et al. 2007). Even adopting a standard Heckscher-Ohlin approach, this could be the expected outcome when land was still the most abundant factor endowment of a region joining a global market (Acemoglu et al. 2002; Acemoglu and Robinson 2006).

II. INEQUALITY OF WHAT, AND FROM WHOM?

Having these historical and theoretical considerations in mind, we cannot take for granted that the reduction of inequality in landownership or agrarian incomes was a general trend in the province of Barcelona, without carrying out a cross-section analysis encompassing a great deal of municipalities. To do this, we have taken as a main source the *Distribution of Personal Wealth in Real Estate Ownership* of 1852 published in the Official Gazette of the Barcelona province. This rather exceptional document lists for each of the municipalities the names of all owners of land, houses and livestock who were subject to payment of the cadastral tax, adding up the monetary evaluation of their taxable incomes and annual tax burden paid. Drawn from this source, we have been able to include in our database more than 86,000 taxpayers in 295 municipalities out of the 311 existing at present in the province. These real estate owners represented 12% of the total population, 24% all males, and 41% of all male inhabitants older than 21 recorded in the provincial census of 1857. The second main source used in our database is a *Land-Use Statistics of the Province of Barcelona* compiled in 1858 by a Spanish topographer, Pedro Moreno Ramirez, which relates the total agrarian area and the extent occupied by each agricultural, forest or pasture land-use in each municipality. This information has been combined with the 1857 census data, so as to construct a dataset to find out the land-use profiles of agrarian income and land ownership inequality in the province of Barcelona in mid-19th century.

The *Distribution of Personal Wealth in Real Estate Ownership* of 1852 is a very exceptional source. According to the Royal Order issued by the then Managing Director of Taxes, Statistics and State Heritage, all Spanish provinces had to publish in their Official Gazettes the whole list of taxpayers, with the taxes they paid and tax burden applied. The aim was to give them "*all possible safeguards that are not required to pay a greater tax burden than the one it corresponds to each one, providing for this purpose a reliable mean to check that the fee which appears in the receipts collectors must provide to them is entirely equal to that assigned to them by the established procedures*" (Bravo Murillo 1852). The document offers a list of the names of each local taxpayer, the cadastral estimated value of his or her property, and the amount of taxes yearly paid. Then, at the end of the list, the total cadastral value of all lands, houses and livestock was added up, together with the total amount of cadastral taxes yearly paid in the municipality. Finally, the two sums were used to assess the tax burden, calculated as the percentage share taken by the cadastral tax out of the total income estimated in the cadastre.

Such unusual transparency can only be understood in the context of the initial efforts to build and legitimate a modern land tax system developed by the Spanish liberal governments after the new Tax Act passed in 1845. Unfortunately, these efforts failed to achieve their ultimate goals for over a century. During the 19th century and the first third of the 20th century all Spanish liberal governments never ended the cadastral maps and enquiries needed to assess an income value for each land unit devoted to a specific crop in a given type of soil, so as to apply a uniform tax burden to calculate the amount of annual taxes to be paid by each taxpayer (Nadal and Urteaga 1990; Muro et al. 1996). Without all this complex process of cadastral inquiry no one could guarantee that properties of equal value always paid the same tax burden in all the municipalities. Due to this long-lasting failure of completing a true cadastral survey, a temporary tax system called *amillaramientos* was established. Instead of following a bottom up process to comply with the most basic principle of tax equity, the system of *amillaramientos* ran top to bottom. Each year the provincial quotas were politically distributed in Parliament at first, and then each provincial quota was politically shared out between municipalities by provincial governors (Carrasco 1867). It was only at municipal level were the already given amount of taxes to be paid for was distributed among the taxpayers according to the estimated cadastral value of their property and income—although provincial governors could take into account the local cadastral information also to allocate the provincial tax quota in each municipality.

The *Distribution of Personal Wealth in Real Estate Ownership* published in 1852 clearly demonstrated that the tax burden applied to different municipalities varied a lot, from twelve per cent of the local aggregated income up to more than twenty. It seems rather understandable that the bold initiative taken by the Spanish Ministry of Finance, ordering all provinces to publish their list of taxpayers, was carried out only once—as far as we know. Several historians have used some partial information taken from these provincial lists (Díez-Espinosa 1986; Segura 1993; Calatayud et al. 2000; Díaz-Marín 2000; Burgueño 2007), but this is the first time that a big dataset is created and fully analysed using the whole information they contain.

All these details are relevant for our purpose, because they entail a very important ambiguity in the economic data provided by this exceptional source. The primary information contained in the local *amillaramientos* referred to the surfaces of land owned by each taxpayer, together with their houses and livestock. Clearly, this was information on the distribution of agrarian wealth. Owing to other contemporary sources (Peña 1852; Carrasco 1867) we know the specific methods used by the Finance

officials to estimate in monetary terms an average yearly income from the cadastral information on personal properties recorded in physical units. However, only these final cadastral estimates of annual incomes were published in the *Distribution of Personal Wealth in Real Estate Ownership* of 1852. This is understandable, taking into account the aim to assess the tax burden variation among different taxpayers and municipalities of the same province. But it requires us to deal with the resulting ambiguity: are we calculating inequalities of wealth or income? It is well known that inequality of wealth is always greater than income inequality (Van Zanden 1995). While all people should at least be able to survive with the latter, properties were usually the results of a long-lasting accumulation that could only be carried out by those having higher incomes, and often over generations (Shenk et al. 2010).

The answer is far from simple. We cannot take this income information as if it had recorded all sorts of agrarian earnings, since only the estimated revenues from land, houses and livestock were included. All the data provided is about the aggregate value of these properties locally owned by each taxpayer. However, this information on personal wealth is given by means of an estimated average income that any owner or tenant could obtain yearly from their properties, according to the standardized procedures applied by the cadastral officials. Surprisingly enough, the Gini coefficients obtained from this indirect data on personal agrarian wealth, by means of an estimated value of a yearly income taken from them, are rather similar to the ones directly calculated from the distribution of landownership measured in surface units from the local *amillaramientos*. This intriguing coincidence deserves to be studied in the future, and might have something to do with the existence of proportionality between the distributions of wealth and rents paid for housing (Peña 1852). Some economists had alleged the existence of this kind of correspondence at the time, and suggested to use the data on rental housing as an easy proxy for personal income (San Julián 2010).

In any case, the way of accounting the value of agrarian wealth of every taxpayer through an estimated income introduces and important bias in our dataset: a relevant share of all taxpayers included in the lists had only a very poor house of their own. Their recorded income was the implicit rent that could have been obtained by leasing these poor houses in the market, after having deduced a quarter of the rent as repair costs. Some others could also be sharecroppers, either as *rabassa* winegrowing tenants living in a village or as sharecropping families who, according to another typical Catalan contract called *masoveria*, had to live in the farmhouse where they worked—usually when landowners were wealthy enough not to work the *masia* by themselves. In this case, the cadastral valuation had to include the sharecropper with their net income, obtained by deducting from their annual earnings the rent paid to the landowner (Peña 1852).

However, in most cases there were in the *Distribution of Personal Wealth in Real Estate Ownership* of 1852 a great deal of very poor taxpayers with only rather fictitious incomes, because they were below the lowest male agricultural wage at the time, and no one could have survived with such a yearly earning. According to the available series of Catalan agricultural wages for unskilled tasks, like digging, during the five years between 1850 and 1854 an agricultural labourer who worked 260 days a year would earn an income of some 1,720 Spanish *reales* in the province of Barcelona (Ramon Garrabou and Tello 2002). The urban planner Ildefons Cerdà calculated the prevailing family budgets at the time in Barcelona, and according to his detailed data the subsistence minimum expenditure on food, clothing and housing would have required some 6,622 *reales* for a full working-class family (Cerdà 1967-1968 [1867]). This means that at least three or four adult unskilled wages like the ones considered

would have had to be added up in order to achieve the minimum standard of living calculated by Cerdà. The cost of living was probably cheaper outside Barcelona, but this data reveal that some 1,500 to 2,000 *reales* could be considered a minimum income to survive at the time. However, the list of taxpayers in the *Distribution of Personal Wealth in Real Estate Ownership* of 1852 included a lot of people below that level (see Table A1 in the annex): an astonishing 84-87% appeared in the document with a cadastral attributed income under the abovementioned poverty line of 1,500-2,000 annual *reales*.

Although all these people who had such a small property worth less than 2,000 *reales* a year only owned 27% of all income recorded, they paid a respectable 30% of all cadastral taxes raised in the whole province. And if we set aside the very special case of Barcelona city, in the rest of rural districts the proportion of taxes paid by taxpayers with an attributed income lower than 2,000 *reales* ranged from 32 to 50%. Assuming that such poor taxpayers had endured exactly the same tax rate as the very rich, the prevailing tax system would already have been very regressive. Our data show that they always bore an even higher tax burden (see Table A2 in the annex). This clearly explains why the wealthy rural elites were so interested in including such a great amount of poor people in the list of taxpayers. They had already discovered, together with the provincial officials, that the Spanish Treasure could raise a lot by extracting a bit from many taxpayers who only had very little. Insofar as the tax quotas of each province and municipality came as given by previous policy decisions taken top-to-bottom from the parliament and provincial governors, it was literally true that everything paid by the poorest contributors became tax cuts for the wealthy taxpayers.

In per capita terms, while the vast majority of poorer taxpayers were only attributed with cadastral earnings ranging from several tens to some hundreds of *reales*, and paid taxes for a few tens to less than a *real* per year, the small group of the richest taxpayers owned rural properties worth tens of thousands *reales*, and paid taxes for several thousand *reales* a year. It was as if they were in different orders of magnitude, and somehow they were. In an electoral system based on the census of taxes paid, this clear differentiation between levels of wealth and taxation meant that only major taxpayers were entitled to vote. We wonder, though, if the Spanish tax system described above might have something to do with the granting of voting rights to the entire adult male population as early as 1890; and also, consequently, with the immediate corruption of this general male suffrage by the so called Spanish *caciquismo* (Moreno-Luzón 2007). The anomalous tax system based on the political up-to-bottom allocation of cadastral quotas established, in effect, a perverse rule of the game encouraging the creation of vertical lobbies to get the minimum tax share to be paid to the Treasure, and receive the maximum public expenditure in each province and municipality (Curto-Grau et al. 2010). A comparative historical study of the relationship between the tax and electoral systems might shed new light on that matter.

In any case, the inclusion of so many people owning only a house, and perhaps a garden, together with landless tenants with very low yearly earnings, clearly biases our database on landownership and agrarian incomes derived from it. However, their presence also provides valuable information. Furthermore, it is not easy to establish a non-arbitrary threshold value to clearly separate the 'real' agricultural landowners to the ones who mainly earned most of their living working with their hands, in spite of having a house and a small plot of their own, or perhaps a sharecropping contract. We will later explain the solutions we have found to deal with this database in order to try to obtain significant results on wealth and income distribution.

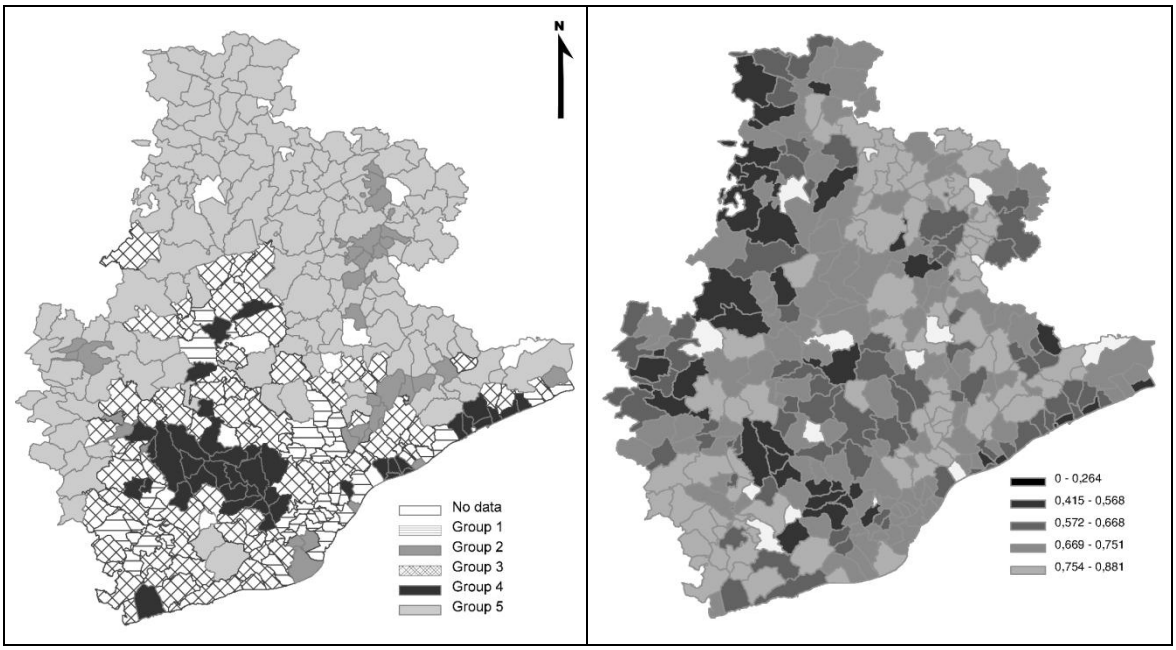
Before resuming with our analysis, we must refer to other concerns raised by this historical source. What credibility can we give to the information it contains, given the tax purpose of the document? Our research team has worked for many years using the private accounting records of the patrimony of the Marquis of Sentmenat, one of the richest Catalan landowners at the time. From his private records, we know that during the five years between 1850 and 1854 the Marquis earned in the two municipalities of Sentmenat, and Palau-solità-i-Plegamans, an actual average income of 12,047 and 15,983 *reales* a year respectively (Ramón Garrabou, Planas, and Saguer 2001). The *Distribution of Personal Wealth in Real Estate Ownership* of 1852 attributed to the Marquis of Sentmenat a yearly cadastral income of 11,607 and 15,323 *reales* in the same municipalities: a downward deviation of only 3.9%! Although this is only a single case, the comparison increases significantly our trust in the accuracy of the information provided by this source.

III. NO APPARENT INEQUALITY PATTERN?

In order to obtain a set of municipality groups based on statistically rigorous assembly, the dataset has been split off according to similarity criteria considering cluster analysis from the percentage of winegrowing, cereal-cropping or forest area over total agricultural land of each municipality.[3] The resulting land-use categories were five: mainly winegrowing with an important share of cereal-cropping land-use (group 1), mainly cereal-cropping (group 2), mainly cereal-cropping with an important share of winegrowing land-use (group 3), mainly winegrowing (group 4) and mainly forest (group 5). The first result get by mapping this clusters has been quite puzzling. Comparing the maps in Figure 2, no apparent pattern seems to appear in the spatial distribution of main land-uses and prevailing inequality of agrarian incomes earned from real estate ownership. Often, the differences between neighbouring municipalities located in the same zone of land-use specialization were as pronounced as the ones observed among the major boundaries between land-use areas of winegrowing, cereal-cropping, and woodland.

Figure 2. *Comparison between the main cluster land-use groups and the Gini indices of inequality in the municipalities of the province of Barcelona in 1852-1858*

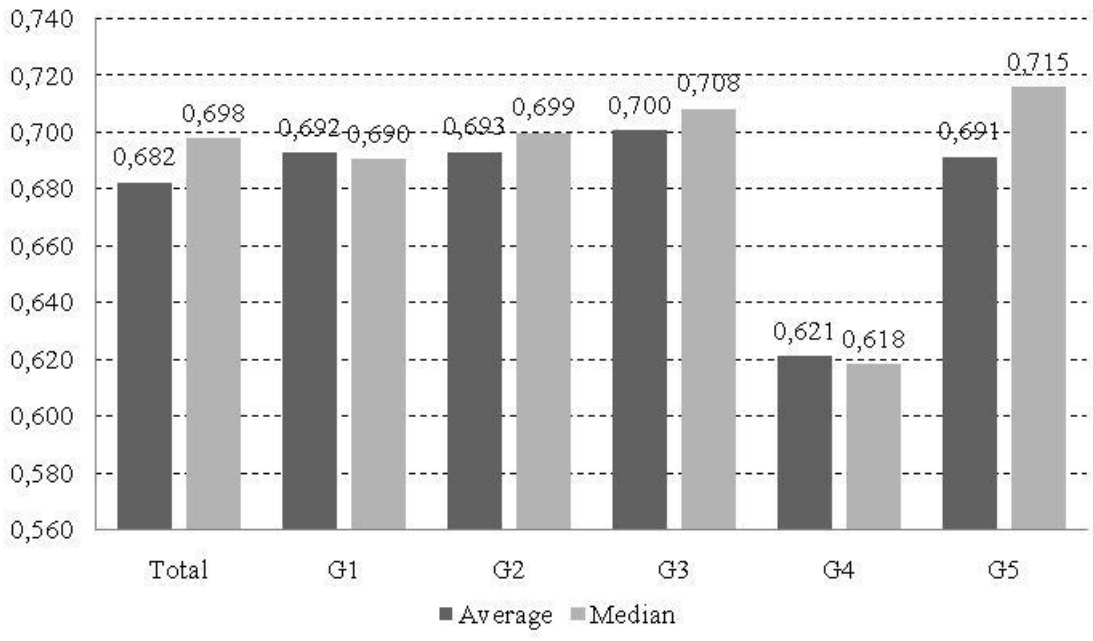
[3] We consider non-hierarchical clustering used in MINITAB 15.1. It clusters the data according to MacQueen's algorithm (see Johnson and Wichern 2007). The information of municipal land uses has been taken from the 1858 *Land-Use Statistics of the Province of Barcelona* compiled by Pedro Moreno Ramirez.



Source: our own, from the *Land-Use Statistics of the Province of Barcelona* compiled in 1858 by the topographer Pedro Moreno Ramirez (manuscript 1733 of the National Geographic Institute), and from the *Distribution of Personal Wealth in Real Estate Ownership* of 1852 (Library of the University of Barcelona, reference 146-1-II/13).

Nevertheless, a clearer picture arises when the mean and median values obtained for each cluster land-use group are compared with the ones of the whole sample (Figure 3). The Gini indices were actually lower in the winegrowing municipalities than in cereal-cropping or mixed land-use ones, while the highest inequality values were recorded in mainly forest areas.

Figure 3. *Gini indices in the distribution of incomes earned from rural properties, according to cluster land-use groups in the municipalities of the Barcelona province in 1852-1858*



Source: our own, from the same historical sources referred in Figure 2.

However, the differences between averages appear to be less marked than expected while the value distances among mean and median warns us about the likely existence of non-normal distributions in the dataset. This first outcome leads us to ask about the underlying reasons for this lack of an apparent pattern of inequality in the incomes earned from rural properties in the province of Barcelona in mid-19th century, and the best statistical way to deal with them. Taking into account the characteristics of the available information, and the abovementioned biases present in the dataset, we can outline a list of five likely factors that may have obscured these first results:

1. There were no large areas of monoculture in the province of Barcelona; almost all municipalities combined different proportions of any sort of land usages. The very different size of townships, and the absence of large flat areas, involved the existence of many contrasting realities in the land-uses prevailing within each municipality. In particular, the larger and more populous townships always combined cereal crops in the flattest lands with forest uses in the more slopping ones, and vineyards planted in intermediate slopes. Thus, we have never a 'pure' winegrowing municipality clearly detached from other totally devoted to cereal or forest uses.
2. As explained above, the database includes only taxpayers who had some real estate of their own. That means excluding some people deprived of property that, nevertheless, earned most or all of their income by working in agriculture. At the same time, however, the database includes a large proportion of taxpayers only owing a poor house and a small vegetable garden, or having a sharecropping contract. Whether they owned a house or hired one in the market, the differences could be minimal. If there existed a significant number of adults deprived of property, and they were unevenly distributed between municipalities with different land usages, this may introduce another bias in our database.
3. The simultaneous presence of wealthy landowners and well-off peasants along with a high proportion of landless residents who only held a poor house with garden, or could rely on a sharecropping contract, involves mixing very different realities in the same database. The resulting distribution seems to move in different orders of magnitude. As already explained, this is largely the outcome of ambiguous data which is halfway between a distribution of land ownership and a distribution of agrarian income. To make it more coherent and handier, either all types of income are included in the database or all attributed cadastral earnings should be converted into the original valuation of real estate property.
4. The municipalities were not only very different in size, but also in population and wealth. As population density increased, so did the number of residents who made their living with activities that had little or nothing to do with land and livestock ownership. In this point, the contrast between rural towns, villages and the city matters. Barcelona becomes a special case, and often we need to set it aside as an outlier.
5. The inequality degree in the distribution of agrarian income within each municipality also depended on its level of wealth. As mentioned earlier, poorer areas could have lower indexes because people had to achieve at least a subsistence minimum. However, the frontier of maximum inequality rose along with the wealth of a community. Consequently, the comparisons of inequality between municipalities should take into account their respective

levels of wealth. For example, if inequality indices were lower in winegrowing municipalities than in the ones where cereal crops or forest uses predominated, and these areas specialized in vineyards became also wealthier, average values do not reflect the greater distance from the maximum possible inequality associated with this.

In order to solve these difficulties, and improve the quantitative analysis of our enquiry, we will undertake a deeper analysis of rural income inequality taking the following three decisions: a) we are going to add to the original database the adult male population without any land, house or cattle of their own, taken as a zero group in the valuation of property in each municipality, by subtracting from the population census figures of 1857 the number of landowners included in the lists of taxpayers of 1852; b) we are going to add a minimum vital income of 1,500 *reales* a year to the earning valuation of property held by all inhabitants included in the new dataset, in order to overcome the valuation ambiguity of the data on personal wealth by turning it into a distribution of agrarian incomes; and c) we are going to set aside the Gini index and use Theil indices to carry out further analysis, as these makes it easier to calculate the frontier of maximum inequality linked to the wealth of each community, and compare it with the actual inequality registered.

IV. A DEEPER ANALYSIS OF AGRARIAN INCOME INEQUALITY

The following calculus of the Theil inequality indices have been obtained from the dataset of income cadastral values recorded for every taxpayer included in each municipality in the *Distribution of Personal Wealth in Real Estate Ownership* of 1852:

$$Theil(1)_i = \frac{1}{N}\sum_j \frac{x_j}{\bar{x}} \ln\left(\frac{x_j}{\bar{x}}\right) \quad (1)$$

$$Theil_{Max} = Ln(N) \quad (2)$$

$$Theil(1)_{Normalized} = \frac{Theil_i}{Theil_{Max}} \quad (3)$$

where N is the number of observations, i is the municipality, $x_{i,j}$ each one of the individual observations of the annual incomes for every municipality i and $\bar{x}$ is the mean value of the distribution. The Theil index shows less inequality as values tend to zero and more inequality as values tend to one. In a first approach, we have considered N as the number of all taxpayers in each municipality. This distribution shows the main statistics calculated in Table 1:

Table 1. *Main statistics of the database on 1852 taxpayers in all the municipalities of the province of Barcelona*

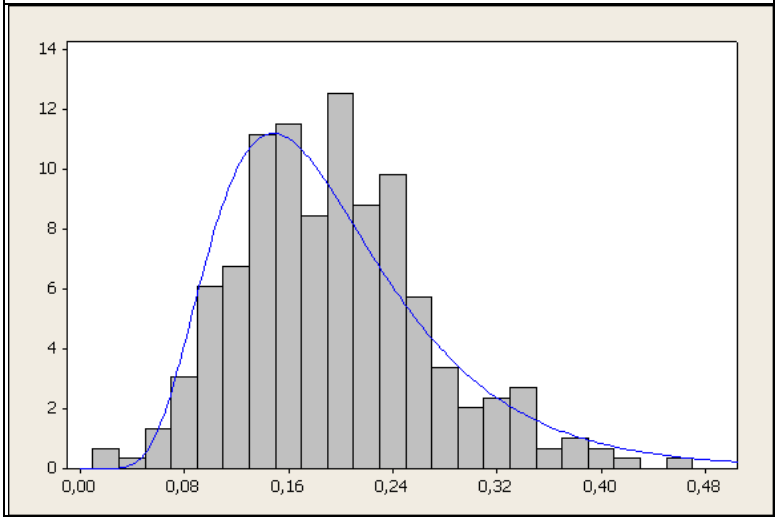
Number	295
Mean	0,195
Standard deviation	0,074
Median	0,192

Source: our own, from the *Distribution of Personal Wealth in Real Estate Ownership* of 1852 (Library of the University of Barcelona, reference 146-1-II/13).

To grasp the outline of this dataset, and obtain a more complete picture of the distribution of wealth in the municipalities of the province of Barcelona, we have

constructed the histogram which appears in Figure 4. Instead of a normal distribution around the mean, it shows higher concentrations of municipalities near two intervals which are relatively far from the average. The first peak assembles a group of municipalities with lower levels of inequality, around 0.15, while the second one displays another group with higher levels of inequality around 0.20—the mean of the sample is at 0.19:

Figure 4. *Theil Index histogram for all the taxpayers in all the municipalities of the province of Barcelona in 1852 (lognormal fit)*



Source: our own, from the same historical source referred in Table 1.

The dispersion of these Theil indices, added to the two peak concentrations around inequality values far from the mean, leads us to seek a few complementary explanations. As we have already discussed, our dataset is highly heterogeneous. We find a maximum population of 235,643 inhabitants in the city of Barcelona, together with many municipalities having a minimum below 300 inhabitants. At the same time the mean and median values of either the inhabitants or taxpayers differ significantly, thus indicating the need for a deeper statistical analysis (Table 2).

Table 2. *Comparison between the main statistics of the database on the number of taxpayers in 1852 and of inhabitants in 1857 in all the municipalities of the province of Barcelona*

	Taxpayers in 1852	**Inhabitants in 1857**
Maximum	9,616	235,643
Minimum	17	211
Mean	297	2,396
Median	205	979
Standard deviation	9,616	235,643

Source: our own, from the *Distribution of Personal Wealth in Real Estate Ownership* of 1852 (Library of the University of Barcelona, reference 146-1-II/13) and population census of 1857 (available at URL: http://www.ced.uab.es/index.php?newlang=eng).

Therefore, in order to correct the potential bias attributable to the wide range of variation in the number of taxpayers and inhabitants in different municipalities, the inequality indexes have been recalculated using the Theil (1) index. These values are homogenous among the observations of the sample, regardless of its size. Then, in order to check the relationship between this inequality index and the main factor used to

explain it, we have repeated the analysis of the basic statistics splitting the municipalities according to the prevailing land-use (Table 3).

Table 3. *Main statistics of the database on the number of taxpayers in 1852 according to cluster land-use groups in each municipality of the province of Barcelona*

	All municipalities	**Group 1** *winegrowing with cereal*	**Group 2** *cereal-cropping*	**Group 3** *cereal with winegrowing*	**Group 4** *wine-growing*	**Group 5** *forest*
Number	295	35	33	65	41	120
Mean	0,195	0,190	0,193	0,210	0,146	0,206
Median	0,192	0,165	0,191	0,200	0,139	0,202
Standard deviation	0,073	0,071	0,062	0,063	0,047	0,079

Source: our own, from the same historical sources referred in Figure 2.

.

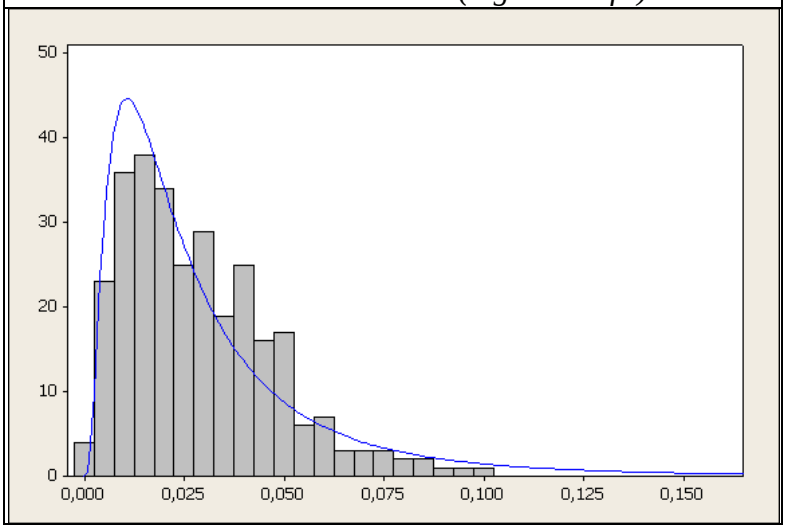
Observing Table 3, mainly winegrowing municipalities (group 4), and also to some extent the mainly winegrowing municipalities with an important share of cereal-cropping (group 1), were less unequal than the others (with an even lower standard deviation in cluster group 4). These results go in the same direction as those observed in Figure 3 and accentuate the differences between land-use groups. Considering Theil (1), the winegrowing municipalities were 25% more even than the whole sample, while the differences considering Gini indices were only 10%.

V. ESTIMATING INEQUALITY IN PERSONAL AGRARIAN INCOMES OF THE ENTIRE POPULATION

Now we will try to deal with the double bias encountered, due to the fact that the original dataset includes taxpayers only, not the entire rural population who earned incomes from agrarian activities; and also that many of these taxpayers appear in it with implausible incomes below the minimum subsistence level. The first bias reduces and the second one increases the actual inequality level, but without knowing their relative weight we cannot guess how they have skewed our database. To correct the first bias, we have subtracted from the population figures in the census of 1857 the number of landowners included in the lists of taxpayers of 1852, in order to then add to the original database the adult male population without any land, house or cattle of their own, taken as a zero group in the valuation of property in each municipality. Afterwards, so as to turn the ambiguous dataset on personal wealth into a clearer distribution of agrarian incomes, we have added a minimum vital income of 1,500 *reales* a year to the earning valuation of property held by all inhabitants included in the new dataset. As already explained, this vital income is obtained considering the unskilled daily wage of a Catalan labourer at the time multiplied by 260 working days a year.

Unfortunately these two changes will entail some disadvantages as well. The major drawback is that all inequality levels resulting from the new dataset are, as we can expect, lowers than the original ones. If we obtain the histogram for the whole distribution of the new dataset, we can observe in Figure 5 a strong shift towards lower values, with a huge grouping of observations around 0.01 while the mean is 0.03.

Figure 5. *Theil Index histogram for all adult male population in all the municipalities of the province of Barcelona in 1852-1858 (lognormal fit)*



Source: our own, from the same historical sources referred in Table 2.

Nevertheless, comparing Figure 5 with Figure 4 obtained for taxpayers only the double peak of municipalities around two different levels of inequality has disappeared. This interesting result also appears in the separated histograms for municipalities with different land usages. Taking this strong shift towards a more even distribution into account, from now on we can only consider the relative differences between the new Theil indices obtained in each municipality and not their absolute values significant. The key question is how different are the new distributions from the previous ones obtained with only taxpayers. Is the equality increase of all municipalities in the dataset comparable to that of each different land-use category? Are the relative distances in inequality levels between winegrowing, cereal-cropping and forest municipalities maintained, increased or reduced?

Table 4. *Average Theil index in the original dataset compared with the ones calculated for estimated agrarian incomes of all male adult population, according to cluster land-use groups of municipalities in the province of Barcelona in 1852-1858*

	All	**Group 1** *winegrowing with cereal*	**Group 2** *cereal-cropping*	**Group 3** *cereal with vines*	**Group 4** *wine-growing*	**Group 5** *forest*
Number	295	36	33	65	41	120
Theil index of only taxpayers	0,195	0,185	0,193	0,210	0,146	0,206
Theil index of all adult male population	0,029	0,020	0,022	0,032	0,013	0,030
% variation for taxpayer's group mean	100,0	11,03%	11,52%	15,30%	8,68%	14,60%
% variation for the average of all population	100,0	71,0%	77,5%	111,9%	44,0%	105,0%

Source: our own, from the same historical sources referred in Figure 2 and Table 1.

The results obtained with the new dataset do not show in Table 4 an apparent change in the relative position of municipal inequality levels according to the main land-use. Nonetheless they stress the lower inequality in winegrowing municipalities (over 50% lower than the mean), together with the higher inequality in low-populated forestry zones (group 5), and also in mainly cereal-cropping areas with an important share of winegrowing (group 3).

VI. TAKING POPULATION SIZE INTO ACCOUNT

Another possible factor that could bias the inequality values obtained with our dataset is the distortion due to very different population densities. Following Boserup (1983) we have established at 65-70 inhabitants/km^2 an upper threshold of population density able to be sustained with a highly intensive agrarian economy, and considered that with any population density greater than 70 inhabitants/km^2 the society had to rely on other industrious or industrial economic activities at the time. To conduct an initial sensitivity analysis we have assembled in a new sample the Theil indices of municipalities that had population densities above 70 inhabitants/km^2 in 1857, or were the capital of a district. The data has been obtained from the population density of each municipality weighed against the population density of the neighbouring municipalities, in order to correct for possible bias due to the existence of administrative units with different size (Table 5):

Table 5. *Average Theil index of municipalities with population densities >70 inhab./km^2 weighted against neighbouring ones, or being capital of a district in the province of Barcelona in 1852-1858*

	Capital of a district	**>70 inhabitants/km^2**
Number	11	127
Theil index of only taxpayers	0,124	0,185
Theil index of all adult male population	0,015	0,028
% variation for taxpayer's average	63,6	94,9
% variation for the average of all population	51,7	96,6

Source: our own, from the same historical sources referred in Table 1.

Looking at the right column in Table 5, and comparing with Table 4, we find out that the inequality indices of municipalities with population densities greater than 70 inhabitants/km^2 were rather similar than the ones obtained for the whole dataset. The distribution of these municipalities resembles the one found in winegrowing municipalities, with a high concentration of observations around low levels of inequality, slightly above the values obtained from the sample mean, and showing a marked difference between the mean and median values. In contrast, comparing with Table 4 the left column in Table 5 we can find inequality values in municipalities that were capitals of a district lower than the provincial average. This result is significantly enhanced when all adult male population is included. Owing to the fact that this group has only 11 observations, we will analyze each of them in detail (Table 6).

The reasons that made the city of Barcelona and its surroundings a very special case are quite clear in Table 6. Only five municipalities had in 1852 a number of taxpayers greater than a thousand: Manresa (1,686), Terrassa (1,671), Mataró (1,319), Vic (1,284) and Vilanova i la Geltrú (1,071). In the municipal area where the city of

Barcelona now stands there were instead 9,353 property owners included in the tax list.[4] In this latter case they were mostly house owners or possessors of built-up land, not agricultural or forest landowners. Moreover, as it was the only city bringing together a population of 235,643 inhabitants in 1857 (while Mataró was only 16,595, Manresa 15,264, Sabadell 13,945, Vic 13,712, Vilanova i la Geltrú 11,395 and Terrassa 8,721), the proportion of taxpayers among residents of Barcelona was one of the lowest in the province: one in 25, while in the other six cases it ranged from 5 to 16.

Table 6. *Theil inequality indices of taxpayers or all adult male population in municipalities being capital of a district in the province of Barcelona in 1852-1858*

Capitals of districts	Taxpayers	All adult male population
Barcelona	0,089	0,010
Arenys	0,090	0,031
Berga	0,120	0,012
Granollers	0,176	0,028
Igualada	0,062	0,007
Manresa	0,146	0,016
Mataró	0,111	0,016
Sant Feliu de Llobregat	0,117	0,002
Terrassa	0,136	0,013
Vic	0,160	0,013
Vilafranca del Penedès	0,126	0,012
Mean of the Barcelona province	*0,124*	*0,015*
Median of the Barcelona province	*0,123*	*0,013*

Source: our own, from the same historical sources referred in Table 1.

The overall results shown in Table 6 also highlight the lower inequality degree of agrarian income distribution existing in larger towns and cities, compared with average values in the rest of rural municipalities. Among these urban areas the lowest inequality appeared in Barcelona, Arenys de Mar and Igualada district capitals. This result contrasts with the comparatively higher inequality found in urban municipalities that could be considered more industrial at the time.

VII. ESTABLISHING THE INEQUALITY POSSIBLE FRONTIER (IPF) AND EXTRACTION RATIO (IER)

After having incorporated the previous corrections and caveats in the calculation of Theil indices, now we have to face the most difficult task: how to overcome the lack of a clear pattern which apparently arises when comparing the land-use maps of the mid-19th century with distribution of rural income inequality in the province (Figure 2). The main suggestion we get from this spatial comparison is that there was a greater historical contingency in the geographical patterns of agrarian wealth inequality than in the geographical distribution of prevailing land usages. This might be due to diverging local paths: while the landowners of a municipality could have decided to keep their forest and pasture lands exploited in the traditional manner, raising livestock and selling timber, firewood or charcoal, others might have chosen to establish in them a great deal of *rabassa* tenants who transformed the same sorts of marginal lands into vineyards. These different occasional decisions could have reinforced themselves over time in

[4] When constructing our dataset, the boundaries of the Barcelona urban system have been set into the limits of the current municipality; thus the data has been adjusted with the available in former municipalities that were aggregated to the city from 1897 onwards.

neighbouring areas, leading through path dependence and self-reinforcing loops to contrasting spatial realities juxtaposed into the same territory.

The main question that arises is whether we can find or not some key omitted variables which could capture and explain a great deal of this intriguing contingency. The type of feudal jurisdiction –whether manorial, royal or under the church–, the inequality degree, and population densities at the beginning of this process could be considered good candidates. However, an important side of the question is that once the landowners of a place had decided to offer or not an opportunity to establish immigrants or disinherited people as winegrowing tenants in their marginal lands, this would have entailed consequences for population sizes and levels of wealth in each community. If there was any relationship between the level of wealth and inequality in a rural community, this could provide an interesting entryway to capture the disturbing degree of local contingency we found. This is why we decided to start working with the idea of an inequality possible frontier (thereinafter, IPF) which depends upon the level of agrarian wealth, as put forward by Milanovic et al. (2007). When the wealth of a community increases, so does the IPF since it may generate a greater distance between the vast majorities kept at subsistence level and a tiny elite who could concentrate the rest of income.

Therefore, we are going to use the IPF in order to calculate new inequality indices of personal agrarian income adjusted to different levels of rural wealth. The first step is to work out the maximum values of income inequality in each municipality. Following Milanovic et al. (2007) the average income of the elite is:

$$Y_e = \frac{\mu \cdot N - s \cdot N \cdot (1-\varepsilon)}{\varepsilon \cdot N} = \frac{1}{\varepsilon}\ \mu - s \cdot (1-\varepsilon) \qquad (4)$$

where μ is the average income of the municipality, N is the total adult male population, s is the subsistence income and y ε is the percentage of population that represents the elite also in this municipality.

To obtain the Theil index for the IPF ($Theil_{IPF}$) of each municipality, we use equation (1). Then, the local population is divided into two groups, the first one with the subsistence income and the other which obtains the rest of the surplus of the municipality, as shown in equation (5).

$$Theil_{IPF} = \frac{1}{N}\ \ N-\varepsilon \cdot N\ \cdot \frac{s}{\mu} \ln\ \frac{s}{\mu}\ \ + \frac{1}{N}\ \varepsilon \cdot N \cdot \frac{Y_e}{\mu} \ln\ \frac{Y_e}{\mu} \qquad (5)$$

If we consider $\mu = \alpha \cdot s$, that is, we assume that the average income of the municipality is a multiple α of the subsistence income, then $s = \mu/\alpha$:

$$Theil_{IPF} = \frac{1}{N}\ \ N-\varepsilon \cdot N\ \cdot \frac{\mu}{\alpha \cdot \mu} \ln\ \frac{\mu}{\alpha \cdot \mu}\ \ + \varepsilon \cdot N \cdot \frac{Y_e}{\mu} \ln\ \frac{Y_e}{\mu}\ \ = \frac{1}{N}\ \frac{N \cdot\ 1-\varepsilon}{\alpha} \cdot \ln\ \frac{1}{\alpha}\ + \varepsilon \cdot N \cdot \frac{Y_e}{\mu} \ln\ \frac{Y_e}{\mu} \qquad (6)$$

If we modify equation (4) assuming $s = \mu/\alpha$, then we have:

$$Y_e = \frac{1}{\varepsilon}\ \mu - \frac{\mu}{\alpha} \cdot (1-\varepsilon)\ \ = \frac{\mu}{\varepsilon}\ 1 - \frac{(1-\varepsilon)}{\alpha} \qquad (7)$$

And if we include this expression in equation (6), we have:

$$\text{Theil}_{\text{IPF}} = \frac{1}{N}\ \frac{N\cdot\ 1-\varepsilon}{\alpha}\cdot \ln\ \frac{1}{\alpha}\ + \varepsilon\cdot N\cdot \frac{\frac{\mu}{\varepsilon}\ 1-\frac{(1-\varepsilon)}{\alpha}}{\mu}\ln\ \frac{\frac{\mu}{\varepsilon}\ 1-\frac{(1-\varepsilon)}{\alpha}}{\mu} = \frac{1-\varepsilon}{\alpha}\cdot \ln\ \frac{1}{\alpha}\ +\ 1-\frac{(1-\varepsilon)}{\alpha}\ \cdot$$

$$\ln\ \frac{1}{\varepsilon}\cdot\ 1-\frac{(1-\varepsilon)}{\alpha} \qquad (8)$$

Lastly, to make comparable this index with the rest of the values obtained for the entire dataset we have normalized equation (8) depending on N. This is why we calculate the IPF for this indicator, that is, we assume that N-1 members of the municipality get the subsistence income, while one member receives the rest of the income. In this case we consider that ε·N=1, that is, $\varepsilon = \frac{1}{N}$ and then:

$$\text{Theil}_{\text{IPF-MAX}} = \frac{1-\frac{1}{N}}{\alpha}\cdot \ln\ \frac{1}{\alpha}\ +\ 1-\frac{(1-\frac{1}{N})}{\alpha}\ \cdot \ln\ \frac{1}{\frac{1}{N}}\cdot\ 1-\frac{(1-\frac{1}{N})}{\alpha} = \frac{N-1}{N\cdot\alpha}\cdot \ln\ \frac{1}{\alpha}\ +$$

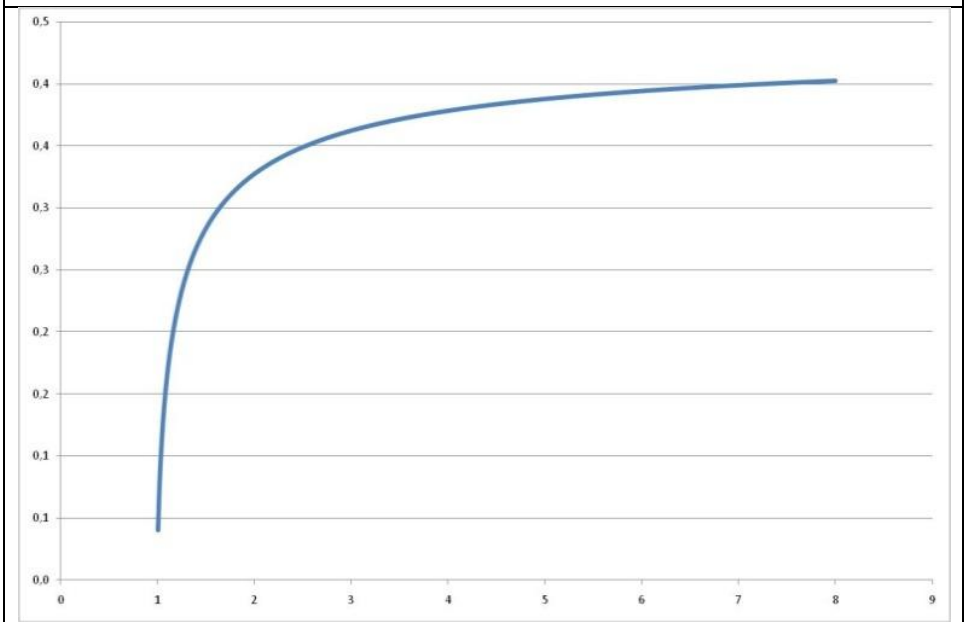
$$1-\frac{(N-1)}{N\cdot\alpha}\ \cdot \ln\ N\cdot\ 1-\frac{(N-1)}{N\cdot\alpha} \qquad (9)$$

Therefore, the normalized $\text{Theil}_{\text{IPF}}$ index corresponds to:

$$\text{Theil}'_{\text{IPF}} = \frac{\text{Theil}_{\text{IPF}}}{\text{Theil}_{\text{IPF-MAX}}} \qquad (10)$$

In Figure 6 we can observe the behaviour of the $\text{Theil}'_{\text{IPF}}$ depending on α, which is expressed as the number of times that the average income of the municipality exceeds the average value of subsistence for a fixed number N (thus assuming that all municipalities have the same dimension).

Figure 6. *An example of inequality possible frontier (IPF) expressed as the Theil'$_{IPF}$ indices resulting from α (the average income of the municipality as a multiple of the subsistence income) in the municipalities of the province of Barcelona in 1852-1858*



Source: our own, with equation (9) considering ε=0.05 and N=1000, using the dataset obtained from the same historical sources referred in Table 1.

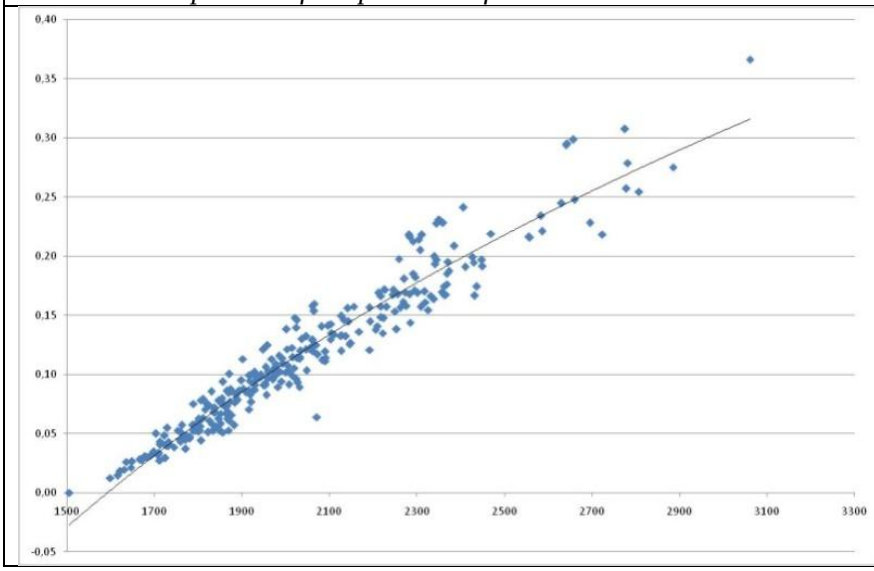
From the calculus of the Theil'$_{IPF}$ we can obtain the inequality extraction ration (IER thereinafter) for each municipality, considering:

$$IER = \frac{Theil}{Theil'_{IPF}} \quad (11)$$

IER indicates the percentage of the actual inequality that existed in each municipality respect to the IPF, which is the maximum potential of inequality possible with a defined value for ε and α. To do this, we calculated $Theil'_{IPF}$ from (9), assuming ε = 0.01 (the elite is 1% of the total population), N is the value of the adult male population of the municipality, and approaching α to the number of times that average income exceeds the mean income of the municipality. In this case, when ER → 0 the value indicates that the actual level of inequality registered in the municipality was well below the potential frontier of maximum value of inequality, that is, tend to potential high levels of equality. In the other extreme, when ER → 100% the level of inequality obtained is close to the level of maximum potential inequality. From (8) and (9) we can affirm that the maximum value of inequality may depend, besides the values of α and ε, of the size of the municipality considered. This bias is corrected when we consider IER.

The distortion introduced in the calculation of maximum $Theil_{IPF}$ index by the different municipal population size can be seen by comparing Figure 6 and 7. Despite a clear upward trend, that is, a potential increase in inequality as the average income level grows, we observe in Figure 7 some deviations depending on the township size.

Figure 7. *Theil'$_{IPF}$ (1) indices resulting from average income of the municipality in Spanish* reales *a year for the whole dataset of the municipalities of the province of Barcelona in 1852-1858*



Source: Source: our own, from the same historical sources referred in Table 1.

The last result confirm that the calculation of the IER may be a good approximation to the value of the actual inequality related to the maximum IPF of each municipality, which also helps us to correct potential errors resulting from very different population sizes in the database (Table 7):

Table 7. *Extraction ratio (IER) as % of actual Theil index compared with the maximum IPF in agrarian income distribution, according to cluster land-use groups, population densities and other features in the municipalities of the province of Barcelona in 1852-1858*

	extraction ratio (IER)	**number of municipalities**
All municipalities of the dataset	24.9%	295
Group 1: *winegrowing with cereal-cropping*	24.3%	36
Group 2: *mainly cereal-cropping*	25.0%	33
Group 3: *cereal-cropping with winegrowing*	26.5%	65
Group 4: *mainly wine-growing*	18.7%	41
Group 5: *mainly forest*	26.3%	120
With > 70 inhabitants per km^2	23.4%	127
District capitals only	25.0%	11

To calculate the $\text{Theil}_{\text{IPF}}$ indices of each municipality, when the result was grater than 1 we considered that 1% of the population was the local elite. If not, we considered the elite made up of one person. Source: our own, from the same historical sources referred in Figure 2 and Table 1.

Table 7 confirms many of the previously reported results, adding at the same time another perspective. Winegrowing municipalities were further away from potential levels of inequality while municipalities with mainly cereal-cropping and forest land usages were a bit closer to their maximum IPF. It is important to stress that this happens in spite of the fact of having previously included in our database a vital minimum income for all male adults, which inevitably entailed a compression of all Theil indices around very low absolute values of income inequality. Although the percentage differences found out in IER values are of the same order of magnitude as those in the Gini indices obtained with the original property values shown in Figure 3, they actually become much more relevant when the abovementioned bias is taken into account. The results are also very significant for the capitals of a district: before taking IPF into account this group recorded lower inequality values than in winegrowing municipalities, but their IER appear to be higher and close to the average. These evidences allow us to affirm that the study of income inequality using the IER approach has revealed some important hidden sides of the question.[5]

To test the robustness of the exercise we repeat it considering Theil (0), where[6]:

$$Theil\ \ 0\ \ = \frac{1}{N}\ \ \sum_{i=1}^{N} \frac{x}{x_j} \qquad (12)$$

The Theil index for the IPF ($\text{Theil}_{\text{IPF}}$) is obtained considering (12) and (5) as we have done before

$$\text{Theil}_{\text{IPF}} = \frac{1}{\text{N}}\ \ \text{N-}\varepsilon \cdot \text{N}\ \ \cdot \ln\ \frac{\mu}{\text{s}}\ \ + \frac{1}{\text{N}}\ \varepsilon \cdot \text{N} \cdot \ln\ \frac{\mu}{\text{Y}_{\text{e}}} \qquad (13)$$

If we consider $\mu=\alpha \cdot s$, that is, we assume that the average income of the municipality is a multiple α of the subsistence income, then $s= \mu/\alpha$:

[5] For example, while the One way Anova test suggests different IER averages when we consider the land-use categories (at a 5% confidence level), the same test for mean IERs becomes statistically not significant when we consider other variables like different jurisdictional domains (manorial, royal or under the church) that prevailed in each municipality up to the abolition of feudalism in 1836.

[6] For a more accurate discussion about the use of Theil (1) or Theil (0) as inequality indicators see Litchfield (1999) and Theil (1979). Theil (0) overemphasizes the differences in the lower tail of the distribution.

$$Theil_{IPF} = \frac{1}{N} \; N - \varepsilon \cdot N \; \cdot \ln \; \frac{\alpha \cdot \mu}{\mu} \; + \varepsilon \cdot N \cdot \ln \; \frac{\mu}{Y_e} \; = \; 1 - \varepsilon \; \cdot \ln \; \alpha \; + \varepsilon \cdot \ln \; \frac{\alpha}{Y_e} \; = \ln \; \alpha \; - \varepsilon \cdot \ln(Y_e) \qquad (14)$$

If we modify equation (4) assuming s= μ/α, then we have:

$$Y_e = \frac{1}{\varepsilon} \; \mu - \frac{\mu}{\alpha} \cdot (1-\varepsilon) \; = \frac{\mu}{\varepsilon} \; 1 - \frac{(1-\varepsilon)}{\alpha}$$

And if we include this expression in equation (14), we have:

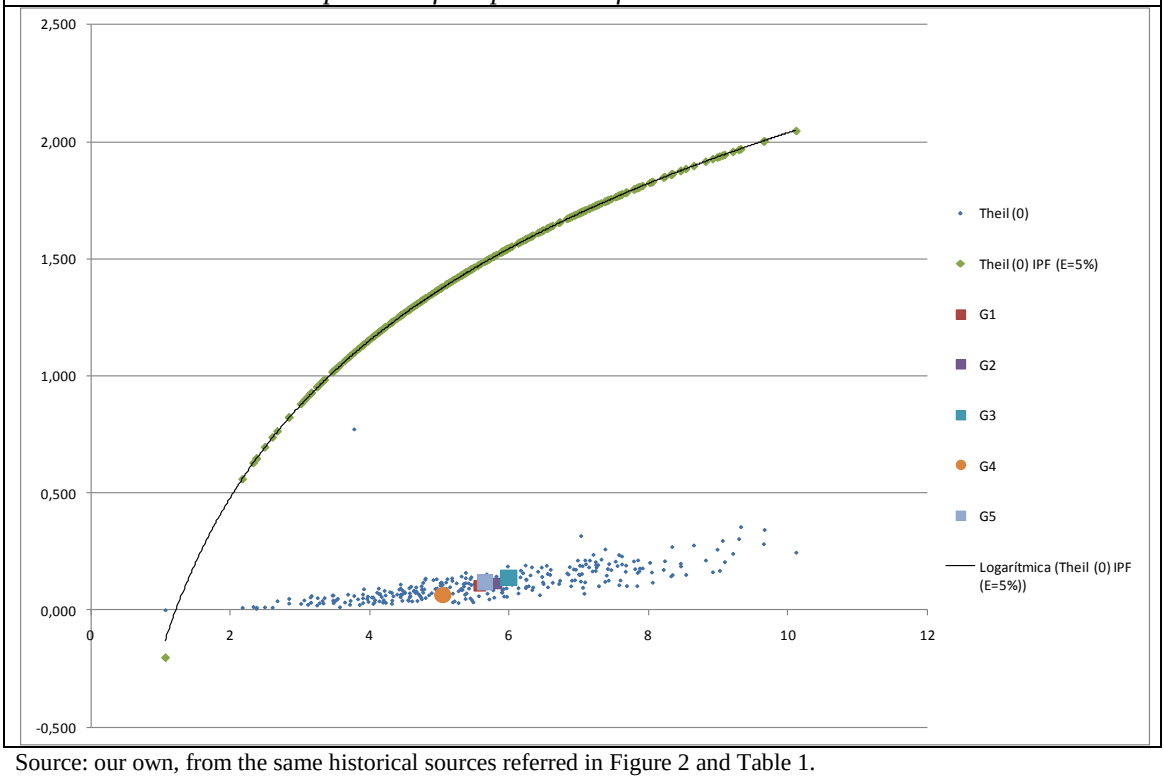
$$\text{Theil}_{\text{IPF}} = \ln \; \alpha \; - \varepsilon \cdot \ln \; \alpha \; - \varepsilon \cdot \ln \; 1 - \frac{1-\varepsilon}{\alpha} \; = \; 1-\varepsilon \; \cdot \ln \; \alpha \; + \varepsilon \cdot \ln \; \varepsilon \cdot (1 - \frac{1-\varepsilon}{\alpha}) \qquad (15)$$

Therefore, the IER for each municipality is:

$$\text{IER} = \frac{\text{Theil}(0)}{\text{Theil}'_{\text{IPF}}(0)} \qquad (16)$$

Considering $\varepsilon = 0.05$, the shape of the IER is described in figure 8, where the y-axis is the Theil (0) index and the x-axis is α, that is, the number of times that the average income of the elites exceeds the average income of the municipality:

Figure 8. *Theil'$_{IPF}$ (0) indices and cluster group averages resulting from the value of α in each municipality (as the number of times that the average income of the elite exceeds the average income of the municipality) for the whole dataset, compared with the corresponding IPF in the municipalities of the province of Barcelona in 1852-1858*

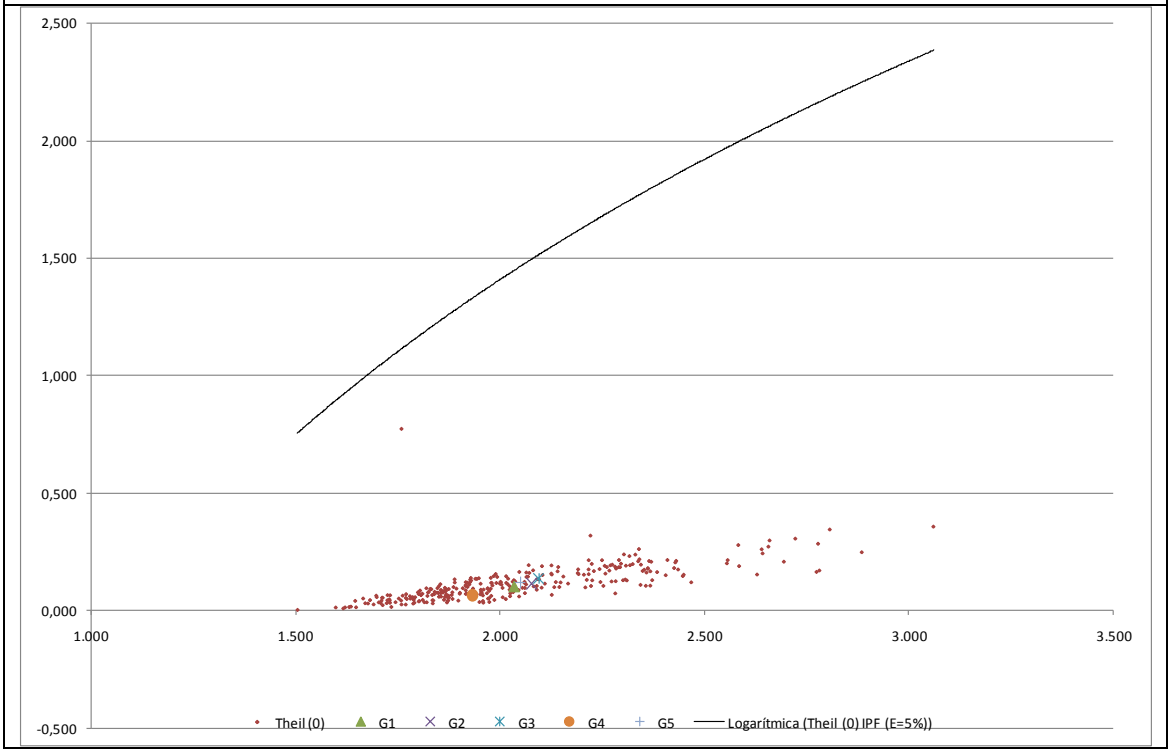


Source: our own, from the same historical sources referred in Figure 2 and Table 1.

Results go in the same direction to those observed in Figure 7, and help to make clearer an interesting point. Due to the fact that Theil (0) is independent of the size of each municipality, Figure 8 clearly shows the increasing distances of each observation to their corresponding maximum IPF. The overall distribution has a slight upward slope which confirms a growing inequality as the municipality's total agricultural wealth increased. However, the values of the maximum inequality frontier (IPF) increased even more. Therefore, as municipalities become wealthier the difference between the actual and potential inequality rose. Plotting the cluster land-use group averages in the graph also makes apparent that winegrowing municipalities where less rich and more even than forest and cereal-cropping ones, while averages of the mixed cases tended to group together in the wealthier and more unequal right side, near the cereal-cropping areas (probably because they coincided with more populated towns).

If we repeat the exercise considering the level of inequality over the average per capita income in each municipality (x-axis) –in a comparable way with the tests made by Milanovic et al. (2007) at national level—, the results confirm again that municipalities with higher levels of average income show greater distances among actual and potential inequality (see Figure 9).

Figure 9. *Theil'$_{IPF}$ (0) indices and cluster group averages resulting from mean income of the municipality in Spanish* reales *a year for the whole dataset, compared with the corresponding curve of inequality possible frontier (IPF) in the municipalities of the province of Barcelona in 1852-1858*



Source: our own, from the same historical sources referred in Figure 2 and Table 1.

Figures 8 and 9 summarize the main results found with our analysis. They confirm that before the Phylloxera plague vineyard specialization was mainly performed by poor landless peasants who sought to earn their living working as tenants on the thin and sloping soils leased to them by landowners. Nevertheless, this commercial specialization played a key role by linking the province of Barcelona with the emerging Atlantic economies, and giving way to an increase in population densities near the level

of an urban-industrial economy (Badia-Miró et al. 2010). Figures 8 and 9 also uphold our initial hypothesis that agrarian income inequality was kept lower in wine-growing municipalities than in any other place. This reduction in income inequality took place notwithstanding the land improvements made by these poor winegrowers, which increased the wealth of the whole community thus enhancing the frontier of a possible maximum inequality (IPF).

We have stressed a key feature throughout this paper: the hard work of terracing poor sloping soils and planting vineyards was a huge investment in land improvement (Olarieta et al. 2008), which consequently increased the wealth of the entire rural community. How can this be reconciled with the fact that average wealth in winegrowing townships appears to be the lowest in Figure 9? The distinction between agricultural wealth averages per person or unit of land becomes a key issue here. As can be seen in Table 8, wealth or income per unit of land was higher in wine-growing municipalities than in forestry areas or poor cereal zones intercropped with vines or olive trees. Nevertheless, per capita averages were lower in the former than the latter:

Table 8. *Average wealth per person and unit of agricultural land in Spanish reales, according to cluster land-use groups and population in the municipalities of the province of Barcelona in 1852-1858*

	number	**cadastral average per capita income**		**cadastral average income per hectare**	
		mean	**median**	**mean**	**median**
all municipalities of the dataset	295	2,042.8	1,981.7	1,102.1	410.6
G1: *winegrowing with cereal*	35	2,035.4	2,003.8	2,201.4	828.3
G2: *mainly cereal-cropping*	33	2,076.9	2,015.2	3,518.9	884.7
G3: *cereal-cropping with vines*	65	2,095.0	2,090.1	495.1	402.1
G4: *mainly wine-growing*	41	1,932.0	1,916.0	1,626.5	975.5
G5: *mainly forest*	120	2,049.5	1,979.4	252.7	200.6

Source: our own, from the same historical sources referred in Figure 2 and Table 1.

Catalan vineyards were either spread over former forest and brushwood lands or replacing poor intercropped cereal lands previously sown within sparse rows of vines and olive trees. The right columns in Table 8 clearly confirm that vineyard specialization enhanced the wealth of land. However, left columns highlight that vineyards also required higher labour intensity and this increased population densities even more. Therefore per capita levels of agricultural income and wealth became the lowest, besides being more evenly distributed.

This feature coincides with the estimates made in mid-18th century France by François Quesnay who also attributed to the winegrowing peasant-owners the lowest non-wage agricultural income in his *Tableau Économique* and other writings (Milanovic 2010). However, French winegrowers were mainly property-holders: exactly the same status that Catalan *rabassa* tenants aimed to win some day with their collective struggle. Compared with their French counterparts, the Catalan wine-growing tenants can only be considered as would-be peasants. Nevertheless, their legal and actual status was also clearly stronger than many other tenants-at-will, or labour-tenants, that existed in several regions of Europe at the time, such as the *statartorpare* in Sweden, *husmennene* in Norway, *husmaendene* in Denmark, or *heuerlinge* in Northwestern Germany (Mörner 1970). Unlike the German *heuerlinge*-system (Schlumbohm 1996), for example, that left the disinherited layers of the rural society at the mercy of landowners' will, the Catalan *rabassa* winegrowers were entitled with a temporary ownership over the vines they had planted as long as the vineyard was kept alive (Carmona and Simpson 1999).

During the 19th century many precarious *heuerling*-tenants emigrated from North-western Germany to the United States, while most Catalan *rabassa*-sharecroppers fiercely fought with the landowners to stay in the land and become wholly owners of it. In Albert Hirschman terms, the former took the 'exit' option while the latter raised their 'voice' and organized a collective action (Hirschman 1970). Therefore, we may conclude that by transforming into vineyards a previous landscape of brushwood, forest and poor cereal crops these *rabassa* tenants not only opened a room for themselves among the Catalan population (Figure 1). They also gained a place in society and a share of its income (Garrabou et al. 2008). By increasing population numbers and deepening the home market, this eventually helped to turn Catalonia into a late-modern industrious society (De Vries 2008) and an early-contemporary industrial economy (Valls 2004).

VIII. CONCLUSIONS AND FUTURE PROSPECTS

We conclude that despite the initial high degree of contingency found in the spatial location of Gini indices (Figure 2), and the lack of any simple correlation between inequality indices and other variables tested, we have discovered some relevant land-use patterns of inequality in personal agrarian wealth or income distribution in the municipalities of the Barcelona province in mid-19th century. This land-use inequality profiles have been confirmed and enhanced by using Theil indices of estimated income distribution for all the adult local population, and applying the inequality possible frontier (IPF) approach to compare the actual extraction ratio (IER) with the maximum attainable one.

The results confirm that agrarian inequality was lower in winegrowing municipalities than in mainly cereal-cropping or forest ones, in spite of the fact that attaining higher population densities, developing a commercial vineyard specialization, and increasing the total wealth above a subsistence line, could have also meant an extended frontier (IPF) of possible inequality through a greater potential extraction ratio (IER) by an agrarian elite. As noted in the introduction, this outcome stands somehow against the opposite expected pathway according to the existing literature and other historical examples. This counterexample can be interpreted as a historical process of empowerment achieved by the Catalan rural class of wine-growing tenants tanks to the long-lasting social fight they waged from the 18th century onwards, as other diachronic and more descriptive case studies have already suggested.

In this sense, the statistical cross-section analysis conducted with a remarkably large database of more than 86,000 recorded taxpayers in 295 municipalities has provided for the first time solid quantitative answers to a set of questions posed for a long time by Catalan rural historians. Our results also reinforce the ideas of those who argue that, beyond the undeniable impact of purely economic factors, the historical path followed by wealth or income distribution moves between greater degrees of freedom under a strong influence of other social, cultural and political forces (Atkinson et al. 2007). As Krugman (2007) has pointed out, changes in regulations, institutions and politics matter.

Beyond the analysis of agrarian inequality here conducted only from a land-use standpoint, this large database offers many possibilities to be exploited from other perspectives. In future research we will use the different indices obtained with this in-depth analysis on personal agrarian inequality to extend a model previously developed to identify the main driving forces that led to vineyard specialization in the province of Barcelona (Tello et al. 2008; Garrabou et al. 2009). This will allow us to include wealth

and income distribution as new variables in that model, together with population density, time-distances to the main seaports, main agronomical and environmental features of the territory –like average slopes, rainfall or temperatures—, and the sort of manorial or royal feudal jurisdiction that existed prior to their abolition in 1836. Adding to our dataset on cadastral valuation of agricultural wealth other commercial, industrial and professional incomes estimated in another volume, the same historical source will allow in future to calculate the social tables of income distribution in Catalonia, and conduct a decomposition analysis of its within, between or overlapping factors.

Annex

Table A1. *Number of taxpayers in the* Distribution of Personal Wealth in Real Estate Ownership *of 1852 in the Barcelona province*					
Districts of the Barcelona province	**taxpayers**				
	all	**with less than 2,000 *reales***	**%**	**with less than 1,500 *reales***	**%**
Barcelona	11,940	7,642	64.0	7,004	58.7
Arenys	6,774	6,161	91.0	5,980	88.3
Berga	3,657	2,970	81.2	2,820	77.1
Granollers	8,384	7,608	90.7	7,447	88.8
Igualada	9,852	9,055	91.9	8,785	89.2
Manresa	9,561	8,796	92.0	8,601	90.0
Mataró	5,326	4,748	89.1	4,576	85.9
Sant Feliu de Llobregat	8,673	8,021	92.5	7,834	90.3
Terrassa	8,276	7,659	92.5	7,491	90.5
Vic	7,356	6,430	87.4	6,242	84.9
Vilafranca del Penedès	6,500	5,676	87.3	5473	84.2
Province of Barcelona	***86,299***	***74,766***	***86.6***	***72,253***	***83.7***

Source: our own, from the *Distribution of Personal Wealth in Real Estate Ownership* of 1852 in the Barcelona province (Library of the University of Barcelona, reference 146-1-II/13).

Table A2. *Taxes paid and tax burden of tax payers above and below an attributed cadastral income of 2,000 reales a year in the Barcelona province, according to the* Distribution of Personal Wealth in Real Estate Ownership *of 1852 (in* reales *a year or %)*

Districts of the Barcelona province	estimated cadastral income of all taxpayers	taxpayers with more than 2,000 *reales*				
		estimated cadastral income	% of all income attributed	taxes paid	% of all taxes paid	% of tax burden
Barcelona	40,745,709	36,242,839	88.9	4,447,032	87.4	12.3
Arenys	5,918,547	3,362,731	56.8	513,458	55.6	15.3
Berga	5,061,354	3,708,250	73.3	541,062	68.5	14.6
Granollers	7,774,228	5,178,452	66.6	812,785	66.3	15.7
Igualada	6,778,104	3,579,993	52.8	629,203	50.2	17.6
Manresa	6,933,038	4,343,674	62.7	755,428	60.5	17.4
Mataró	5,076,673	2,980,214	58.7	472,361	57.0	15.8
Sant Feliu de Llobregat	6,555,209	3,710,259	56.6	606,685	55.1	16.4
Terrassa	6,571,379	3,781,913	57.6	580,909	57.3	15.4
Vic	6,994,514	5,110,590	73.1	1,039,174	72.2	20.3
Vilafranca del Penedès	7,038,780	4,895,405	69.5	890,345	68.2	18.2
Barcelona province	***105,447,534***	***76,894,320***	***72.9***	***11,288,442***	***69.6***	***14.7***
Districts of the Barcelona province	**taxes paid by all taxpayers**	**taxpayers with less than 2,000 *reales***				
		estimated cadastral income	**% of all income attributed**	**taxes paid**	**% of all taxes paid**	**% of tax burden**
Barcelona	5,087,106	4,502,870	11.1	640,074	12.6	14.2
Arenys	923,500	2,555,816	43.2	410,042	44.4	16.0
Berga	790,410	1,353,104	26.7	249,348	31.5	18.4
Granollers	1,225,356	2,595,776	33.4	412,571	33.7	15.9
Igualada	1,252,699	3,198,111	47.2	623,496	49.8	19.5
Manresa	1,249,441	2,589,364	37.3	494,013	39.5	19.1
Mataró	829,013	2,096,459	41.3	356,653	43.0	17.0
Sant Feliu de Llobregat	1,100,946	2,844,950	43.4	494,261	44.9	17.4
Terrassa	1,013,776	2,789,466	42.4	432,866	42.7	15.5
Vic	1,439,601	1,883,924	26.9	400,427	27.8	21.3
Vilafranca del Penedès	1,304,541	2,143,375	30.5	414,196	31.8	19.3
Barcelona province	***16,216,389***	***28,553,214***	***27.1***	***4,927,947***	***30.4***	***17.3***

Source: our own, from the *Distribution of Personal Wealth in Real Estate Ownership* of 1852 in the Barcelona province (Library of the University of Barcelona, reference 146-1-II/13).

References

Acemoğlu, Daron, and James A. Robinson. 2006. *Economic origins of dictatorship and democracy*. Cambridge: Cambridge University Press.

Acemoglu, Daron; Robinson, James A. and Simon Johnson. 2002. Reversal of fortune: geography and institution in the making of the modern world income distribution. *The Quarterly Journal of Economics* 117(4):1231-1294. doi:10.1162/003355302320935025

Atkinson, Anthony B. and Thomas Piketty (eds.) 2007. *Top incomes over the twentieth century: a contrast between Continental European and English-speaking countries*. Oxford: Oxford University Press.

Badia-Miró, Marc; Tello, Enric; Valls, Francesc and Ramon Garrabou. 2010. The grape phylloxera plague as a natural experiment: the upkeep of vineyards in Catalonia (Spain), 1858-1935. *Australian Economic History Review* 50(1):39-61. doi:10.1111/j.1467-8446.2009.00271.x

Balcells, Albert. 1980. *El Problema agrario en Catalunya: la cuestión rabassaire (1890-1936)*. Madrid: Ministerio de Agricultura, Pesca y Alimentación.

Boserup, Ester. 1983. *Population and Technological Change: A Study of Long-Term Trends*. University of Chicago Press, February.

Bourguignon, François and Christian Morrison. 2002. The Size Distribution of Income among World Citizens. *American Economic Review* 92:727-744.

Bravo Murillo, Juan. 1852. Real Orden del 10 de febrero de 1852 firmada por el Director General de Contribuciones Directas, Estadísticas y Fincas del Estado, *Gaceta de Madrid* 12/02/1852:2-3.

Burgueño, Jesús. 2007. Cartografia cadastral de la província de Lleida (segles XVIII-XIX). In *La cartografia cadastral a Espanya (segles XVIII-XX)*, 39-49. Barcelona: Institut Cartográfic de Catalunya.

Calatayud, Salvador; Millán, Jesús; Romeo, Mª Carmen. 2000. El rentismo nobiliario en la agricultura valenciana del siglo XIX". *Revista de Historia Económica* 19(1):79-107 (Available at URL: http://e-archivo.uc3m.es/bitstream/10016/2129/1/RHE-2000-XVIII-1-Calatayud-Millan-Cruz.pdf).

Carmona, Juan, and James Simpson. 1999. The "Rabassa Morta" in Catalan Viticulture: The Rise and Decline of a Long-Term Sharecropping Contract, 1670s–1920s. *Journal of Economic History* 59:290-315. doi:10.1017/S0022050700022841

Carrasco, Pio A. 1867. *Tratado de las contribuciones directas de España*. Madrid: Establecimiento Tipográfico de T. Fontanet.

Cerdà, Idelfons. 1867. *Teoría general de la urbanización y aplicación de sus principios y doctrinas a la reforma y ensanche de Barcelona*. Facsimile edition by Estapé, F. (ed.), Madrid: Instituto de Estudios Fiscales.

Curto-Grau, Marta; Herranz-Loncán, Alfonso and Albert Solé-Ollé. 2010. The Political Economy of Infrastructure: the Spanish "Parliamentary Roads" (1880-1914). Working Paper of the Asociación Española de Historia Económica DT-AEHE Nº 1008 (Available at URL: http://www.aehe.net/2010/07/dt-aehe-1008.pdf).

Cussó, Xavier; Garrabou, Ramon and Enric Tello. 2006. Social metabolism in an agrarian region of Catalonia (Spain) in 1860-1870: Flows, energy balance and land use. *Ecological Economics* 58(1):49-65. doi:10.1016/j.ecolecon.2005.05.026.

De Vries, Jan. 2008. *The Industrious revolution: Consumer behavior and the household economy, 1650 to the present*. New York: Cambridge University Press.

Díaz-Marín, Pedro. 2000. Oligarquía y fiscalidad: los primeros pasos de la contribución de inmuebles, cultivo y ganadería en la provincia de Alicante. *Revista de Historia Económica*, XVIII(2):309-338.

Díez-Espinsosa, José Ramón. 1986. *Desamortización y economía agraria castellana: Valladolid, 1855-1868*. Valladolid: Diputación Provincial/Institución Cultural Simancas.

Garrabou, Ramon; Tello, Enric; Cussó, Xavier and Marc Badia-Miró. 2009. Explaining agrarian specialization in an advanced organic economy. The province of Barcelona in mid-nineteenth century. In Vicente Pinilla (ed.) *Markets and Agricultural Change in Europe from the 13th to the 20th Century*, 137-172. Turnhout: Brepols Publishers.

Garrabou, Ramón; Planas, Jordi and Enric Saguer. 2001. *Un capitalisme impossible?: la gestió de la gran propietat agrària a la Catalunya contemporània*. Vic: Eumo Editorial/Universitat de Vic.

———. 2010. Management of Large Rural Estates in Catalonia (XIX-XXth centuries): an Approach through Farm Accounts. Communication to the T-15 RUR19 session on *Farm Account and Rural Patterns of Development* at the European Social Science History Conference (ESSHC 2010), Ghent (Belgium).

Garrabou, Ramon and Enric Tello. 2002. Salario como coste, salario como ingreso: el precio de los jornales agrícolas en la Cataluña contemporánea (1727-1930). In José-Miguel Martínez Carrión (ed.) *El nivel de vida en la España rural, siglos XVIII-XX*, 173-176. San Vicente del Raspeig: Publicaciones de la Universidad de Alicante.

Garrabou, Ramon; Tello, Enric and Xavier Cussó. 2008. El cambio de usos del suelo en la comarca del Vallès (1850-2000): fuerzas motoras y agentes rectores de la transformación del territorio. In Ramón Garrabou and José Manuel Naredo (eds.) *El Paisaje en Perspectiva Histórica: Formación y Transformación del Paisaje en el Mundo Mediterráneo*, 233-258. Zaragoza: Prensas Universitarias de Zaragoza.

———. 2010. Ecological and Socio-economic functioning of the Mediterranean agrarian systems in the middle of the nineteenth century. A Catalan case study (the Vallès county, 1850-70). In Erich Langthaler and Ernst Langthaler (eds.) *Agrosystems and Labour Relations in European Rural Societies*, 119-154. Turnhout: Brepols Publishers.

Hirschman, Albert O. 1970. *Exit, voice, and loyalty: Responses to decline in firms, organizations and states*. Cambridge (MASS.): Harvard University Press.

Hornborg, Alf; McNeill, John R. and Joan Martínez Alier (eds.) 2007. *Rethinking Environmental History. World-System History and Global Environmental Change*. Lanham: Altamira Press.

Johnson, Richard A. and Dean W. Wichern. 2007. *Applied multivariate statistical analysis*, 6th edition. Englewood Cliffs (NJ): Prentice-Hall.

Krugman, Paul. 2007. *The Conscience of a Liberal*. New York: W.W. Norton.

Lindert, Peter H. and Jeffrey G. Williamson. 2003. Does Globalization Make the World More Unequal? In Michael D. Bordo, Alan M. Taylor and Jeffrey G. Williamson (eds.) *Globalization in Historical Perspective*, 227-271. Chicago: Chicago University Press.

Litchfield, Julie A. 1999. *Inequality: Methods and Tools*. Text for World Bank's Web Site on Inequality, Poverty, and Socio-economic Performance (Available at URL: http://www.worldbank.org/poverty/inequal/index.htm).

Marull, Joan; Pino, Joan and Enric Tello. 2008. The loss of landscape efficiency: An ecological analysis of land-use changes in Western Mediterranean agriculture (Vallès county, Catalonia, 1853-2004). *Global Environment. A Journal of History and Natural and Social Sciences* 2:112-150.

Marull, Joan, Pino, Joan, Tello, Enric and María José Cordobilla. 2010. Social metabolism, landscape change and land-use planning in the Barcelona Metropolitan Region. *Land Use Policy* 27(2): 497-510. doi:10.1016/j.landusepol.2009.07.004

Milanovic, Branko. 2005. *Worlds Apart. Measuring International and Global Inequality*. Princeton: Princeton University Press.

Milanovic, Branko; Lindert, Peter H. and Jeffrey G. Williamson. 2007. *Measuring ancient inequality*. World Bank Policy Research Working Paper No. 4412 (Available at URL: http://ssrn.com/abstract=1033224).

Milanovic, Branko. 2010. Level of income and income distribution in mid-18th century France, according to François Quesnay, MPRA Paper nº 27692, Munich. (Available at URL:http://mpra.ub.uni-muenchen.de/27692/).

Moreno-Luzón, Javier. 2007. Political clientelism, elites and caciquismo in Restoration Spain (1875-1923). *European History Quarterly* 37(3):417-441. doi: 10.1177/0265691407078445

Mörner, Magnus. 1970. A Comparative Study of Tenant Labor in Parts of Europe, Africa and Latin America 1700-1900: A Preliminary Report of a Research Project in Social History. *Latin American Research Review* 5(2):3-15 (Available at URL: http://www.jstor.org/stable/2502223?origin=JSTOR-pdf).

Muro, José Ignacio; Nadal, Francesc and Luis Urteaga. 1996. *Geografía, estadística y catastro en España: 1856-1870*. Barcelona: Ediciones del Serbal.

Nadal, Francesc and Luis Urteaga. 1990. *Cartography and state: national topographic maps and territorial statistics in the nineteenth century*. Barcelona: Publicacions de la Universitat de Barcelona.

Nadal, Jordi and Emili Giralt. 1960. *La Population catalane de 1553 à 1717: l'emmigration française et les autres facteurs de son développement*. Paris: SEVPEN.

Olarieta, José Ramón; Rodriguez-Valle, Fernando L. and Enric Tello. 2008. Preserving and destroying soils, transforming landscapes: Soils and land-use changes in the Vallès County (Catalunya, Spain) 1853-2004. *Land Use Policy* 25(4): 474-484. doi:10.1016/j.landusepol.2007.10.005

Peña, Celestino 1852. *Tratado de estadística territorial y pecuaria, acompañado de un reglamento general para su establecimiento y conservación.* Pontevedra: Imprenta de N. Pazos y José Antunez.

Piketty, Thomas; Postel-Vinay, Gilles and Jean-Laurent Rosenthal. 2006. Wealth Concentration in a Developing Economy: Paris and France, 1807-1994. *American Economic Review* 96(1):236-256. doi: 10.1257/000282806776157614

Prados de La Escosura, Leandro. 2008. Inequality, Poverty, and the Kuznets Curve in Spain, 1850-2000. *European Review of Economic History* 12(3):287-324. doi:10.1017/S1361491608002311

Roine, Jesper and Daniel Waldenström. 2009. Wealth Concentration over the Path of Development: Sweden 1873–2006. *Scandinavian Journal of Economics* 111(1):151-187. doi: 10.1111/j.1467-9442.2008.01558

San Julián, Javier. 2010. *Economic ideas and economists in the Parliament in the liberal age: The attempt to implement a tax on incomes in Spain in 1868-1869*. Working Paper E10/236 of the Faculty of Economics and Business at the University of Barcelona (Available at URL: http://www.ere.ub.es/dtreball/E10236.rdf/view).

Santiago-Caballero, Carlos. 2011. Income inequality in central Spain, 1690–1800. *Explorations in Economic History* 48 (1):83-96. Doi: 10.1016/j.eeh.2010.09.004

Schlumbohm, Jürgen. 1996. Micro-history and the macro-model of the European Demographic System in pre-industrial times: Life course patterns in the parish of Belm (Northwest Germany), Seventeenth to the Nineteenth Centuries. *The History of the Family. An International Quarterly* 1(1):81-95. doi:10.1016/S1081-602X(96)90021-4

Segura, Antoni. 1993. *Burgesia i propietat de la terra a Catalunya en el segle XIX: les comarques barcelonines*. Barcelona: Curial.

Shenk, Mary K.: Borgerhoff Mulder, Monique; Beise, Jan; Clark, Gregory; Irons, William; Leonetti, Donna; Low, Bobbi S.; Bowles, Samuel; Hertz, Tom; Bell, Adrian; Piraino, Patrizio. 2010. Intergenerational Wealth Transmission among Agriculturalists: Foundations of Agrarian Inequality. *Current Anthropology* 51(1): 65-83. doi: 10.1086/648658

Theil, Henri. 1979. The Measurement of Inequality by Components of Income, *Economics Letters* 2:197-199.

Tello, Enric. 1997. La conflictividad social en el mundo rural catalán, del Antiguo Régimen a la Revolución liberal, 1720-1833. *Historia Agraria* 13:89-104.

Tello, Enric; Badia-Miró, Marc; Cussó, Xavier; Garrabou, Ramon and Francesc Valls. 2008. *Explaining vineyard specialization in the province of Barcelona (Spain) in the mid-19th century*. Working Paper E08/201 of the Faculty of Economics and Business at the University of Barcelona (Available at URL: http://www.ere.ub.es/dtreball/E08201.rdf/view).

Tello, Enric; Garrabou, Ramon and Xavier Cussó. 2006. Energy Balance and Land Use: the Making of an Agrarian Landscape from the Vantage Point of Social Metabolism. In Mauro Agnoletti (ed.) *The conservation of cultural landscapes*, 42-56. Wallingford: CAB International.

Valls, Francesc. 2004. Viticulture et industrialisation en Europe du Sud: Les cas du Languedoc, du Portugal et de la Catalogne. *Domitia* 5:41-51 (Available at URL: http://www.univ-perp.fr/fr/recherche/centres_de_recherche/domaines_des_sciences_humaines_et_sociales/crhism/domitia/n_5.html).

Van Zanden, Jan Luiten. 1995. Tracing the Beginning of the Kuznets Curve: Western Europe during the Early Modern Period. *Economic History Review* 48(4):643-664 (Available at URL: http://www.jstor.org/stable/2598128)

Vilar, Pierre. 1962. *La Catalogne dans l'Espagne moderne: Recherches sur les fondements économiques des structures nationales*. Paris: SEVPEN.

Williamson, Jeffrey G. 1991. *Inequality, Poverty and History*. Cambridge (Mass): Basil Blackwell.

———. 1999. Real Wages, Inequality, and Globalization in Latin America before 1940. *Revista de Historia Económica* XVII (special issue):101-142.

———. 2006. *Globalization and the Poor Periphery before 1950*. Cambridge (Mass): The MIT Press.