DOCUMENTS DE TREBALL
DE LA FACULTAT D'ECONOMIA I EMPRESA

Col.lecció d'Economia

E13/290

An agency-oriented model to explain vine-growing specialization in the province of Barcelona (Catalonia, Spain) in the mid-nineteenth century

MARC BADIA-MIRÓ[*] AND ENRIC TELLO[**]

[*]*Departament d'Història i Institucions Econòmiques, Facultat d'Economia i Empresa, Universitat de Barcelona, Av. Diagonal, 690, 08034, Barcelona, Espanya, e-mail: mbadia@ub.edu, (corresponding autor)*
Xarxa de Referència en Economia i Polítiques Públiques
Centre d´Estudis 'Antoni de Capmany' d´Economia i Història Econòmica. Grup de Recerca Consolidat en Història i Desenvolupament Econòmics (Indústria, Empresa i Sostenibilitat).

[**] *Departament d'Història i Institucions Econòmiques, Facultat d'Economia i Empresa, Universitat de Barcelona, Av. Diagonal, 690, 08034, Barcelona, Espanya, e-mail: tello@ub.edu*
Centre d´Estudis 'Antoni de Capmany' d´Economia i Història Econòmica. Grup de Recerca Consolidat en Història i Desenvolupament Econòmics (Indústria, Empresa i Sostenibilitat).

Acknowledgements
Enric Tello has counted with the support given by the Spanish research projects HAR2009-13748-C03 and HAR2012-38920-C02-02, and the Partnership Grant SSHRC 895-2011-1020 on *Sustainable Farm Systems: long-term socio-ecological metabolism in Western agriculture* funded by the Social Sciences and Humanities Research Council of Canada (2012-2017). Marc Badia-Miró acknowledges the support of the Spanish research projects ECO2012-39169-C03-03 and XREPP. Both authors are members of the Consolidated Research Group in Economic History and Development (Industry, Business and Sustainability) at the Centre d'Estudis Antoni de Capmany (2009SGR153). We also thank the help received from all members of these research teams, and especially to Ramon Garrabou, Francesc Valls-Junyent, Xavier Cussó, Josep Colomé, Jordi Planas, Lluís Parcerisas, Ricard Garcia-Orallo and Pere Pascual. We are also grateful for the criticisms and suggestions to earlier or partial versions of this work made by James Foreman-Peck, Jean-Pascal Bassino, Pedro Lains, Joan Ramon Rosés, Juan Carmona, Giovanni Federico, Cormac O'Grada and two other anonymous reviewers. None of them are responsible for our own mistakes.

Resum

En aquest treball presentem un model per explicar el procés d'especialització vitícola assolit als municipis de la província de Barcelona, a mitjans del s. XIX,que cerca entendre com va sorgir històricament un avantatge comparatiu fruit d'un procés que esdevindria un dels punts de partida del procés d'industrialització a Catalunya. Els resultats confirmen els papers jugats pel impuls "Boserupià" de la població en un context d'intensificació de l'ús de la terra, i d'un impuls del mercat "Smithià" en un context d'expansió de la demanda per part de les economies atlàntiques. També es posa de manifest la importància de les dotacions agro-ecològiques i les condicions socio-institucionals relacionades amb la desigualtat d'ingrés. La difusió de la vinya donà com a resultat unes comunitats rurals menys desiguals fins al 1820, tot i que aquesta desigualtat augmentà de nou a partir d'aleshores.

JEL Codes: I39, N33, N53, Q56

Paraules clau: Especialització agrícola, vinya, impuls de la població, integració del mercat, idoneïtat de la vinya, desigualtat rural, rati renda-salari, Catalunya.

Abstract

We present a model of vine-growing specialization in the municipalities of the province of Barcelona in the mid-19th century that explains how a comparative advantage arose through a process deemed to be one of the starting points for Catalan industrialization. The results confirm the roles played by the 'Boserupian' population-push on land-use intensification and the 'Smithian' market-pull in a growing demand from the Atlantic economy. They also stress the conditioning function of agro-ecological endowments and socio-institutional settings related to income inequality. Vineyard planting gave rise to less unequal rural communities until 1820, but inequality grew again afterwards.

Keywords: Agricultural specialization, vine-growing, population push, market integration, grapevines suitability, rural inequality, rental-wage ratios, Catalonia

1. Introduction

This article presents and tests a model which explains vine-growing specialization in the province of Barcelona, based on the stylized facts pointed out in many case studies published by rural historians. It combines the theoretical insights of either Hecksher-Olhin or the New Economic Geography approaches when considering comparative advantages, factor endowment and the impact market openness to international markets had on the Catalan economy. According to the existing historiography, the spread of vineyards started at the end of the 17th century and increased until the *Phylloxera Vastatrix* plague at the end of the 19th century. In 1858 115,454 hectares were planted with vines which accounted for 51 per cent of the farmland in the province of Barcelona, and some 16,000 hectares more were added until the *Phylloxera* crisis in the 1880s (Badia-Miuró et al., 2010). This process was triggered by the following driving forces: a) population growth; b) market connection with an increasing demand for liquors and wines from a growing Atlantic economy; and c) the planting of vineyards in mainly poor sloping lands landowners leased to small grower-tenants with little or no land of their own by an emphyteutic contract called *rabassa morta* in Catalan—as it expired when the vines planted died (Vilar, 1962; Giralt, 1965; Balcells, 1980; Carmona and Simpson, 1999; Colomé, 2000; Garrabou et al., 2000; Garrabou et al., 2008; Garrabou et al., 2009; Colomé et al., 2002; Badia-Miró et al., 2010).

This wine-exporting specialization brought about the most important change crop allocation experienced in the Catalan rural society of that time. It had a deep effect on the composition and evolution of foreign trade (Pan-Montojo, 1994; Carmona et al., 2001, Valls, 2001a; 2001b; 2003; Pinilla and Ayuda, 2007). Furthermore, commercial profits accumulated by winemakers and traders also contributed to finance the comparatively early industrialization of Catalonia (Sudrià and Pascual, 1999; Marfany, 2010; 2012). A closer domestic market integration between rural and urban places was also fostered by means of this vine-growing specialization (Valls, 2007). Thanks to the opportunities which opened up for the poorest sections of the peasantry, a deeper domestic demand for cheaper textiles manufactured by the nascent industry ensued (Sánchez and Nadal, 1998). This outcome of the Catalan viticulture stands out against other contemporary paths which some Southern European regions followed, such as the French Languedoc, where vines or looms became alternative ways of economic development (Johnson, 1995; Valls, 2004). Therefore, explaining winegrowing specialization in Catalonia is a relevant economic historical issue.

Some partial versions of our model with successful results have already been published (Tello et al., 2008; Garrabou et al., 2009). However, we are offering here what we consider to be the complete and final version of it. In the first section we present the model and the stylized facts of the available evidence. The second section enumerates the datasets that have allowed us to empirically test the model, going deeper into the expected impact of each variable. In section three we check the model against the datasets assembled. Section four discusses the results and conclusions.

2. A historical model to explain how a comparative advantage arose

At first sight, the theoretical background underlying this historical narrative could be considered to be an applied version of the Heckscher–Ohlin model. According to it, vine-growing specialization would have developed in those Catalan municipalities with more favourable factor endowment to meet the increasing demand for wine. However, the existing literature not only points out that vines tended to spread where land and labour endowments were most suitable. Historians have also tried to explain how this comparative advantage arose throughout a specific historical process. Figure 1 describes the set of driving forces to be considered. Some of them can be regarded as naturally given, such as agro-climatic endowment. Others depended on human agency, like migrations that changed population densities or the readiness of many landless peasants to invest their labour force to turn poor sloping land into terraced vineyards (Olarieta et al., 2008).

Figure 1 – About here

In other words, we are assuming an agency-oriented explanation of this historical process of land-use change (Lambin et al., 2000; Moran and Ostrom, 2005). Figure 1 highlights the 'Boserupian' pushing force of increasing population densities that triggered more intensive land uses in mainly rural municipalities (Boserup, 1981; Netting, 1993; Hunt, 2000); and the market-pulling 'Smithian' force exerted by an overseas wine demand which induced a reallocation of land and labour towards vine-growing. These population-pushing or market-pulling forces had different impacts on the local land-use changes, depending on two other sets of conditioning factors, namely the specific agro-climatic endowments and the existence of a labour force ready to enter into tenancy contracts to grow vines (Garrabou et al., 2008) .

This agency-oriented model of land-use change combines what environmental historians (Cronon, 1991) as well as New Economic Geography (Krugman, 1993a; 1993b) call first-nature and second-nature variables. While agro-climatic endowments are first-nature factors, the dynamic interaction between the other variables becomes a set of second-nature drivers—included time-distances to the nearest seaport that we take as a proxy for the market-pulling force (Badia-Miró et al., 2010). What eventually really matters is the combination between them. Except for the pulling market force of demand, all variables had to move along a specific range of values, higher than a minimum but not exceeding an upper level, so as to fit with the rest in a suitable economic factor endowment. Local suitability to vine-growing was the outcome of a myriad of decisions taken by a lot of people interacting in a given set of challenges and opportunities which in turn they transformed.

This agency-driven impulse set in motion self-reinforcing processes of vineyard planting, and some additional loops could be established within them. Planting vines using the long-lasting leases of *rabassa morta* could attract immigrants seeking new opportunities. This in turn might open a way of access to land for poor landless peasants, while the increasing reliance on distant markets may affect income distribution as well. The result would depend on the evolution of terms of trade and socio-

institutional responses. As long as a foreign demand for wine kept growing at a higher rate than the local labour supply, we may expect that this market connection helped to reduce income inequality in winegrowing areas (Lindert and Williamson, 2003; Williamson, 2006; 2011). Though, the actual outcome would also depend on other social and political factors at stake.

This vine-growing specialization stopped when one or several key variables exceed certain threshold values. For example, attaining population densities higher than the ones capable to be sustained by a still mainly agrarian economy, or exhausting marginal lands available to plant vineyards. As a result they faced a dilemma: Either demographic surpluses started to emigrate again towards other places, or local economies started a structural change to more industrial activities (Colomé et al., 2010, Colomé and Valls, 2012). It would be great to carry out this analysis along several dates, in order to assess whether or not the relative weight of first-nature and second-nature variables changed throughout this historical process. Nevertheless, the available datasets only allow us to perform a cross-section analysis in the mid-19th century.

2.1. *Specifying 'Boserupian' population push and 'Smithian' market pull*

Our first dataset is taken from the *Estadística Territorial* of the province of Barcelona compiled in 1858 (Muro et al., 2011). This land-use figures have been benchmarked with other cadastral records used in several case studies, and they enabled us to highlight the role that a large number of farm plots held by poor smallholders, who had to give up on the idea of achieving self-sufficiency through poly-culture, played in the spread of vineyards (Garrabou et al., 2000; 2001; 2010; Tello et al., 2008). The spatial distribution of vineyards in the province of Barcelona in 1858 shows that basically vine-growing municipalities were located either along the coast (around the seaports of Mataró and Vilanova), or covered the flatter areas in the pre-littoral corridor (between the towns of Vilafranca del Penedès, Igualada, Manresa and Terrassa). We also observe a higher presence of vines in areas closer to Barcelona, and lower levels in the municipalities far from the coast—while there was a first ring allocated for grains and vegetables around the city (Map 1).

Map 1 – About here

A further step was to identify those municipalities that showed a cluster with similar levels of vine-growing specialization by using local I-Moran's indices:

$$I_i = z_i \sum_j W_{ij} z_j$$

where I_i is the local I-Moran's index, $z_{i,t}$ is the standardized value of the considered dataset in region i, and $W_{i,j}$ is the spatial weight matrix.[1] The results are shown in Map 2:

[1] In our case, we consider queen contiguity standardized by length border, so that we have weighed contact values by the length of the common border among municipalities. This choice of the spatial weight matrix is not neutral. If we compare the results obtained from different weight matrices (non-standardized or standardized by number of neighbours) we could observe some dissimilarity, particularly among those

Map 2 – About here

As expected, local spatial autocorrelation appears to be significant in high-high relations in three clusters of vine-growing specialization located in the south-west (the Penedès County, around the town of Vilafranca and approaching the town of Vilanova), at the north-east side of the city of Barcelona near the sea (the Maresme County, around the town of Mataró), and in some parts near the centre of the province (Pla de Bages County, around the town of Manresa). A significant autocorrelation cluster with low-low values appears at the northern parts, nearer to the pre-Pyrenees mountains around the towns of Berga (Bergadà County) and Vic (Osona County). In the rest of the province vineyards seem to be randomly distributed, i.e. they were intercropped with grains, tree crops, woods and pastures in poly-cultural landscapes.

Grape vines had been grown in Catalonia for many centuries before they became the main cash crop. They were traditionally planted as a temporary crop in small plots of woodland or scrub previously slashed and burnt, until the vines became too old and the vineyard was left to be reforested. Another crop pattern consisted of planting sparse rows of vines with strips of arable land in between, which were alternatively sown with grains or left fallow. These vineyards had long existed as a complementary side to the traditional agricultural system that produced wheat, wine and olive oil in a poly-cultural landscape whose surpluses were mainly oriented to local markets. Things started to change from the 17th century onwards, since population growth made it necessary to adopt more intensive land-use patterns while the Dutch trade connected the Western Mediterranean coast with the emerging Atlantic economy. This European or American demand for spirits and wines started to pull a new commercial type of winegrowing in Catalonia (Vilar, 1962; Fradera, 1987; Valls 2003). Moving beyond the city of Barcelona and its outskirts, population densities increased from nearly 20 inhabitants per square kilometre in 1718 to more than 36 in 1787, and almost doubled again to 64 in 1857-1860. As a result, per capita land availability had reduced from more than five hectares per inhabitant to only one and a half throughout 140 years.

In this context of market integration, the relationship between population growth and the change in crop patterns appears to be less obvious than expected. Up to a point, higher population densities fostered more intensive land uses, such as vine-growing, but further increases above a certain threshold could put an end to vineyard planting—for example, due to the development of industrious or industrial activities that would increase labour costs. An optimal population density for viticulture seems to have been between 25 and 65 inhabitants per km^2 (Badia-Miró et al. 2010), a range that fits the upper threshold for a rain-fed agricultural economy established by Ester Boserup (1981). Only an urban–industrial economy could host higher population densities, as was the case in the industrializing districts of Barcelona, Mataró, Arenys de Mar, Terrassa, Sant Feliu de Llobregat and Vilafranca del Penendès in 1857 (Table 1).

---

municipalities with high-low and low-high relations. The high-high and low-low relations were robust and always appeared regardless of the matrix choice.

Table 1 – About here

Map 3 outlines that those municipalities with higher population densities, together with the capitals of the districts, were clustered in coastal zones around Barcelona, and spread along the rivers Llobregat (with an additional area that extended to the Penedès and Anoia counties) and the Besòs-Congost (along the Vallès County). Moreover, these were precisely the areas where Catalan industrialization began.

Map 3 – About here

Anyhow, it is not the population density at a given date that allows us to capture the push driving force exerted by the 'Boserupian population pressure' on land-use intensification. But we believe it to be the *increase* in population densities between some lower and upper thresholds preceding the change in crop allocation. As we have already checked in earlier versions of the model (Tello et al., 2008), what becomes significant is the growth population experienced along a period of time *before* the levels of vine-growing specialization were laid down. Therefore, we use population increases from 1787 to 1860 as the 'Boserupian' variable. Map 4 and

Map 5 show a rather random distribution of population growth rates, except in some municipalities near the towns of Vilafranca del Penedès, Igualada and Terrassa.

Map 4 – About here

Map 5 – About here

How could these high population densities be fed? With average cereal yields at about 15-16 hectolitres per hectare grown in 44 per cent of farmland, local production of food grains could only fulfil 39 per cent of the consumption needs circa 1860. To cover the other 61 per cent, the province of Barcelona had to import one million hectolitres of wheat per year from Castile or other inland regions of the Iberian Peninsula—since a ban on overseas imports of grain had been imposed in 1820 so as to create a Spanish home market (Map 6).

Map 6 – About here

A deeper market integration of the regional economy ensued after two centuries of an export-led growth of Catalan viticulture. Therefore, market access became a key variable for the impact exerted by this 'Smithian' pulling impulse in different municipalities. Our model assesses this pull effect using travel costs to the seaports, as measured in time distances before the arrival of railways. Map 7 shows the isochronal curves to the nearest harbour (Mataró, Vilanova or Barcelona) during the first third of the 19th century.

Map 7 – About here

Before railroads, the location of every municipality had a deep impact on the economic access to foreign markets. Practically all inland trade had to be carried through cart roads and bridle paths. By

comparing maps 1 and 7, the relationship between vine-growing locations and time distances to the seaports becomes apparent.

2.2. *Specifying agro-climatic endowment*

Agro-climatic endowments acted as conditioning variables that mediated in the local responses to population-push and market-pull. Slope of the land and the texture of soils, rainfall, frost risk, solar radiation, together with altitude and average temperature determined the suitability of different lands for a range of possible crops (Map 8).

Map 8 – About here

Agronomists also use specific agro-climatic indices constructed to obtain a proxy of land aptitude for growing grapevines, such as the Huglin helio-thermic index or the Winkler and Amerine Effective Thermal Integral (Tonietto and Carbonneau, 2004).[2] Their values are seen on Map 9:

Map 9 – About here

A relationship between vineyard locations and agro-climatic endowments shows up when comparing Map 1 with Maps 8 or 9. While municipal averages of temperature and solar radiation seem to be positively correlated with higher percentages of vineyards in farmland, a negative sign is expected when it comes to frost risk. On a less obvious way, average slope and water stress are also expected to be positively correlated with vineyards since landowners had tended to allocate flatter and moister soil to grow vegetables and cereals, and leased sloping and drier lands to small vine-growing tenants. Similarly, we expected the Huglin and Winkler indices to show a positive and significant impact on vine-growing specialization. However, as it will be explained, our results do not confirm this assumption. The reasons seem to lie in the fact that in Catalonia growing vines was not first choice of landowners, but only a second best for lands less suitable for growing grain.

2.3. *Specifying inequality in agricultural wealth and income distribution*

A source published in 1852, the *Repartimiento Personal de la Riqueza Territorial*, has allowed us to take into account inequality in agricultural wealth and/or income distribution, seen as another conditioning factor of the local impact of population push and market pull on winegrowing specialization. This rather exceptional record lists the names of all owners of land, houses and livestock who were subjected to the cadastral tax. The document adds up the evaluation of their annual taxable incomes to obtain the corresponding tax burden of every municipality (Bravo

[2] Given that vines stop vegetative activity below a temperature of ten degrees, and that above that level their growth depends on available sunlight for photosynthesis, the Huglin index of helio-thermal aptitude is obtained by the expression: $IH = S[(T_a–10°)+(T_m–10°)]K/2$, where T_a is the daily average temperature, T_m is the maximum daily temperature during the active period of vegetation, and K is the length ratio of days varying from 1.02 to 1.06 between 40 and 50 degrees latitude. The Active Thermal Integral (ATI) is calculated by adding the daily mean temperatures above or equal to 10°C during the active period of vegetation between March and October: $ATI = ST_a$, where T_a is the active temperature. The Effective Thermal Integral (ETI) of the Winkler and Amerine index is the sum of effective daily mean temperatures, calculated from the monthly average temperatures multiplied by days of each month during the growth season from April to October. So that, $ETI = ST_e$, where the effective temperature (T_e) is the active temperature (T_a) minus 10°C.

Murillo, 1852). Although several historians have used some information taken from these lists, this is the first time that a large dataset is created and thoroughly analysed using the whole information they contain. Our database includes more than 86,000 taxpayers in 295 municipalities out of the 311 existing at present in the province. They represented 12% of the total population, 24% all males, and 41% of all male inhabitants older than 21, as recorded in the provincial census of 1857.

However, this rather exceptional information contains an important ambiguity: Are we calculating inequalities of wealth or income? Wealth inequality is always greater than income inequality, as people have to survive even with lower incomes while properties are accumulated over generations only by those who earn higher ones (Van Zanden, 1995). As is fully explained in (Tello and Badia-Miró, 2011), the data provided refers only to the aggregate value of these properties locally owned by each taxpayer in every municipality, according to the standardized procedures applied by the cadastral officials—including the estimated incomes earned by grower tenants (Peña, 1852). Labour people with no property or tenancy were excluded, while 84% of ratepayers were smallholders having only a poor house with a family garden of their own. The implicit rent of the latter amounted up to 2,000 Spanish *reales*, an income near the poverty line of that time (Cerdà, 1867).

Thus, our dataset becomes truncated and skewed as it is somewhere between wealth and income distribution. In order to turn this dataset on personal real estate wealth into a clearer distribution of agricultural incomes, we have added all non-owners male adults older than 21 before calculating some of our inequality indices; and then, in order to correct the agricultural wages missed, a minimum vital income of 1,500 *reales* a year has also been added to the earning valuation of properties and tenancies held (Garrabou and Tello, 2002, Tello and Badia-Miró, 2011).[3]

Now we come to the main question: Which was the expected relationship between income distribution and vine-growing specialization? Given that the long-lease *rabassa* contract established that the tenancy lasted until the vines' death, grower tenants used to bury strains in order to keep them alive so as to turn their access to the land almost permanent. The duration of the contract, and the rent share over the vintage, became the contested issues of a long social conflict that lasted from the end of the 18th century until the Spanish Civil War (1936-1939) (Balcells, 1980; Tello, 1997; Carmona and Simpson, 1999). Despite this long-lasting clash between landowners and tenants, the spread of the *rabassa* tenancy system may be regarded as a praiseworthy achievement of the poorest sections of Catalan rural society owing to their collective action. In fact, up to the first decades of the 19th century vine-growing had led to a less unequal income distribution compared to

[3] What credibility can we give to this source, given its tax purpose? From the private records of the Marquis of Sentmenat we know that during the five years between 1850 and 1854 this landlord earned in the municipalities of Sentmenat and Palau-solità-i-Plegamans an average yearly income of 12,047 and 15,983 *reales* respectively (Garrabou et al., 2001). The *Distribution of Personal Wealth in Real Estate Ownership* of 1852 attributed to him a yearly cadastral income of 11,607 and 15,323 *reales* in those places.

cereal-cropping or forestry municipalities (Garrabou and Tello, 2002; Tello and Badia-Miró, 2011). Anyhow, was this achievement attained thanks to or in spite of the consequences market integration and population growth brought about?

The answer is far from simple. Following a Heckscher-Ohlin approach, the Stolper-Samuelson theorem states that an increase in relative prices of a commodity will lead to a rise in the return to that factor which is used most intensively in producing it, and conversely, to a reduction in the return to the other less abundant factor. By adopting this theoretical insight, economic historians have shown that the First Globalization following the fall in maritime freight costs from 1870 to the First World War entailed a rise in relative prices of agricultural goods in front of manufactures. This in turn led to a greater inequality in land-abundant and labour-scarce countries that exported primary commodities—as reflected in the rental-wage ratio increases in regions such as Latin America or Eastern Europe. Conversely, labour-abundant and resource-scarce countries, such as Japan and Western Europe, experienced a decrease in rental-wage ratios and a lesser inequality in income distribution (O'Rourke and Williamson, 2001; Lindert and Williamson, 2003; Williamson, 2006; 2011).[4]

Between these contrasting outcomes, where can the case of Catalan viticulture be placed? First of all, we consider the increase in market involvement which initially ran at a slow pace along the 18th century and during the first half of the 19th century. Local populations could increase at a lower or greater rate than the changes relative prices experienced, and be reinforced by migratory flows that altered labour endowment at local level. Social unrest also increased along this period, a phenomenon which led to institutional changes and political decisions that affected income distribution.[5] Looking at the available evidence, we face what seems a contradictory picture. On the one hand, the Gini indices obtained with our dataset on agricultural wealth distribution in 1852 clearly point out a lower inequality level in vine-growing municipalities compared to the ones mainly allocated to cereal cropping and forestry (Table 2).

Table 2 – About here

Per capita incomes were also lower in vine-growing municipalities than in the rest, thus we prompt the following question: Was the lower wealth inequality level simply due to their relative poverty?[6]

[4] According to (Williamson, 2006: 48), wage-rental ratios would have experienced in Spain a slower increase than other non-protectionist European countries such as the United Kingdom, Denmark or Sweden from 1870 to 1914. See also (Prados de la Escosura, 2008).

[5] (Santiago-Caballero, 2011) shows how inequality decreased 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.

[6] This fits the estimates made in the mid-18th century in France by François Quesnay, who attributed to vine-growing peasant-owners the lowest non-wage agricultural income in his *Tableau Économique* (Milanovic, 2010). Thanks to the revolution, French winegrowers became mainly property-holders: Exactly the same status that *rabassa* tenants sought in Catalonia. Compared to them, the Catalan vine-growing tenants can only be considered as would-be peasants. Nevertheless, their legal and economic status was stronger than 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 North-western Germany (Morner, 1970; Schlumbohm, 1996).

To answer this question, we calculated the Theil index of an estimated agricultural income distribution including all adult males, and obtained the corresponding Extraction Ratios (ER) compared to a maximum Inequality Possibility Frontier (IPF) related to per capita income (Milanovic et al., 2011). The results confirm that not only agrarian income inequality was lower in vine-growing municipalities but extraction ratio as well.

Nevertheless, when looking at the long-term trends showed by rental-wage ratios from 1826 to 1893 it becomes apparent that land rents captured almost all gains taken from the two waves of increase in the relative prices of wine. Agricultural wages did not, so income inequality must have tended to increase in Catalan vine-growing areas along the 19th century. Conversely, in cereal-growing areas the long-term trend showed a reduction in rental-wage ratios that must have entailed a lowering of rural inequality (Figure 2).

Figure 2 – About here

The only way to reconcile the evidence given in Table 2 and Figure 2 is to establish a clear distinction between *levels* and *trends*. The long-lasting spread of vineyards from the mid-17th century to the beginning of the 19th century through *rabassa* leases seems to have reduced wealth and income inequality in winegrowing places, at least compared to grain-growing or forestry municipalities. As a result, circa 1850 vine-growing municipalities had lesser inequality levels than the rest. Anyhow, from 1825 onwards inequality started to rise again in vine-growing municipalities whereas in grain-growing areas it diminished. This contrast between levels and trends may help us to unravel a difficult conundrum. How can social unrest in vine-growing municipalities be explained, knowing that agricultural income was more evenly distributed in them than in any other area in the Barcelona province in the mid-19th century?

Perhaps inequality in winegrowing areas was lower precisely because of the collective action Catalan *rabassa* tenants exerted, prompting their empowerment (Tello and Badia-Miró, 2011).[7] On the other hand, Figure 2 clearly shows that landowners took almost all the gains in relative prices along the two main booms Catalan viticulture went trough, i.e. the *Odium* mildew in the 1840s, and the *Phylloxera* plague from 1875 to 1885 (Colomé et al., Forthcoming). Throughout the wine crisis Catalonia underwent after the Napoleonic wars in the 1820s, in the 1860s, and after 1885, the decrease in land rents was also lower than the diminishing trend in relative prices of wine—so that landowners succeeded in downloading the crisis on the rest of the population. Certainly, as sharecroppers Catalan vine-grower tenants could also take some gains from favourable trends in relative prices. However, most of them were smallholders lacking enough access to land to earn a

[7] This relates to the connections between inequality as such, and the perception of it. As Alexis de Tocqueville wrote in *Democracy in America* in 1835, '*When inequality of conditions is the common law of society, the most marked inequalities do not strike the eye; when everything is nearly on the same level, the slightest are marked enough to hurt it. Hence the desire of equality always becomes more insatiable in proportion as equality is more complete*' (reference taken from (Stiglitz, 2012). Besides that, people in the lowest social strata also need to rely on some resources in order to struggle to improve their condition. Therefore, empowerment becomes more likely in societies with intermediate rather than extreme levels of inequality.

living, and had to search for additional incomes as daily labourers hired by wealthier landowners. As a result, income inequality must have tended to rise in winegrowing areas whereas it must have tended to fall in grain-growing municipalities—where land rents remained fairly stable while agricultural wages, which were lower there, tended to converge with coastal ones (Garrabou, Tello 2002). This fits quite well to explain the reasons underlying the strong social and political polarization found within many Catalan rural communities which relied on viticulture during the second half of the 19th century, and along the first third of the 20th century as well (Planas and Valls, 2011).

How do these contrasting results relate to the assumptions made by the Stolper-Samuelson theorem? As we are dealing with a highly labour-intensive cash crop, we should expect that the expansion of viticulture entailed a reduction in inequality through a diminishing trend in rental-wage ratios—always under a *ceteris paribus* assumption. Although we found evidence of lesser levels of wealth inequality in winegrowing municipalities in the mid-19th century, the historical series of rental-wage ratios seem to contradict the expected diminishing trend in vine-growing areas from 1825 onwards. Therefore, we formulate a hypothesis with many nuances. On the one hand, the bold collective action from vine-growing *rabassa* tenants would have harnessed the underlying economic trends in their favour set up in line with Stolper-Samuelson assumptions, provided that these would have not been counteracted by the social power well-off landowners exerted and the public policies implemented at the time (Acemoglu and Robinson, 2006; Milanovic, 2005; 2011). This was probably the case while this regional economy remained commercially open until 1820, but from that date on it was counteracted to a great extent.

The strong protectionist trade policy implemented in Spain after 1820 highlights the social and political forces at stake. After the emancipation of the Latin American colonies, foreign imports of grain were simply banned in order to substitute them with cereals coming from inland Spain. It was not until the democratic revolution of 1868 that this ban was replaced with a moderate tariff which established an effective protection of about 10% over the wholesale wheat price in Barcelona. Following the restoration of the monarchy in 1874, the combined effect of higher tariffs and the devaluation of the Spanish currency increased this effective protection to nearly 20%. Then, in 1891 onwards tariffs were subsequently raised to 30% and more. At the end of the 19th century effective protection reached 50% of the Catalan wheat price (Pascual, 1990: 138-141). This helps us to understand why most wealthy landowners kept their estates poly-cultural and allocated the better lands to cereal crops.

This complex social and political fabric can also explain why it is not so easy to find a simple spatial pattern in the impact of vine-growing specialization in the evolution of rural inequality in Catalonia. As (Williamson, 2006: 58) pointed out, it is even likely that a reverse causality was established between commodity prices and factor endowment—so that a favourable evolution of relative prices fostered *rabassa* leases and attracted more immigrants, thus increasing cheap labour supply and making land-labour relations endogenous at a local level. The whole picture appears to be

sometimes rather blurred. Counter what we found in other variables, income inequality does not show spatial autocorrelation—which means that it was randomly distributed in space in the mid-nineteenth century (Map 10).

Map 10 – About here

3. Running the model

In order to test statistically the determinants of vine-growing specialization the following model has been used:

$$VDSup_j = \alpha_1 + \alpha_2 \cdot AGRCL_j + \alpha_3 \cdot MKAC_j + \alpha_4 \cdot INEQ_j + \alpha_5 \cdot AGPOB_{j,t-1} + \varepsilon_j \quad (1)$$

Where $VDSup_j$ is the percentage proportion of cropland allocated to vineyards, $AGRCL_j$ are a set of agro-climatic variables which could affect vineyard specialization (slope, rainfall, altitude, soil quality, frost risk and agro-climatic suitability indices for growing grapevines), $MKAC_j$ captures the 'Smithian-pull' effect through market access (either domestic or foreign) as assessed by time distances to the seaport of Barcelona.[8] $INEQ_j$ captures income inequality considering Theil indices of income inequality for adult male population as a whole, corrected with a subsistence wage income for all working-age men. To improve the robustness of the estimation we tried using Inequality Extraction Ratio, Theil index with no corrections and Gini index, but no better results were obtained. To capture the 'Boserupian-push' we consider $AGPOB_{j,t-1}$, i.e., the population rate growth for each municipality between 1787 until 1860.[9]

Finally, a few dummy variables were considered: *CPJ* for those municipalities which were capital districts, and *DMES70a* for those with population densities greater than 70 inhab./km^2. Both cases allow us to assess the impact of more urban and diversified economies on vine-growing specialization, and a negative sign ought to be expected. We have also considered *DM_King* to search for a possible positive effect of municipalities having the King as manor, instead of having a member of the nobility or the Church before the manorial system was abolished in 1836—provided that this could entail a more flexible institutional framework. However, no robust results were obtained in all estimates.

Table 3 – About here

Population growth rates between 1787 and 1860 were significant and with the expected sign, so that municipalities with higher rates of population increase before 1860 had higher shares of

[8] When a one-time benchmark is considered the choice for a market access variable is not as relevant as when using a time series analysis. Innovation in transport facilities has a deeper impact in the latter case (Badia-Miró et al., 2010).

[9] We have also considered population densities to capture 'Boserupian' effects, but no better results were obtained. Coefficients were significant but with a negative sign. This suggests that in the mid-19th century the range of population density suitable for growing vineyards had already been attained or even surpassed in most areas of the province of Barcelona with appropriate agro-ecological endowments. Further population increases above that upper threshold entailed a negative impact in winegrowing.

farmland allocated to vineyards. This confirms the 'Boserupian-push effect' which favours more labour-intensive crops. The significance of dummy variables related to capital districts or having population densities higher than 70 inhab./km^2 may suggest the existence of an upper threshold of some 65 inhab./km^2, or one and a half hectares per inhabitant, a figure above which the population push ceased to foster winegrowing. The market access pull, as measured with time-distances to Barcelona, is always significant and negative except when spatial autocorrelation is considered. This highlights the 'Smithian-pulling force' of foreign market access for wine and liquor exports combined with the 'Boserupian-push effect'.

The joint impact of these drivers on local land-use changes depended upon other sets of conditioning factors: Agro-ecological suitability, and income inequality. No surprises appear when using agro-climatic variables. Rainfall levels are significant and negative, indicating vines were planted in drier lands while moister ones were reserved to grain and vegetables. The same happens with altitude. Frost risk is significant and positive. Slope is also significant and negative, and the square of the slope has a negative sign showing that it has a decreasing positive impact. All these results confirm that vineyards were planted as a second-best choice in poorer and sloping lands which were less suitable for grain—but not as much as in forestlands and pastures. We have also repeated the estimates considering the municipal helio-thermal values taken with the Huglin index and the Winkler and Amerine ETI, which are expected to capture the better locations for planting grapevines. Coefficients are not significant, thus reinforcing again that vineyard locations can not be simply explained as a resource allocation owing to agro-climatic endowments given. Therefore, what seems relevant is the interaction between the whole set of variables that put in motion an agency-driven process that *created* a comparative advantage from the available resources.

An important leap forward of our model is to have included inequality as a relevant variable for the first time, and it appears to be significant and negative. That is, those municipalities with higher levels of income inequality tended to have lower vine-growing levels. Conversely, the ones with more even income distribution had higher proportions of vineyards in their farmland in the mid-19th century. To test the robustness of this result we have also considered income inequality values only for the cadastral valuation of the taxpayers' properties, and extraction ratios. In all cases the result was the same, showing significant coefficients and the expected sign.[10]

This meaningful result is not merely an outcome of the Stolper-Samuelson mechanism applied to a labour-intensive cash-crop. Due to the social power agrarian elites held, and the public policies implemented in their favour, the evolution rental-wage ratios experienced in Catalan winegrowing areas from 1820 onwards was exactly the opposite to the one expected according to a *ceteris paribus*

[10] We have also analysed the weight that each term of the equation has in the final outcome. The result reveals that geographical variables such as altitude, rainfall or slope have a slightly greater impact than the others. Among the agency-oriented variables, inequality and market access stand out over the impact of population push.

assumption required by this theorem. Thus, we have to stress the roles played by the protectionist Spanish trade policy, and by the Catalan *rabassa*-sharecroppers who fiercely fought against their landowners to stay in the land, reduce the rent share or even become whole owners of the vineyards. They did not achieve this last aim—except when the Catalan Tenancy Act was passed in 1934, which Franco's dictatorship abolished in 1939. But they were successful to some extent with the former attempt.

Finally, we have also run some regressions to correct possible spatial autocorrelation problems. As expected, spatial autocorrelation only appears in the impact of time-distances to Barcelona and for average municipal rainfall. All other variables maintain significant coefficients with the expected sign, reinforcing the robustness of the results obtained.

4. Concluding remarks

After having successfully included income inequality as a variable, we consider this to be the final and complete version of our model which explains agricultural vine-growing specialization degree attained in the province of Barcelona in the mid-19th century. It has not been conceived as simply a replication of Hecksher-Ohlin or any other static economic model requiring a *ceteris paribus* assumption, but as a historical dynamic explanation of how a comparative advantage was actually created through an agency-driven process. From this standpoint, the interaction between context and agency becomes crucial. People acted according to the range of opportunities and resources that were available in their context. However, their agency also changed this context and opened new opportunities or altered to a point the prevailing factor endowment.

By gathering large datasets available from many sources, not yet fully exploited, we have successfully tested a thorough explanation of this historical process of winegrowing specialization, deemed to be a starting point for industrialization and modern economic growth in Catalonia. Our results confirm the prime role played by the 'Smithian' market-pulling force combined with the 'Boserupian' population-pushing effect, the two main drivers of land-use change. At the same time they stress the conditioning function the prevailing agro-ecological endowment had, as well as socio-institutional settings that gave rise to different levels of income or wealth inequality. What stands out most is the fact that vineyard specialization can not be explained as a simple market-driven resource reallocation, undertaken only according to a given set of agro-climatic features. The active development of second-nature factors is as important as the first-nature endowments set in advance (Cronon, 1991; Krugman, 1993b).

As the rest of these variables had already been tested in previous versions of the model (Garrabou et al., 2009), the most important novelty found is that land-use profiles of inequality in agricultural income distribution matter a great deal. In Catalonia, vineyard spread led to a less unequal rural society until the mid-19th century. However, these lower inequality levels in winegrowing municipalities went later hand in hand with a rise in rental-wage ratios that showed a persistent

trend to increase inequality again—a result which contradicts the expected situation in a labour-intensive cash-crop according to the Stolper-Samuleson theorem under a *ceteris paribus* assumption. This helps us to explain the strong polarization and ceaseless social unrest that existed in winegrowing Catalan municipalities from the mid-19th century until the Spanish Civil War (1936-1939).

We may conclude that by transforming a previous landscape of brushwood and forest, or of cereal crops grown in unsuitable poor land, into vineyards these *rabassa* sharecroppers not only opened a gateway for themselves within Catalan villages and towns. They also gained a place in society and a share of its income. By increasing population numbers and deepening the home market, this helped to turn Catalonia eventually into a late-modern industrious society and an early-contemporary industrial economy. Some legacies of this historical path remain nowadays. Ironically, the most tasteful and appreciated Catalan wines still come from these poor sloping lands formerly terraced by *rabassers*-tenants, while flatter lands with higher helio-thermic indices produce more abundant vintages of low quality grape juice only suitable for making sparkling *cava*.

Acknowledgements

Enric Tello has counted with the support given by the Spanish research projects HAR2009-13748-C03 and HAR2012-38920-C02-02, and the Partnership Grant SSHRC 895-2011-1020 on *Sustainable Farm Systems: long-term socio-ecological metabolism in Western agriculture* funded by the Social Sciences and Humanities Research Council of Canada (2012-2017). Marc Badia-Miró acknowledges the support of the Spanish research projects ECO2012-39169-C03-03 and XREPP. Both authors are members of the Consolidated Research Group in Economic History and Development (Industry, Business and Sustainability) at the Centre d'Estudis Antoni de Capmany (2009SGR153). We also thank the help received from all members of these research teams, and especially to Ramon Garrabou, Francesc Valls-Junyent, Xavier Cussó, Josep Colomé, Jordi Planas, Lluís Parcerisas, Ricard Garcia-Orallo and Pere Pascual. We are also grateful for the criticisms and suggestions to earlier or partial versions of this work made by James Foreman-Peck, Jean-Pascal Bassino, Pedro Lains, Joan Ramon Rosés, Juan Carmona, Giovanni Federico, Cormac O'Grada and two other anonymous reviewers. None of them are responsible for our own mistakes.

References

ACEMOGLU, D. and ROBINSON, J.A. (2006).*Economic Origins of Dictatorship and Democracy*. Cambridge University Press.

ANONYMOUS (1838).*Itinerario de la mayor parte de los caminos y veredas de las cuatro provincias de Barcelona, Tarragona, Lérida y Gerona, con los pueblos y posadas situadas en las carreteras, y las horas que a paso de tropa distan unos de otros*. Imprenta de Manuel Texero: Barcelona.

BADIA-MIRÓ, M., TELLO, E., VALLS, F. and GARRABOU, R. (2010). The grape phylloxera plague as a natural experiment: the unkeep of vineyards in Catalonia (Spain) 1858 - 1935. *Australian Economic History Review* **50**, 1.

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

BERTRÁN SOLER, T. (1847).*Itinerario descriptivo de Cataluña: comprende la descripción del antiguo Principado, su actual división territorial, militar, eclesiástica y judicial*. Imprenta de Oliveres: Barcelona.

BOSERUP, E. (1981).*Population and Technological Change: A Study of Long-Term Trends*. University of Chicago Press.

BRAVO MURILLO, J. (1852). Real Orden de 10 de febrero de 1852 firmada por el Director General de Contribuciones Directas, Estadísticas y Fincas del Estado in *Gaceta de Madrid*, 2-3.

CARMONA, J. and SIMPSON, J. (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.

CARMONA, J., COLOMÉ FERRER, J., PAN-MONTOJO J. and SIMPSON, J. (2001).*Viñas, bodegas y mercados: El cambio técnico en la vitivincultura española, 1850–1936*. Prensas Universitarias de Zaragoza: Zaragoza.

CERDÀ, I. (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.), Instituto de Estudios Fiscales: Madrid.

COLOMÉ, J. (2000). Pequeña explotación agrícola, reproducción de las unidades familiares campesinas y mercado de trabajo en la viticultura mediterránea del siglo XIX: el caso catalán. *Revista de Historia Económica - Journal of Iberian and Latin American Economic History* **18**, 281–307.

COLOMÉ, J., CUCURELLA-JORBA, M. and VALLS, F. (2010). Poblament i despoblament a la Catalunya vitícola (1760-1910). *Butlletí de la Societat Catalana d'Estudis Històrics* **21**, 137-155.

COLOMÉ, J., GARCIA, R., PLANAS, J. and VALLS, F. (Forthcoming). L'évolution du prix du vin en Catalogne entre 1680 et 1935. *Annales du Midirevue de la France méridionale*.

COLOMÉ, J., SAGUER, E. and VICEDO, E. (2002). Las condiciones de reproducción económica de las unidades familiares campesinas en Cataluña a mediados del siglo XIX in *El nivel de vida en la España rural, siglos XVIII-XX*., MARTÍNEZ CARRIÓN, J. (ed). Publicaciones de la Universidad de Alicante: Alicante, 321–356.

COLOMÉ, J. and VALLS, F. (2012). Las consecuencias demográficas de la crisis filoxérica en la región vitícola del Penedés (Cataluña). *Historia agraria* **57**, 47-77.

CRONON, W. (1991).*Nature's metropolis: Chicago and the Great West*. W.W. Norton & Co Ldt: New York.

FONT, J. (1999).*La formació de la xarxa de transport a Catalunya (1761-1935)*. Oikos-Tau and Universitat de Barcelona: Barcelona.

PASCUAL, P. (1990).*Agricultura i industrialització a la Catalunya del segle XIX*. Crítica: Barcelona.

FRADERA, J.M. (1987).*Indústria i mercat: les bases comercials de la indústria catalana moderna (1814-1845)*. Crítica: Barcelona.

FRIGOLA, V. (1824).*Relación de los pueblos de que consta el Principado de Cataluña*. Imprenta de la viuda e hijos de D. Antonio Brusi: Barcelona.

GARRABOU, R., PLANAS, J. and SAGUER, E (2000). Sharecropping and the management of large rural estates in Catalonia, 1850–1950. *The Journal of Peasant Studies* **28**, 89–108.

GARRABOU, R., PLANAS, J. and SAGUER, E. (2001).*Un capitalisme impossible?: la gestió de la gran propietat agrària a la Catalunya contemporània*. Eumo Editorial, Universitat de Vic.

GARRABOU, R. and TELLO, E. (2002). Salario como coste, salario como ingreso: el precio de los jornales agrícolas en la Cataluña contemporánea (1727-1930) in *El nivel de vida en la España rural, siglos XVIII-XX*., ed. J. Martínez Carrión. Publicaciones de la Universidad de Alicante: Alicante, 173-6.

GARRABOU, R., TELLO, E. and CUSSÓ, X. (2008). El cambio de usos del suelo en la comarca del Vallés (1850-2000): fuerzas motoras y agentes rectores de la transformación del territorio. in *El paisaje en perspectiva histórica: formación y transformación del paisaje en el mundo Mediterráneo*., Garrabou, R. and Naredo, J.M. (eds.). Prensas Universitarias de Zaragoza: Zaragoza, 233-258.

GARRABOU, R., TELLO, E. and CUSSÓ, X. (2010). Ecological and Socio-economic functioning of the Mediterranean agrarian systems in the middle of the nineteenth century. A Catalan case study (the Vallés county, 1850-70) in *Agrosystems and Labour Relations in European Rural Societies*, STEINER, E.L. and Langthaler, E. (eds.). Brepols Publishers: Turnhout/New York.

GARRABOU, R., TELLO, E., CUSSÓ, X. and Badia-Miró, M. (2009). Explaining agrarian specialization in an advanced organic economy: cereal production, consumption and trade in the province of Barcelona (Spain) in the mid-19 th century in *Markets and Agricultural Change in Europe from the 13th to the 20th Century*, ed. PINILLA, V. (ed.). Brepols Publishers, 137-72.

GIRALT, E. (1965). El conflicto "rabassaire" y la cuestión agraria en Cataluña hasta 1936. *Revista de Trabajo* **7**, 51–72.

HERRANZ-LONCÁN, A. (2007). The spatial distribution of Spanish transport infrastructure between 1860 and 1930. *The Annals of Regional Science* **41**, 189–208.

HERRANZ-LONCÁN, A. (2008).*Infraestructuras y crecimiento económico en España, 1850-1935*. Fundación de los Ferrocarriles Españoles.

HUNT, R.C. (2000). Labor productivity and agricultural development: Boserup revisited. *Human Ecology* **28**, 251–277.

JOHNSON, C.H. (1995).*The life and death of industrial Languedoc, 1700-1920*. Oxford University Press: New York, USA.

KRUGMAN, P. (1993a). First nature, second nature, and metropolitan location. *Journal of Regional Science* **33**, 129–144.

KRUGMAN, P. (1993b).*Geography and Trade*. The MIT Press: Cambridge, MA.

LAMBIN, E.F., ROUNSEVELL, M. and GEIST, H. (2000). Are agricultural land-use models able to predict changes in land-use intensity? *Agriculture, Ecosystems and Environment* **82**, 321–331.

LINDERT, P.H. and WILLIAMSON, J.G. (2003). Does Globalization Make the World More Unequal? in *Globalization in Historical Perspective*, BORDO, M.D., TAYLOR, A.M. and WILLIAMSON, J.G. (eds.). Chicago University Press: Chicago, 227-271.

MARFANY, J. (2010). Is it still helpful to talk about proto-industrialization? Some suggestions from a Catalan case study. *The Economic History Review* **63**, 942-973.

MARFANY, J. (2012).*Land, Proto-Industry and Population in Catalonia, c. 1680-1829: An Alternative Transition to Capitalism?*. Ashgate Publishing: London.

MILANOVIC, B. (2005).*Worlds apart: measuring international and global inequality*. Princeton University Press: Princeton.

MILANOVIC, B. (2010). Level of income and income distribution in mid-18th century France, according to Francois Quesnay. *World Bank Policy Research Working Paper Series* 10545.

MILANOVIC, B. (2011).*The Haves and Have-Nots. A Brief Idiosyncratic History of Inequality Around the Globe*. Basic Books: New York.

MILANOVIC, B., LINDERT, P.H. and WILLIAMSON, J.G. (2011). Pre-Industrial Inequality. *The Economic Journal* **121**, 255-272.

MORAN, E.F. and OSTROM, E. (2005).*Seeing the forest and the trees: human-environment interactions in forest ecosystems*. The Mit Press: Cambridge, MA.

MORNER, M. (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**, 3-15.

MURO, J.I., NADAL, F. and URTEAGA, L. (2011).*Estadística Territorial de la Provincia de Barcelona 1859. Pedro Moreno Ramírez*. Societat Catalana de Geografia/Institut d'Estudis Catalans.: Barcelona.

NETTING, R.M.C. (1993).*Smallholders, householders: farm families and the ecology of intensive, sustainable agriculture*. Stanford University Press: Stanford, CAL.

OLARIETA, J.R., RODRIGUEZ-VALLE, F. And TELLO, E. (2008). Preserving and destroying soils, transforming landscapes: Soils and land-use changes in the Valles County (Catalunya Spain) 1853–2004. *Land Use Policy* **25**, 474–484.

O'ROURKE, K.H. and WILLIAMSON, J.G. (2001).*Globalization and history: the evolution of a nineteenth-century Atlantic economy*. The MIT Press: Cambridge, MA.

PAN-MONTOJO, J. (1994).*La bodega del mundo. La vid y el vino en España, 1800-1936*. Alianza Editorial: Madrid.

PASCUAL, P. (2000).*Els Torelló: una família igualadina d'advocats i propietaris*. Fundació Salvador Vives Casajuana/Rafael Dalmau.: Barcelona.

PASCUAL, P. (1999).*Los caminos de la era industrial. La construcción y financiación de la Red Ferroviaria Catalana (1843-1898).* Edicions de la Universitat de Barcelona/Fundación Ferrocarriles Españoles.: Barcelona.

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

PINILLA, V. and AYUDA, M.I. (2007). The International Wine Market, 1850-1938. An Opportunity for Export Growth in Southern Europe? in *Wine, Society, and Globalization. Multidisciplinary Perspectives on the Wine Industry*, Campbell, G. and Guibert, N. (eds.). Palgrave Macmillan: New York, 179–199.

PLANAS, J. and VALLS, F. (2011). ¿Por qué fracasaban las cooperativas agrícolas? Una respuesta a partir del análisis de un núcleo de la Cataluña rabasaire. *Investigaciones de Historia Económica - Journal of the Spanish Economic History Association* **7**, 310-321.

PRADOS DE LA ESCOSURA, L. (2008). Inequality, poverty and the Kuznets curve in Spain, 1850 - 2000. *European Review of Economic History* **12**, 287-324.

SÁNCHEZ, A. and NADAL, J. (1998). En los orígenes del éxito algodonero catalán in: *De La Fibre à La Fripe. Le Textile Dans La France Meridionale Et l'Europe Mediterraneene, XVIIIe-XXe Siècles.* Université Paul Valéry, Montpelier, 35–57.

SANTIAGO-CABALLERO, C. (2011). Income inequality in central Spain, 1690-1800. *Explorations in Economic History* **48**, 83-96.

SCHLUMBOHM, J. (1996). Micro-history and the macro-model of the European Demographic System in pre-industrial times: Life course patterns in the parish of Belm (Nortwest Germany). Seventeenth to the Nineteenth centuries. *The history of the Family, An International Quarterly* **1**, 81-95.

STIGLITZ, J.E. (2012).*The Price of Inequality: How Today's Divided Society Endangers Our Future.* WW Norton.

SUDRIÀ, C. and PASCUAL, P. (1999). Financing a railway mania: capital formation and the demand for money in Catalonia, 1840 - 1866. *Financial History Review* **6**, 127-45.

TELLO, E. (1997). La conflictividad social en el mundo rural catalán, del Antiguo Régimen a la Revolución liberal, 1720-1833. *Historia Agraria* **7**, 89-104.

TELLO, E. and BADIA-MIRÓ, M. (2011). Land-use profiles of agrarian income and land ownership inequality in the province of Barcelona in mid-nineteenth century. *Working Paper of the Spanish Agricultural Society DT-SEHA* 11-01.

TELLO, E., BADIA-MIRÓ, M., CUSSÓ, X., GARRABOU, R. and VALLS, F. (2008). Explaining vineyard specialization in the province of Barcelona (Spain) in the mid-19th century. *Documents de Treball.Facultat Economia i Empresa.Universitat de Barcelona* 08-201.

TONIETTO, J. and CARBONNEAU, A. (2004). A multicriteria climatic classification system for grape-growing regions worldwide. *Agricultural and Forest Meteorology* **124**, 81–97.

VALLS, F. (2001a). Cambios estructurales en e comercio vinícola y progresos en la ciencia enológica en cataluña durante el primer tercio del siglo XIX in *Viñas, bodegas y mercados. El*

cambio técnico en la vitivinicultura española, Carmona, J., Colomé, J., Pan-Montojo, J. and Simpson, J. (eds.). Prensas Universitarias de Zaragoza: Zaragoza, 239–264.

VALLS, F. (2001b). El paper de les exportacions vitícoles en la configuració de les relacions exteriors de l'economia catalana, 1672-1869. *Butlletí de la Societat Catalana d'Estudis Històrics*. **13**, 161-172.

VALLS, F. (2003).*La Catalunya atlàntica: aiguardent i teixits a l'arrencada industrial catalana*. Eumo editorial: Vic.

VALLS, F. (2004). Viticulture et industrialisation en Europe du Sud: Les cas du Languedoc, du Portugal et de la Catalogne. *Domitia* **5**, 41-5.

VALLS, F. (2007). Compitiendo con el champagne. La industria española de los vinos espumosos antes de la Guerra Civil. *Revista de Historia Industrial*, **33**,l 47–79.

VAN ZANDEN, J.L. (1995). Tracing the Beginning of the Kuznets Curve: Western Europe during the Early Modern Period. *Economic History Review* **48**, 643-64.

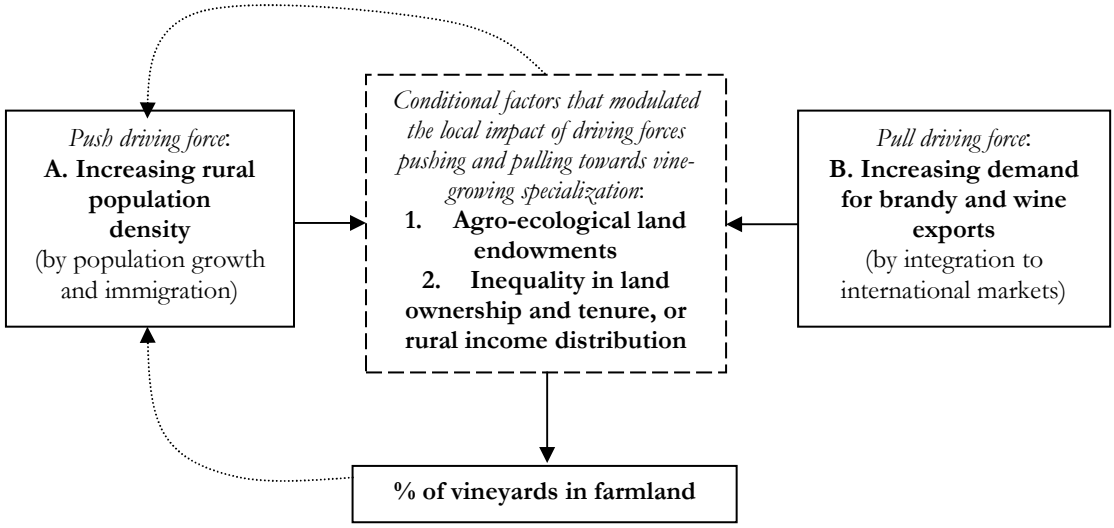
VILAR, P. (1962).*La Catalogne dans l'Espagne moderne: Recherches sur les fondements économiques des structures nationales*. SEVPEN: París.

WILLIAMSON, J.G. (2006).*Globalization and the Poor Periphery before 1950*. The MIT Press: Cambridge, MA.

WILLIAMSON, J.G. (2011).*Trade and Poverty: When the Third World Fell Behind*. The MIT Press: Cambridge, MA.

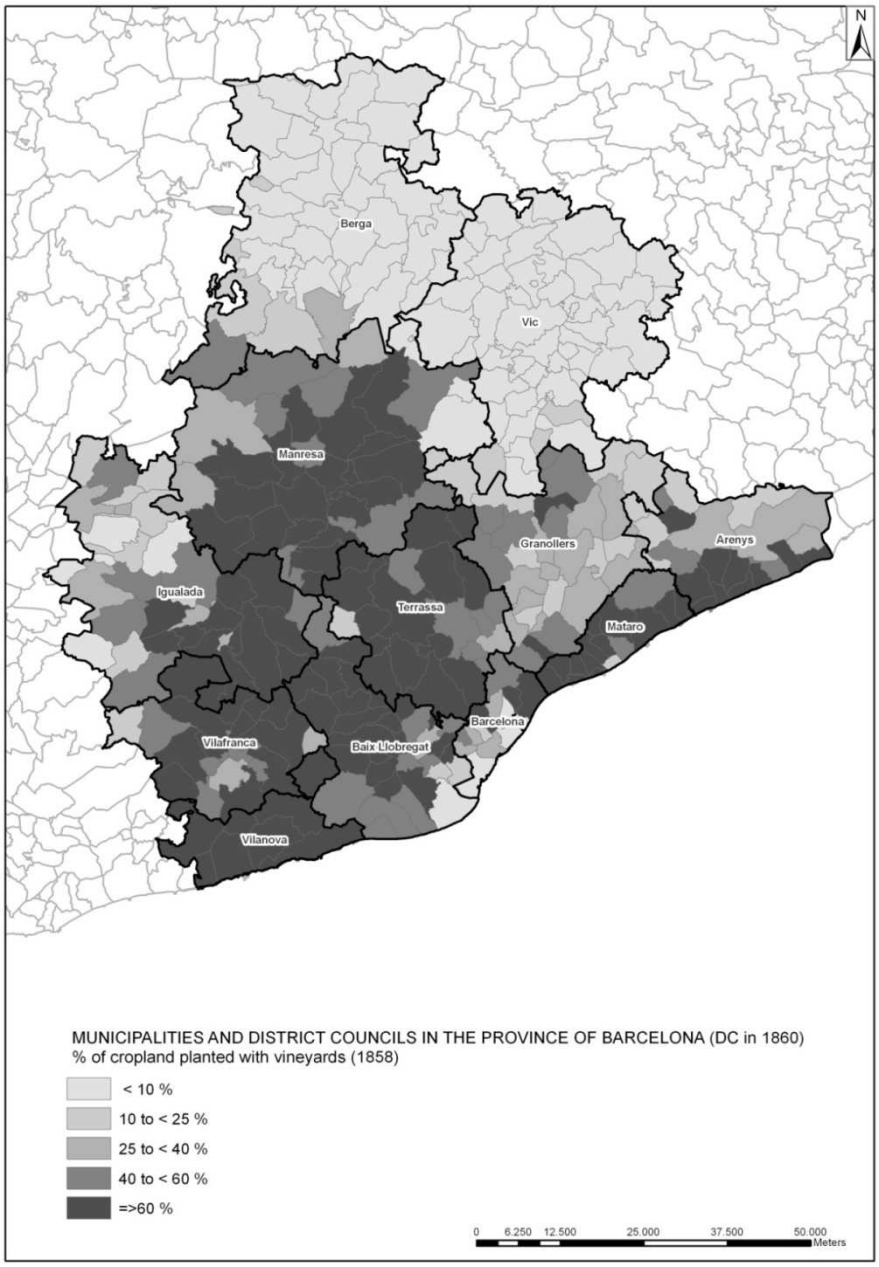
Figures, tables and Maps

Figure 1 - ***Pushing or pulling drivers and conditioning factors of Catalan vine-growing specialization developed until 1860***



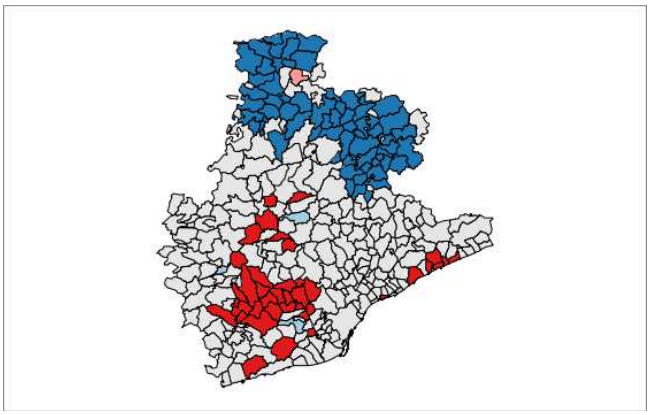
Source: Our own, based in (Garrabou et al., 2009; Badia-Miró et al., 2010).

Map 1 - *Proportion of cropland allocated to vineyards in every municipality in 1858*



Source: Our own, from the *Estadística Territorial* (Muro et al., 2011).

Map 2 – *Univariate Local Moran for the vineyard specialization*



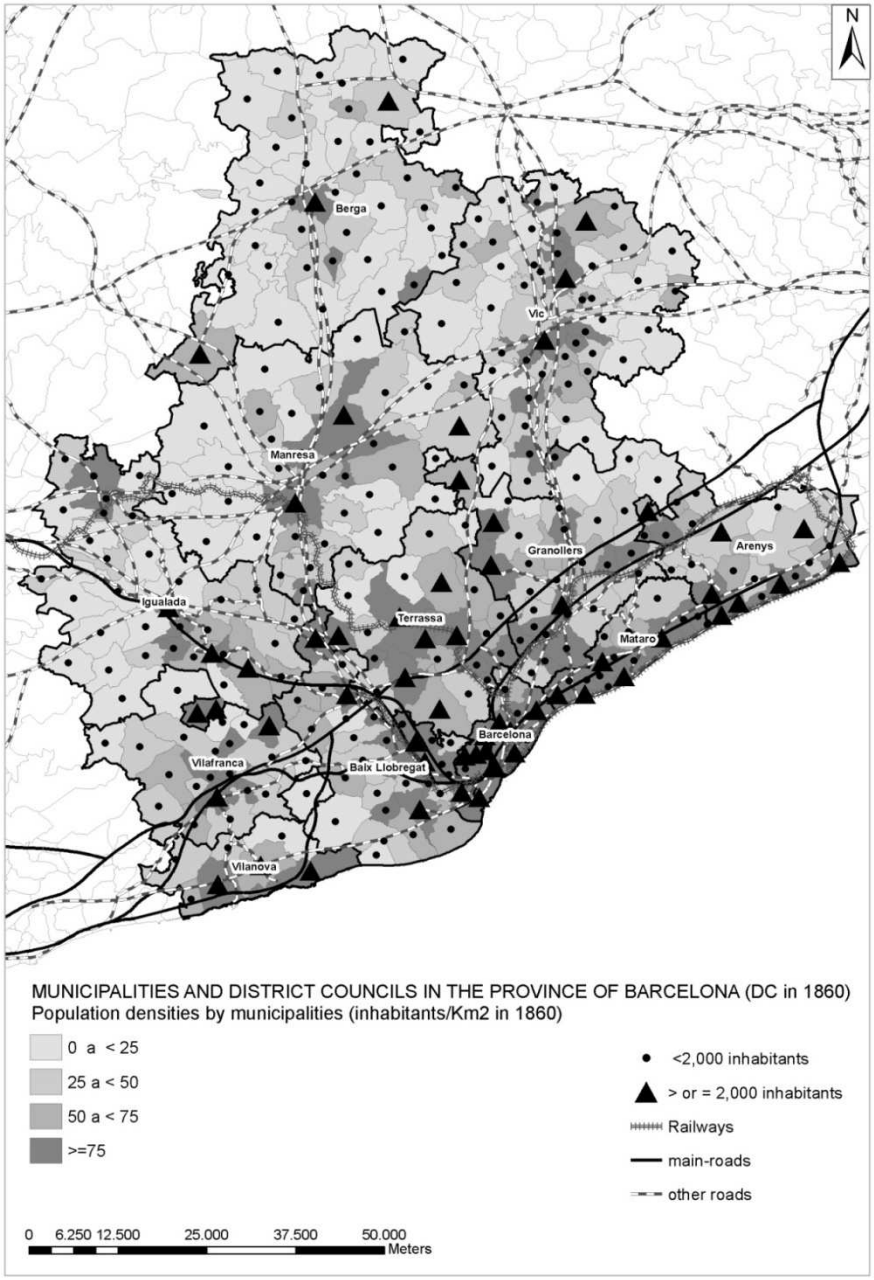
Source: Our own making from the same data of Map 1 considering SpaceStat at a p-value=0.05. Red values indicate high-high relations, blue values are low-low relations, light reds are high-low relations and light blue are low-high relations.

Table 1. ***Population increase and population densities in the districts of the province of Barcelona (1718-1857)***

Districts	1718			1787			1857			yearly growth rates 1718 - 1858	yearly growth rates 1787 - 1858
	Inhabi-tants	Inhab-itants /km²	ha /inhabi-tant	Inhabi-tants	Inhab-itants /km²	ha /inhabi-tant	Inhabi-tants	Inhab-itants /km²	ha /inhabi-tant		
Barcelona	36,781	234.4	0.43	125,745	801.4	0.12	247,942	1,580.30	0.06	1.4%	1.0%
Arenys	14,599	36.6	2.73	30,070	75.3	1.33	37,063	92.9	1.08	0.7%	0.3%
Berga	12,121	10	10.03	19,299	15.9	6.3	39,632	32.6	3.07	0.8%	1.0%
Granollers	16,819	27.7	3.61	22,819	37.5	2.66	38,521	63.4	1.58	0.6%	0.7%
Igualada	12,354	12.5	8.02	25,714	26	3.85	54,934	55.5	1.8	1.1%	1.1%
Manresa	16,586	14.7	6.8	25,692	22.8	4.39	53,057	47	2.13	0.8%	1.0%
Mataró	16,639	92.2	1.08	29,986	166.2	0.6	43,164	239.3	0.42	0.7%	0.5%
Sant Feliu	8,110	17.1	5.84	24,207	51.1	1.96	39,588	83.5	1.2	1.1%	0.7%
Terrassa	9,937	17.3	5.79	20,552	35.7	2.8	52,737	91.7	1.09	1.2%	1.3%
Vic	21,740	20.1	4.98	40,954	37.8	2.64	59,618	55.1	1.82	0.7%	0.5%
Vilafranca	11,721	17.6	5.67	28,837	43.4	2.31	48,079	72.3	1.38	1.0%	0.7%
TOTALS	177,407	23.7	4.23	393,875	52.5	1.9	714,335	95.3	1.05	1.0%	0.8%
Outside Barcelona District	140,626	19.2	5.2	268,130	36.6	2.73	466,393	63.7	1.57	0.9%	0.8%

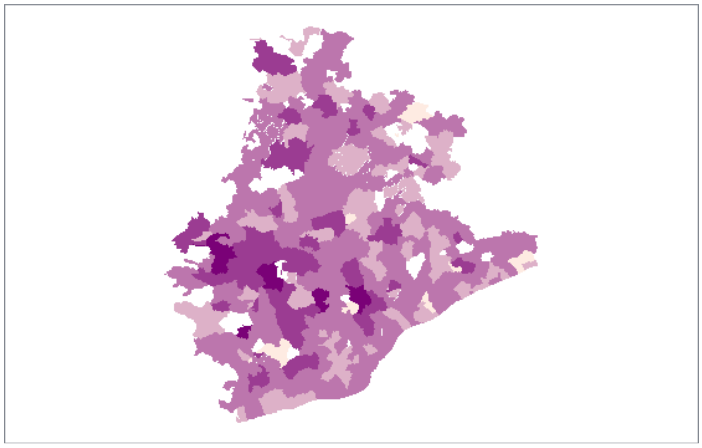
Sources: Our own, based on population census taken from Centre d'Estudis Demogràfics (http://www.ced.uab.es/index.php).

Map 3. ***Population densities and main transport networks in the province of Barcelona in 1860***



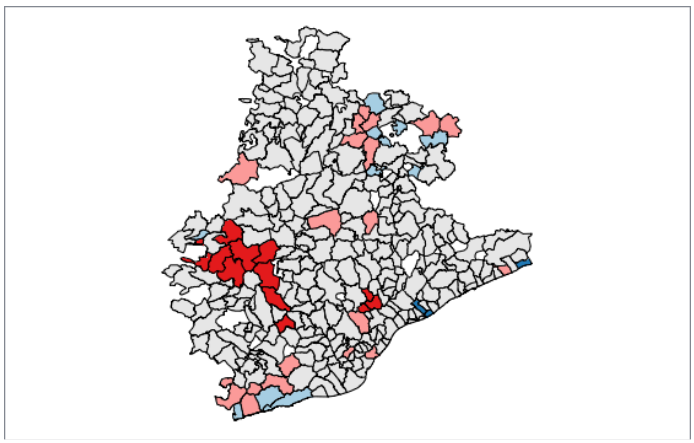
Source: Our own, from tha Centre d'Estudis Demogràfics (http://www.ced.uab.es/index.php). We thank Barcelona Regional for facilitating digital information on the road and rail networks in 1860.

Map 4. ***Average annual population growth rates from 1787 to 1860***



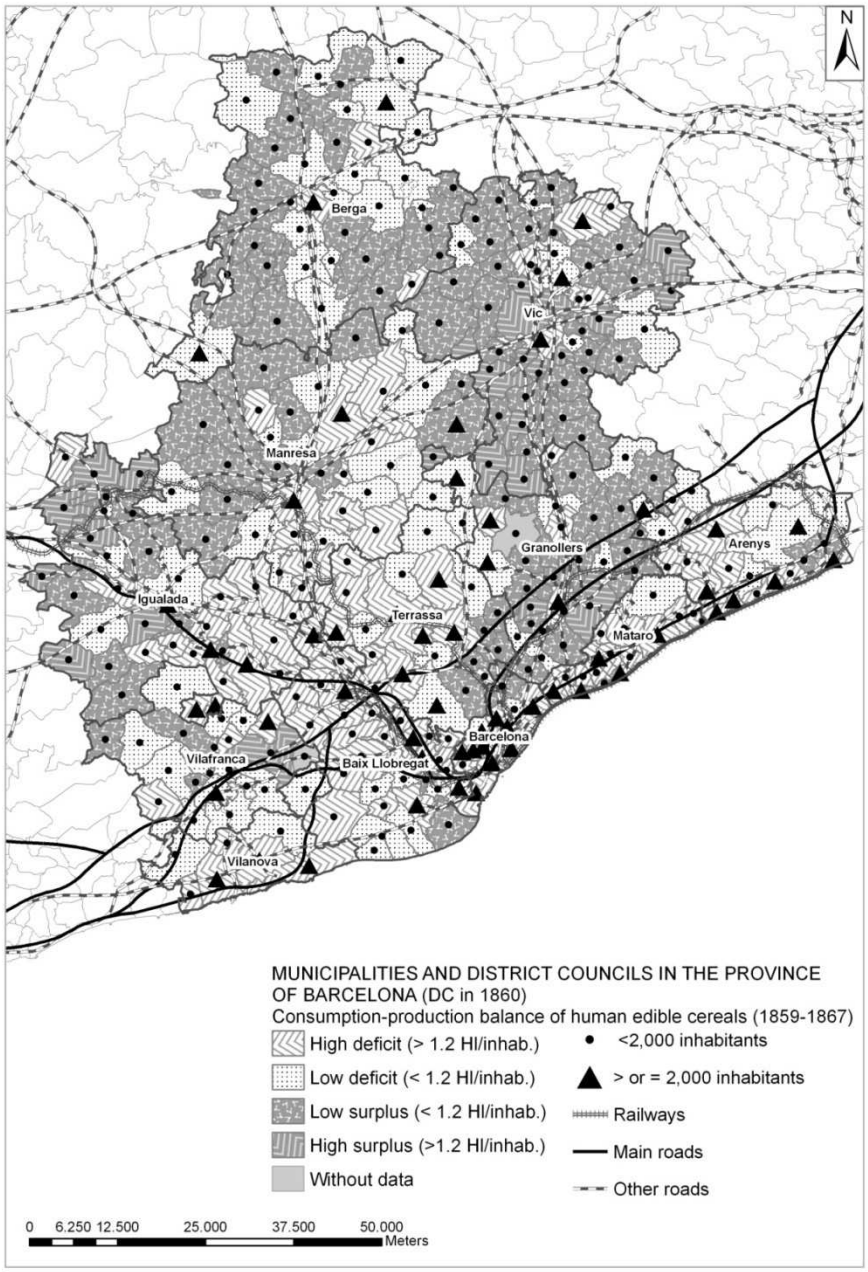
Source: Our own, with population data of the 1787 and 1860 census taken from the Centre d'Estudis Demogràfics (http://www.ced.uab.es/). Dark purple shows higher growth rates.

Map 5. ***LISA map for average annual population growth rates to detect spatial autocorrelation (1787-1860)***



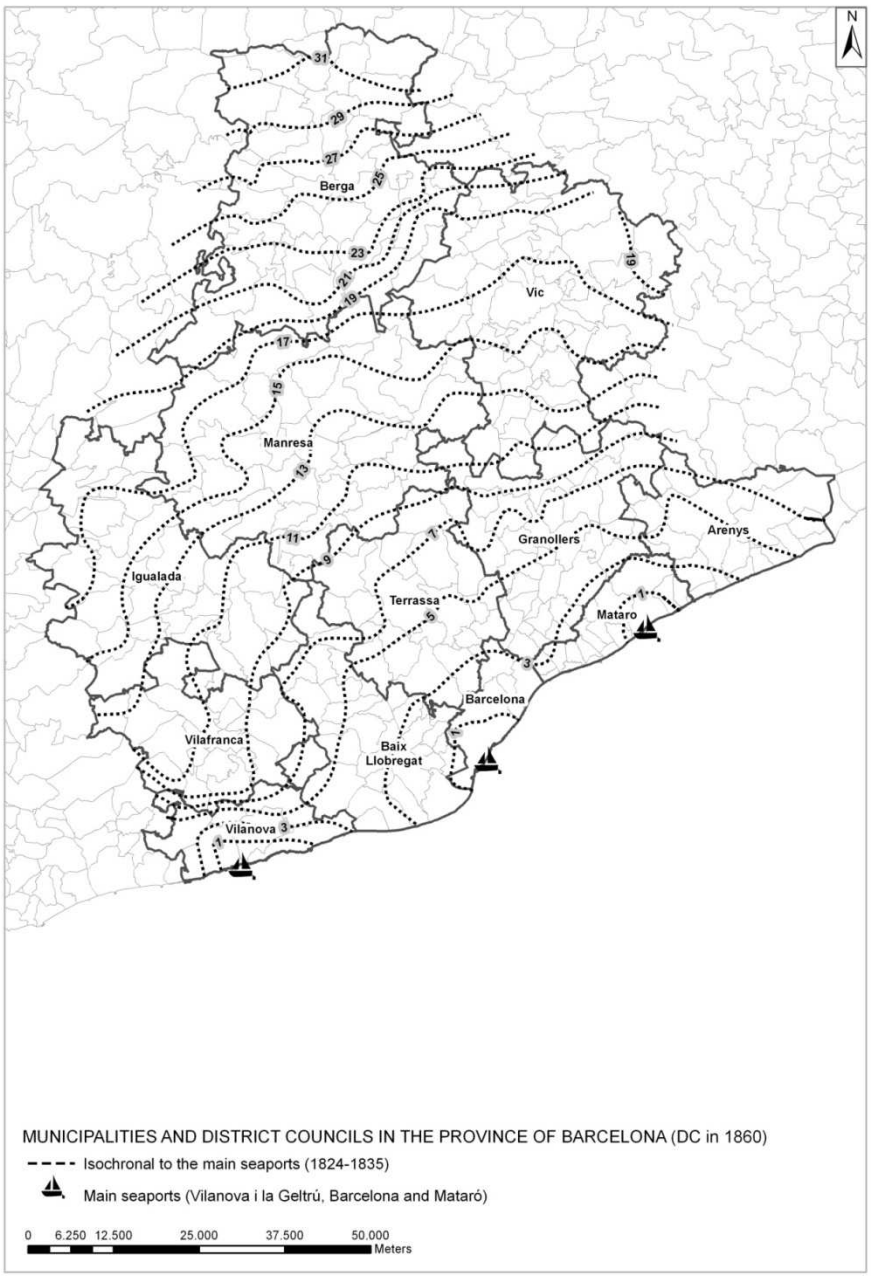
Source: Our own making considering SpaceStat at a p-value=0.05. Red values indicate high-high relations, blue values are low-low relations, light reds are high-low relations and light blue are low-high relations.

Map 6. ***Shortage in cereal food production to meet local consumption in the municipalities of the province of Barcelona (1859-67)***



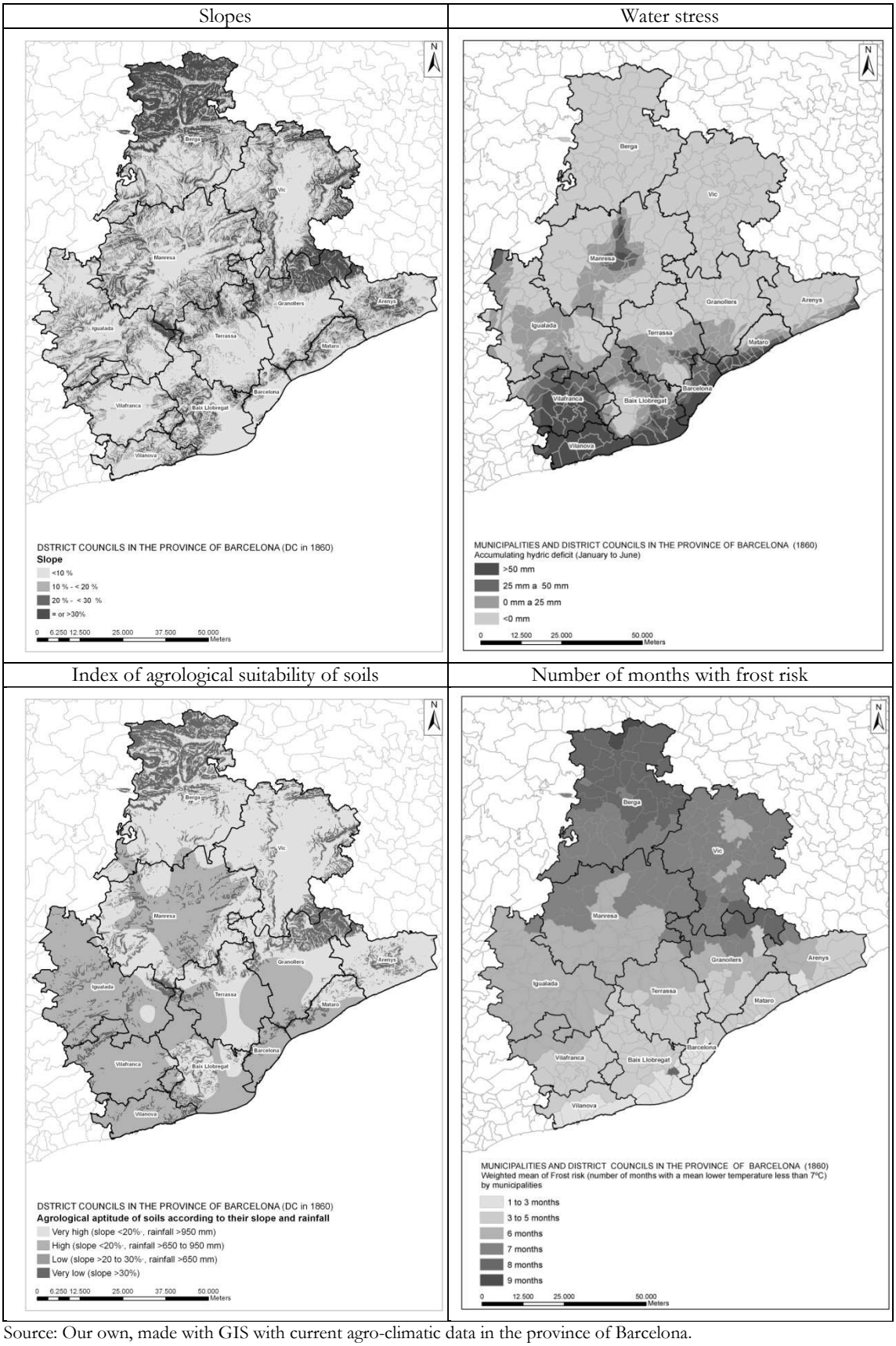
Source: Our own, from the dataset compiled with the *Estadístiques de la producció i consum de cereals als partits judicials de la província de Barcelona* (National Library of Catalonia, Fons de la Junta de Comerç, lot CXXVI, boxes 163 and 164).

Map 7. ***Time distances to the nearest seaport using existing cart roads and bridle paths in the province of Barcelona in 1824-1838***



Source: Our own, from two itineraries published before the first Catalan railway was set up in 1848 (Frigola, 1824; Anonymous, 1838), checked with other sources (Bertrán Soler, 1847) or authors (Vilar, 1962; Font, 1999; Pascual, 1999; Herranz-Loncán, 2007; 2008).

Map 8. ***Some agro-ecological endowments to grow vines or grains in the province of Barcelona***



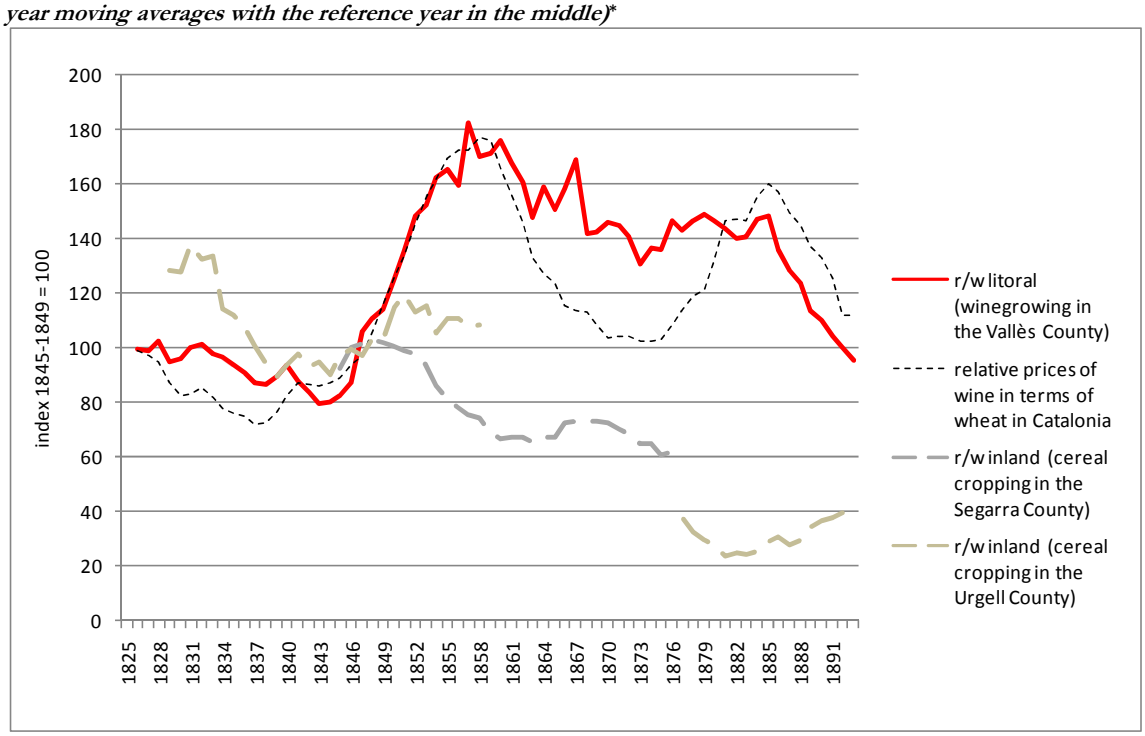
Source: Our own, made with GIS with current agro-climatic data in the province of Barcelona.

Table 2. ***Land-use profiles of inequality in agricultural wealth or income distribution in the municipalities of the province of Barcelona in 1852-1858***

Prevailing land uses	Gini indices of the cadastral valuation of property		Extraction Ratios expressed as % of the actual Theil indices of agricultural income distribution, compared to the maximum Inequality Possibility Frontier (IPF)
	average	median	
all municipalities with land-use data in 1858	68.2	69.8	24.9
mainly winegrowing municipalities	64.7	65.2	22.0
mainly cereal cropping	69.1	69.9	25.2
mainly allocated to forestry uses of land	70.1	72.0	25.0

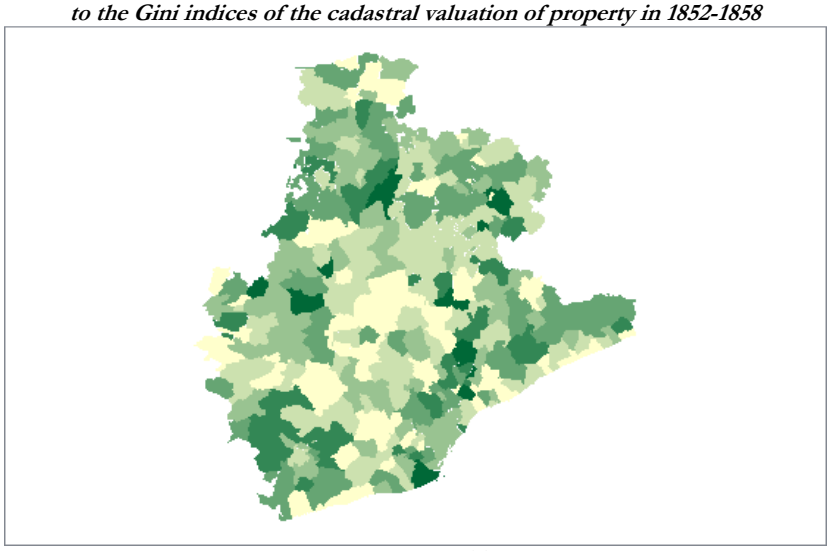
Source: our own, calculated from the *Repartimiento Personal de la Riqueza Territorial* of 1852 (Library of the University of Barcelona, reference 146-1-II/13), the population census of 1857 (taken from the Centre d'Estudis Demogràfics, http://www.ced.uab.es/), and the *Estadística Territorial* compiled in 1858 (Muro et al., 2011). Theil indices, Extraction Ratios and the IPF have been calculated for the whole adult male population older than 21, and adding a minimum vital income of 1,500 Spanish *reales* a year (Tello and Badia-Miró, 2011).

Figure 2. ***Evolution of rental-wage ratios in coastal winegrowing counties (Vallès), or in inland cereal cropping ones (Segarra and Urgell), compared to the relative prices of wine in Catalonia (1826-1893, all data in eleven-year moving averages with the reference year in the middle)****



Source: our own, calculated from the land rents of the Marquis of Sentmenat (Garrabou et al., 2011) and the Torelló family (Pascual, 2000), the series of agricultural wages from (Garrabou and Tello 2002), and the relative prices of wine from (Colomé et al., Forthcoming).

Map 10. ***Income inequality in the municipalities of the province of Barcelona, according to the Gini indices of the cadastral valuation of property in 1852-1858***



Source: Our own, from the sources referred in Table 2. Greener municipalities have higher levels and yellower lesser levels of income inequality.

Table 3. ***Explaining vine-growing specialization in the province of Barcelona in the mid-19th century***

	TOBIT (1)			TOBIT (2)			OLS			OLS - Only Vineyard			OLS Spatial LAG - Only Vineyard		
const	1.100	*0.110*	***	0.921	*0.107*	***	0.764	*0.042*	***	0.809	*0.065*	***	0.084	*0.051*	*
Rho													0.594	*0.053*	***
AGPOB_1787_1860	9.771	*1.716*	***	10.522	*1.806*	***	7.347	*1.440*	***	6.015	*1.640*	***	3.797	*1.150*	***
DEN1860															
PLV	-2.93E-04	*1.36E-04*	**	-2.58E-04	*1.43E-04*	*									
PEND	0.006	*0.003*	**	0.010	*0.003*	**	0.008	*0.002*	***	0.006	*0.003*	**	0.037	*0.006*	***
PEND^2													-0.001	*0.000*	***
ALT	-0.001	*0.000*	***	-0.001	*0.000*	***	-0.001	*0.000*	***	-0.001	*0.000*	***	0.000	*0.000*	***
DISTBCN	-0.009	*0.004*	**	-0.007	*0.004*	*	-0.010	*0.003*	***	-0.007	*0.004*	*			
THEIL1NOR_CONT															
THEL1NORM_POBMA	-4.746	*0.815*	***				-3.032	*0.653*	***	-3.571	*0.776*	***	-1.156	*0.537*	**
ER5T1				0.247	*0.065*	***									
CPJ	-0.166	*0.077*	**				-0.124	*0.065*	*						
DM_KING							-0.091	*0.027*	***	-0.059	*0.032*	*			
DMES70a	-0.137	*0.036*	***							-0.074	*0.034*	**			
N	292			292			292			229			229		
Log-likelihood	-24.892			-37.646			56.717			44.364			94.547		
Adjusted R-squared							0.583			0.350			0.639		
Schwarz criterion	106.551			120.706			-68.020			-45.258					
Akaike criterion	69.783			91.292			-97.434			-72.728			-175.094		
Hannan-Quinn	84.511			103.074			-85.652			-61.646					

Note: t-ratios are in cursive; ***1, **5, or *10% statistical confidence interval. OLS, ordinary least squares. OLS – Spatial Lag, ordinary least squares considering spatial lags to correct spatial autocorrelation biases.