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History and Urban Primacy: The Effect of the Spanish Reconquista on Muslim Cities[*]

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This paper aims to study the effect of a major historical event on the Spanish city size distribution, the *Spanish Reconquista.* This was a long military campaign that aimed to expel Muslims from the Iberian Peninsula. The process started in the early 1300s and ended around 1500, when the entire peninsula was brought back under Christian rule. The Reconquista had a major effect on the evolution of the Muslim and Christian populations during this period and offers a unique "quasi-natural" experiment. The Reconquista dramatically decreased the population of the three main cities of the Moorish Caliphate - Granada, Cordoba, and Seville. This represents a very particular shock in the sense that these were cities with a vast majority of Muslim population, which was then replaced by Christian residents. Using a methodology closely related to Nitsch (2003) we show that the effect of the Reconquista on both the relative size of these three cities was indeed dramatic and that it cannot be simply explained by similar trends in other important national or international cities. Granada lost 53% of its population during the 1300-1800 period, whereas the figures for Cordoba and Seville were 33% and 7%, respectively. These impressive population drops are still present even after controlling for a large set of country and city-specific socioeconomic indicators. We interpret these results as suggestive that the Spanish Reconquista shock had permanent effects, and therefore, in the context studied here, history does not matter for city growth. Our results suggest that the locational fundamentals that made these three cities the most populated ones in the Peninsula for about 500 years ceased to be crucial growth determinants once Christians took control of them.

JEL classification: R12, N9

Keywords: urban primacy; locational fundamentals; city growth; lock-in effects

1. Introduction

Nitsch (2003) argues that, in most models of city formation, once random events have selected a particular path (e.g. a specific location), the choice typically becomes locked-in regardless of the advantages of alternatives. In this paper we propose a historical example that contradicts this claim. Our focus is on the striking population shifts that took place in

[*] We thank Juan Carlos Cuestas, Anita Ratcliffe, and seminar participants at the NARSC meetings 2011 (Ottawa) for their helpful comments.

the Iberian Peninsula during the 700-1800 time interval. This period of time saw the invasion of the Peninsula by Muslims armies from Northern Africa. In a remarkable short period of time, almost the entire territory was occupied by governor Abd al-Aziz. Figure 1 shows the Caliphate of Cordoba around 1000, at the apogee of Al-Mansur, the de facto ruler of Muslim al-Andalus in the late 10th to early 11th centuries. Al-Mansur's rule marked the peak of power for Moorish Iberia.

This figure and several historical accounts highlight the importance of three urban areas in the Caliphate: Cordoba, Granada, and Seville. We consider these to be the three main Moorish cities during the studied period for two reasons. First, the three are clearly located in the South of the Iberian Peninsula – where the Moorish created urban agglomerations composed almost entirely of Moorish population. Second, Cordoba and Seville were clearly the largest cities in the Peninsula in the year 1000. The third largest city was Toledo, with a population of 37,000, but Granada closely followed with 26,000 inhabitants.

In 722, a noble named Pelayo, started the first phase of what it has been known as the Reconquista. Although there is no clear agreement between historians, this was a long process that was especially intense during the 1300-1500 period. The Reconquista had a major effect on the evolution of the Muslim and Christian populations during this period, as Figure 2 illustrates. Moreover, the population of the three main cities of the Moorish Caliphate - Granada, Cordoba, and Seville – severely decreased during and after the Reconquista. This was the case in absolute terms and as a percentage of total urban population (Figure 3).

This paper seeks to take advantage of this remarkable event to shed light on several existing theories of city growth. In particular, we aim to be able to discriminate between theories that emphasize the importance of lock-in effects, i.e. forces that are intrinsic to a given location and that were determined a long time ago like, for instance, their geographical location, and theories that emphasize the importance of second-nature events, like the agglomeration of population, as the crucial force to explain why cities form and grow.

The rest of the paper is organized as follows. In Section 2 we summarize the literature most closely related to our paper. The historical context is explained in Section 3. In Section 4 we describe our empirical strategy and data sources. The main results are presented in Section 5. Finally, Section 6 concludes.

2. Literature

From a theoretical point of view, our paper is directly linked to the distinction between first and second nature forces in determining city size and city growth. The former are characteristics linked to the physical landscape of a given location, such as temperature, rainfall, access to the sea, the presence of natural resources, or the availability of arable land, while the latter refer to factors relating to human actions and economic incentives, like, for example, scale economies or knowledge spillovers.[1] The seminal paper by Krugman (1991) offers a very clear distinction of these two forces in the context of a formal economic geography model.[2]

In the empirical arena, there is a relatively recent strand of the literature that considers the importance of natural amenities to explain city creation and city growth. For instance, Bleakley and Lin (2012) show that portage sites in different U.S. regions were once fundamental in attracting commerce and manufacturing, and that, in spite of the long time elapsed since then, their effect on city growth is very persistent, suggesting important path dependence. Another example of the importance of natural attributes is Rappaport and Sachs (2003), who find that proximity to the coast is a crucial variable in explaining the current urban concentration in the U.S.

All the previous papers attempt to identify the importance of particular geographical treats to attract people to specific locations. However, none of them attempts to exploit "quasi-natural experiments" i.e. exogenous historical events that can be useful in disentangling first and second nature forces. Below we summarize a few studies that make use of some of these historical events.

Davis and Weinstein (2002) show how the devastating bombing of Hiroshima and Nagasaki during World War II affected the population and posterior growth rates of the

[1] See González-Val and Pueyo (2010) for a more detailed discussion on this.

[2] Picard and Zeng (2010) is a more recent approach to formally compare the two types of forces.

two cities. Their main finding is that, in spite of the huge drop in population immediately after the atomic bombs were dropped, the population of both cities recovered very quickly, returning to their initial level.[3] Another paper that exploits an armed conflict is Miguel and Roland (2011) who analyze the long-run impact of bombing Vietnam during the Vietnam war. By comparing heavily bombed districts to other districts they are able to isolate the impact of the attacks on several socioeconomic variables. One of their findings is that population density in 2002 – about forty-five years after the bombings - did not change much as a result of the conflict. Their evidence can be interpreted as suggesting that initial conditions are indeed very important to understand city growth.

Our paper is most closely related to Nitsch (2003). He studies the dissolution of the Austro-Hungarian Empire at the end of World War I to test whether the population of the empire's main city, Vienna, adjusted to this shock. He finds, that, although the share of Vienna's population in the new territory falls initially, it stabilizes fairly rapidly, suggesting, as in the studies mentioned before, that lock-in effects and history matter a lot for city growth. The analysis we provide differs from Nitsch (2003) in one fundamental aspect. In our case the size of the country is kept constant before and after the Reconquista, whereas in Nitsch the territory occupied by the Austro-Hungarian Empire dramatically decreases after 1918. Second, our "natural experiment" consists of the systematic expulsion of a targeted population, the Muslims, who represented a vast majority in three of the Spanish cities before the Reconquista, namely Cordoba, Granada, and Seville. Our results are also fundamentally different from his. We find that the negative population shock caused in Muslim cities during the Reconquista had permanent effects on their relative importance in the Spanish territory. The relative size of Granada, Cordoba, and Seville never returned to the pre-Reconquista levels, suggesting that history *does not matter* in the sense that the Christian population who occupied these cities after the Reconquista did not find them as appealing as the Muslim population did.[4] In his

[3] Bosker et al. (2007) study the effects of World War II on German city growth form a theoretical point on view, but their emphasis is on identifying multiple equilibria.

[4] In this sense, our experiment is more closely related to invasions and occupations of territories by very different populations. For instance, the colonization of the Incas, Aztecs and Mayan large urban areas by Spaniards in the 16th century.

study, Vienna rapidly returned to its pre-1918 level, in spite of the dramatic reduction in the size of the Austro-Hungarian Empire.[5]

3. Historical Context

Table 1 shows the growth rate in population in different Spanish urban agglomerations during the 800-1600 period.[6] The first thing to notice is that before the Reconquista (800-1000), Cordoba, Granada, and Seville were thriving cities, as their huge rate of population growth indicates. Cordoba was highly populated; some historians consider it the most populated city in the world in 1000 (Chandler, 1987; Chandler and Fox, 1974). Between 1000 and 1200, although the Reconquista is already ongoing, Granada is still growing at a very rapid rate (around 131%), but the population of Cordoba and Seville dropped at very fast rates (86.7% and 11.1%, respectively). Moreover, their decline continued during until 1400. This pattern is consistent with existing historical evidence that the Muslim population progressively retracted to the South as the Reconquista advanced, first from Cordoba to Seville, and then from Seville to Granada, the last Muslim place standing until its fall in 1492 (O'Callaghan, 2003). Seville experienced a re-growth period in the 1400-1600 period, in large part due to the fact that it was the main port in the trade with the New World, confirming the hypothesis of Acemoglu et al (2005).

Spain was not different

Figure 4 shows that the overall behaviour of Spain was not different from that of other countries in this period, so that it is hard to argue that the trend observed in the Muslim cities can be explained by similar trends in other countries. The peculiarity of the Spanish case is that, although the evolution of the overall population is similar to that of other European countries, a huge change in the composition of the population was produced in that period, from a majority Muslim population to a new Christian majority as the Reconquista advanced.

4. Empirical Strategy

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[5] Of course, history does not matter in Nitsch (2003) if by "history" one refers to the historical events around World War I, which led to the dissolution of the Austro-Hungarian Empire.

[6] The cities selected in the table were in the top ten largest cities in at least one of the five years considered.

Nitsch (2003) proposes a framework that is similar to other studies which seek to explain differences in urban concentration across countries. Our benchmark regression is the following:

$$p_i = \alpha + \beta X_i + \gamma \mathbf{SPAIN} + \varepsilon_i \qquad (1)$$

where i is the country. The endogenous variable p_i denotes the urban primacy of the contemporary largest city in country i, defined as the fraction of the city's population over the total urban population of the country. In the case of Spain, p_i is always the primacy of the Muslim city considered in the regression (Granada, Cordoba or Seville). X is a vector of explanatory variables with the potential to affect a country's degree of urban concentration, including country- and city-specific controls. Finally, SPAIN is a dummy variable which takes the value of one only for the Spanish cities data; ε_i is the error term. As in Nitsch (2003), the key coefficient is γ, because it captures the extent to which the Spanish Muslim city considered is larger than the target that is determined by the X variables.

Our panel includes historical data from ten countries (Spain, Germany, France, Italy, Portugal, UK, Austria, Belgium, the Netherlands and Switzerland) covering the period from 800 to 1800 in 11 100-year intervals. To construct the primacies we use city population data and country urban population taken from Bairoch et al. (1988)[7]. The explicative variables included are similar to those considered by Henderson (2000) and Nitsch (2003). Among the country-specific controls we consider the total urban population, per capita Gross Domestic Product taken from Maddison (2003), the land area, according to the 1870 political borders[8] (Malanina, 2009), and the length of waterways, assumed to be constant over time, taken from the CIA *World Factbook*. We also consider a measure of road density, but as a consequence of the scarcity of data for such early periods we use the number of cities where a Roman road crossed as a proxy. This variable has been recently used by Bosker et al. (2012), who discuss the advantages

[7] Bairoch et al. (1988) do not provide population estimates for 1100. For this century we use the interpolated values provided by Eltjo Buringh and Jan Luiten van Zanden on their webpage (http://socialhistory.org/en/projects/global-historical-bibliometrics).

[8] We consider constant boundaries over time, because some of our variables (road density, GDP, waterways, etc.) are defined according to these boundaries.

of Roman roads data. The source for the information on the presence of a Roman road is Talbert (2000)[9].

The city-specific controls include a dummy variable that takes a value of one if the city had a port, and zero otherwise, and a dummy variable that takes a value of one if the city was a transportation hub, and zero otherwise. As in Bosker et al. (2012), we identify locations where two (or more) Roman roads crossed as hub locations. Apart from country per capita GDP, we also consider other two city-specific measures of income: building craftsmen and building labourers wages. These wages are city real wages measured in grams of silver per day; the source is Allen (2001). He provides annual data since the thirteenth to the twentieth century for several European cities, but when data for a particular city is not available we use data from the nearest city within the same country. Missing data are filled with linear interpolations.

Finally, as in Nitsch (2003) we also include a number of relevant interactions (the density of Roman roads interacted with per capita GDP and the two measures of wages to capture the differential effect of infrastructure and income) and a $SPAIN$ dummy interacted with a time trend to analyze changes in γ over time.

One concern with our OLS results is that there may exist spatial elements that affect urban primacy. To deal with this, we apply the robust Lagrange multiplier and Moran's I tests to the residuals of the regression of the model in Eq. (1). The rationale for this is that there may be significant effects across neighbouring countries or countries located nearby others. It is reasonable to assume that the rulers of a kingdom or country respond in some way to increases or decreases in their neighbours' urban primacy. The effect of industrialization may also generate spatial patterns.

The spatial error model extends model (1) by considering an error variable that satisfies

$$\varepsilon_i = \lambda W \varepsilon_i + v_i, \qquad (2)$$

[9] There are two independent projects that provide geocoded data based on Talbert (2000): DARMC (Harvard, http://darmc.harvard.edu) and OmnesViae (http://omnesviae.org/). We acknowledge René Voorburg from the OmnesViae project for kindly providing data.

with $|\lambda| < 1$ being a parameter that reflects the effect of the residuals of neighbouring variables on the residual of location i, W a weighting matrix that measures the distances between the different locations and v_i an iid random variable that describes the error of the regression model. There exist different possibilities for choosing W; we consider a matrix obtained from the coordinates (longitude and latitude) of the locations in order to construct the Euclidean distance between the cities. The spatial autoregressive model considers the following econometric specification:

$$p_i = \alpha + \rho W p_i + \beta X_i + \gamma \mathbf{SPAIN} + \varepsilon_i \qquad (3)$$

with $|\rho| < 1$ measuring the effect on the endogenous variable of primacy in neighbouring countries.

5. Results

Tables 2 to 4 present the main results using OLS to estimate (1). For each city we split the sample between the 800-1300 period and the 1300-1800 one. As we discussed above, there is considerable agreement among historians that the first period corresponds to a "mild" process of Christian re-occupation of Muslim cities, while the second one is a much more intensive one. Furthermore, in specifications (1)-(2) we use country GDP per capita as in Nitsch (2003), whereas in the rest of specifications we use a city measure of income per capita, in columns (3)-(4) we consider building craftsmen wages and in (5)-(6) we use wages of building labourers.

The most important result for our interests is the systematic switch in the sign of the dummy **SPAIN** when one moves from the 800-1300 period to the 1300-1800 one. In the regressions that use wages as a measure of income per capita – columns (3)-(8) - the sign of **SPAIN** in the 1300-1800 period is negative and significant, indicating a clear decline in the share of these cities in total urban population of the country. When we use GDP per capita this coefficient is always negative, but it is estimated with less precision. The coefficient of the 800-1300 period is positive and significant in all specifications in the case of Cordoba, indicating that this city was thriving before the Reconquista. For Granada and Seville, the dummy is not statistically significant during the 800-1300 period. The interaction between **SPAIN** and the time trend is negative and significant in the first period for the case of Cordoba, indicating that, over time, its share declined. In Granada the interaction between term is positive and significant in the first period, corroborating Granada's position as a receptor of Muslim refugees from other locations.

In Cordoba (Table 2), the hub city dummy is negative and sometimes significant, which is somewhat puzzling. One possibility is that this variable is highly correlated with the dummy *Port City*, which has often a positive and significant sign. Urban population has a strong and significant impact on urban primacy, but only in the first subperiod. Road density doesn't have an effect, except in specification (6). The other significant variables are the land area, which enters with a positive sign in the second time interval, and the interaction between road density and GDP per capita, with a negative sign. Finally, the building labourers wages and it squares, along with the interaction terms associated with this wage, enter significantly in the regression. To give an interpretation of the key variable **SPAIN**, the coefficient 0.59 in column (3) suggests that Cordoba's share in total urban population is about 59 percentage points larger than is explained by the economic size of Spain. The negative coefficient of the Spanish dummy interacted with a time trend in this same column indicates that the oversize of Cordoba during the 800-1300 subperiod is somewhat corrected over time, but the effect disappears after 1300. Similarly, the coefficient of -0.49 in column (4) suggests that after 1300 Cordoba's share in total urban population is about 49 percentage points smaller than is explained by the economic size of Spain, pointing to a clear effect of the Reconquista on Cordoba's primacy.

In Granada (Table 3), the interaction between **SPAIN** and the time trend shows a strong association with its urban share in the 800-1300 period. As in the case of Cordoba, *hub city* and *port city* have conflicting opposite signs and urban population has a strong and significant impact on urban primacy, but only in the first subperiod. Land area and the interaction of per capita GDP and road density are significant, with a positive and negative sign, respectively. As in Cordoba, the only measure of income per capita that has an impact is the wage of building labourers. Finally, in Sevilla (Table 4) the importance of the dummy **SPAIN** does not change over time, except in the 800-1300 period of specification (3). The rest of the results are qualitatively similar to those of Cordoba and Granada.

Our results show that, after 1300, these cities never regained their initial primacy shares, therefore the Reconquista had permanent effects on their population. This means that, in the context studied here, history does not matter for city growth because the locational fundamentals that made these three cities the most populated ones in the Peninsula for about 500 years since 800 to 1300 ceased to be crucial growth determinants once Christians took control of them.

Finally, we consider the extent of spatial dependence in the data. To do this we apply the robust Lagrange multiplier and Moran's I tests to the residuals of the regression of the model in Eq. (1), considering both the spatial error model (Eq. 2) and the spatial autoregressive model (Eq. 3). Table 5 reports the p-values of these tests for the two subperiods and the three measures of income. These p-values provide clear evidence against the statistical significance of the spatial effects for the spatial error model and the spatial autoregressive model. The null hypothesis of zero spatial autocorrelation is rejected in all periods for the spatial error model, and in most of them for the spatial autoregressive model[10], indicating the low influence of international migrations in those early periods and the lack of spatial patterns. The results are similar for the three cities. Therefore, the results previously obtained without including spatial effects are robust.

6. Conclusions

In this paper we analyse a quite unique "quasi-natural" experiment, the effect of the Spanish Reconquista on the population of the three main Muslim cities of the Iberian Peninsula, namely Cordoba, Granada, and Seville. Our empirical strategy is to regress urban primacy – measured as the percentage of population in a given city over the country's urban population – on a dummy variable for Spain and several other historical and socioeconomic variables that have been used in the literature, using panel data from several European countries since 800 to 1800. We first find that, in most specifications,

[10] In the cases that we cannot reject the null hypothesis of zero spatial autocorrelation we estimate the corresponding spatial autoregressive model, and results are qualitatively the same as in the simple OLS regressions (the sign and significance of the SPAIN dummy is the same).

the relative size of these cities declined between the 800-1300 period and, especially, in the 1300-1800 one. Since the latter has been considered as the period of time where the Reconquista was most intensive, this result shows that the change in the population composition of these cities – which became occupied by Christians rather than Muslims- implied a huge decline in their relative importance. Second, we show that these cities never regained their initial primacy shares, indicating that the Reconquista can be considered to have had permanent effects on their population. This last finding sharply contrasts with the previous empirical studies on the importance of initial conditions on subsequent city growth, which find that shocks to a city's population have – in the context in which it has been tested - only temporary effects.

Finally, it is important to notice that these findings are not just of esoteric historical interest. There are plenty of events that recurrently affect the size of today's cities in an exogenous way, including wars or natural disasters. The results of this paper may then shed light on the future evolution of these cities and help discriminating between existing urban theories.

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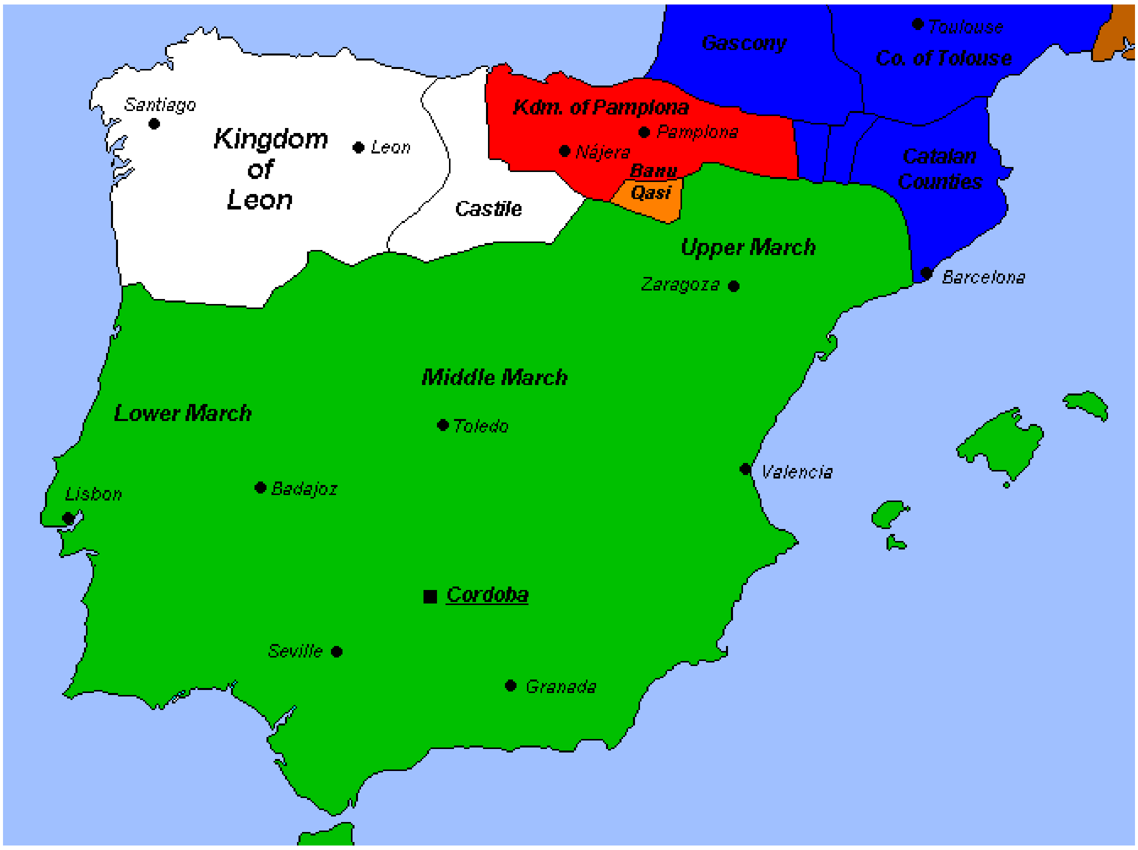
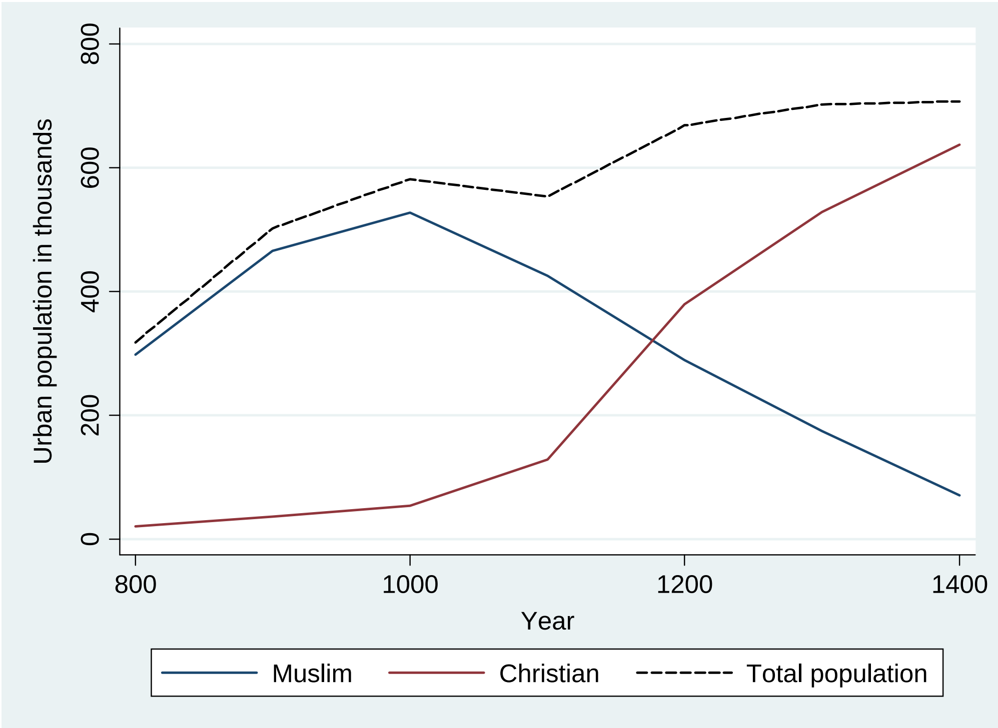
Figure 1: The Caliphate of Cordoba c. 1000



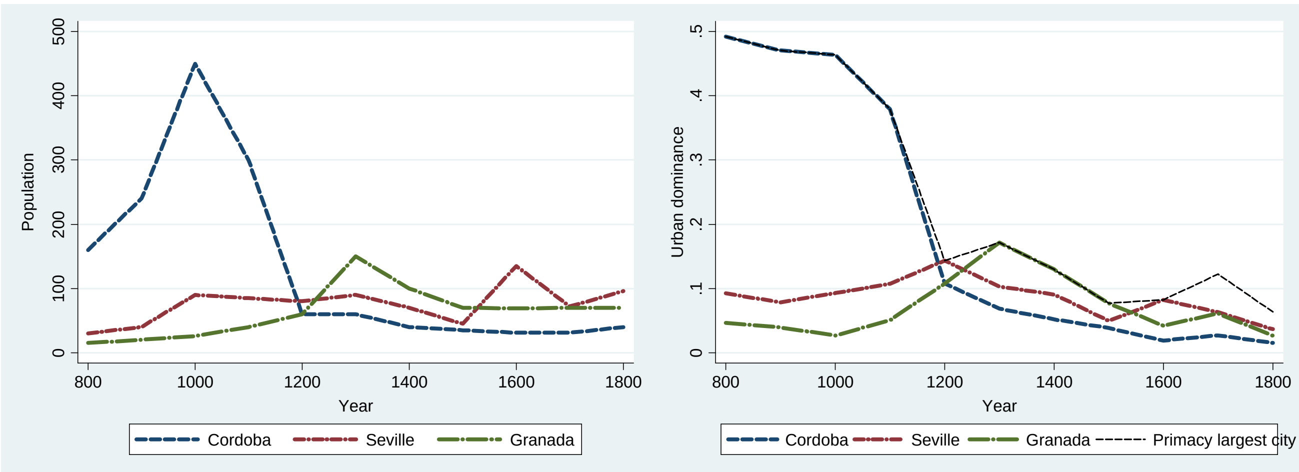
Source: Wikipedia

Figure 2: The evolution of Muslim and Christian populations in Spain, 800-1400



Source: Data estimated by Eltjo Buringh and Jan Luiten van Zanden based on Bairoch et al. (1988). Available at: http://socialhistory.org/en/projects/global-historical-bibliometrics

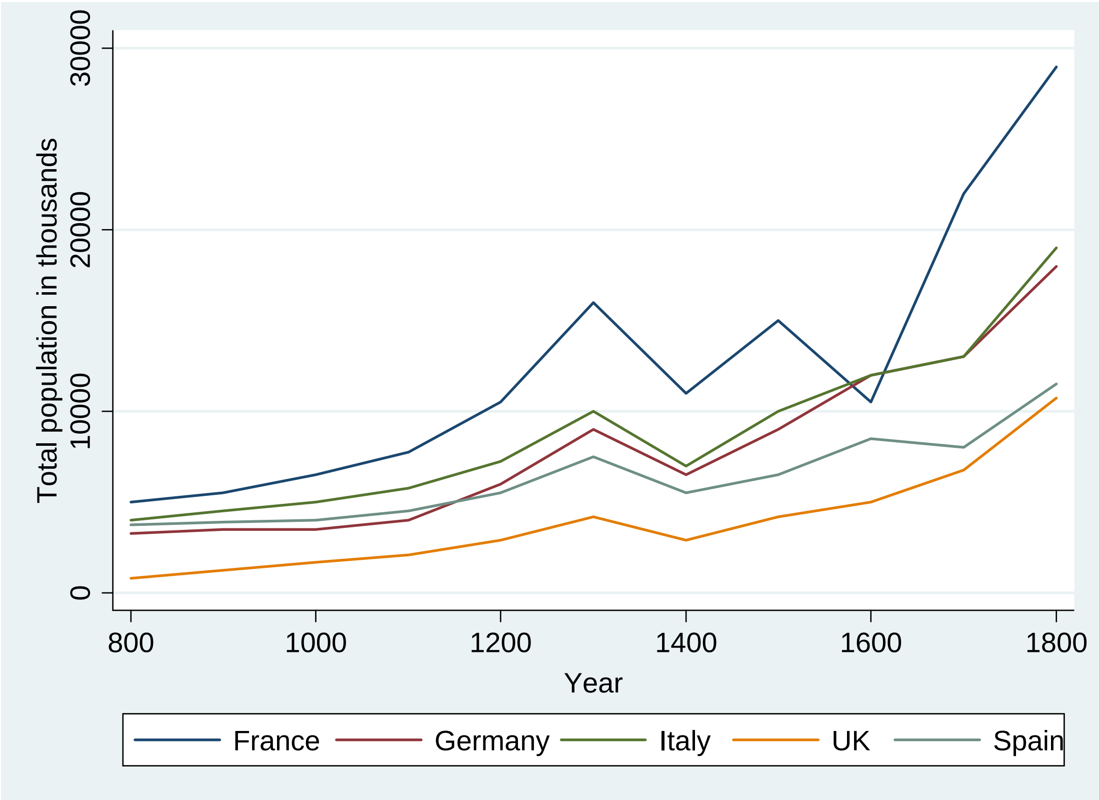
Figure 3: The evolution of population in Cordoba, Seville and Granada, 800-1800



(a) Population (inhabitants in thousands) (b) Share over total urban population

Source: Bairoch et al. (1988).

Figure 4: Population in different European countries, 800-1800



Source: McEvedy and Jones (1978).

Table 1: City growth in Spain

City	*800*	*1000*	*Growth 800-1000 (%)*	*1200*	*Growth 1000-1200 (%)*	*1400*	*Growth 1200-1400 (%)*	*1600*	*Growth 1400-1600 (%)*
Almeria		27,000		20,000	-25.9	25,000	25.0	7,000	-72.0
Barbastro	28,000	35,000	25.0	15,000	-57.1			4,000	
Barcelona		5,000		20,000	300.0	38,000	90.0	32,000	-15.8
Burgos		18,000		20,000	11.1	27,000	35.0	11,000	-59.3
Cartagena		33,000		10,000	-69.7	4,000	-60.0	5,000	25.0
Cordoba	**160,000**	**450,000**	**181.3**	**60,000**	**-86.7**	**40,000**	**-33.3**	**31,000**	**-22.5**
Elvira	15,000	22,000	46.7						
Granada	**15,000**	**26,000**	**73.3**	**60,000**	**130.8**	**100,000**	**66.7**	**69,000**	**-31.0**
Jaen		20,000		15,000	-25.0	15,000		28,000	
Jerez de la Frontera	12,000	19,000	58.3	15,000	-21.1	15,000	0.0	33,000	120.0
Leon		15,000		40,000	166.7	10,000	-75.0	4,000	-60.0
Madrid						8,000		65,000	712.5
Malaga		17,000		15,000	-11.8	40,000	166.7	11,000	-72.5
Merida	30,000	30,000	0.0	15,000	-50.0	11,000	-26.7	6,000	-45.5
Murcia	19,000	15,000	-21.1	15,000	0.0	15,000	0.0	17,000	13.3
Palma		25,000		30,000	20.0	9,000	-70.0	17,000	88.9
Seville	**30,000**	**90,000**	**200.0**	**80,000**	**-11.1**	**70,000**	**-12.5**	**135,000**	**92.9**
Toledo	25,000	37,000	48.0	35,000	-5.4	45,000	28.6	80,000	77.8
Valencia		15,000		26,000	73.3	36,000	38.5	65,000	80.6
Valladolid		6,000		18,000	200.0	20,000	11.1	41,000	105.0
Zaragoza		17,000		21,000	23.5	20,000	-4.8	25,000	25.0

Source: Own calculations based on Bairoch et al. (1988).

Table 2. The impact of the Spanish Reconquista on Cordoba's urban primacy

	[1]	[2]	[3]	[4]	[5]	[6]
	800-1300	1300-1800	800-1300	1300-1800	800-1300	1300-1800
Spain	**0.4***	**-0.19**	**0.59*****	**-0.49*****	**0.88****	**-0.58*****
	(0.23)	**(0.33)**	**(0.21)**	**(0.14)**	**(0.32)**	**(0.19)**
Spain*Time trend	-0.08**	-0.02	-0.06**	0.001	-0.07*	0.03
	(0.03)	(0.02)	(0.03)	(0.01)	(0.03)	(0.02)
Hub city	-0.07	0.17***	-0.16**	0.07	-0.16**	0.02
	(0.1)	(0.04)	(0.08)	(0.1)	(0.07)	(0.09)
Port city	0.08	-0.02	0.22**	-0.04	0.23***	-0.01
	(0.09)	(0.07)	(0.08)	(0.09)	(0.08)	(0.08)
Log (Total urban population,t)	-0.19***	-0.02	-0.21***	-0.03	-0.22***	-0.04
	(0.05)	(0.04)	(0.04)	(0.04)	(0.04)	(0.03)
Log (Road density)	0.06	0.005	-6.29	-0.74	10.15	-0.98***
	(0.31)	(0.27)	(5.93)	(0.91)	(5.98)	(0.23)
Log (Per capita GDP, t)	1.26	1.34				
	(7.5)	(2.12)				
Log (Per capita GDP, t)^2	-0.07	-0.09				
	(0.59)	(0.15)				
Log (Craftsmen wage, t)			-18.49	-2.82		
			(18.76)	(4.75)		
Log (Crafstmen wage, t)^2			4.11	0.61		
			(4.05)	(1.11)		
Log (Building laborers wage, t)					61.001*	-6.93***
					(29.92)	(1.81)
Log (Building laborers wage, t)^2					-18.36**	2.09***
					(8.91)	(0.59)
Log (Land area)	0.06	0.12***	-0.01	0.06	-0.05	0.07
	(0.04)	(0.03)	(0.11)	(0.05)	(0.13)	(0.04)
Log (Waterways)	-0.03	-0.02	-0.02	-0.04**	0.007	-0.02
	(0.02)	(0.01)	(0.02)	(0.02)	(0.02)	(0.01)
Log(Road density)*Log(Per capita GDP)	0.01	-0.04***				
	(0.02)	(0.01)				
Log(Road density)*Log(Per capita GDP)^2	-0.004	0.007				
	(0.008)	(0.006)				
Log(Road density)*Log(Building craftsmen wage)			5.8	0.58		
			(5.31)	(0.88)		
Log(Road density)*Log(Building craftsmen wage)^2			-1.33	-0.13		
			(1.19)	(0.21)		
Log(Road density)*Log(Building laborers wage)					-12.26*	1.13***
					(7.12)	(0.33)
Log(Road density)*Log(Building laborers wage)^2					3.67*	-0.33***
					(2.11)	(0.11)
R^2	0.74	0.77	0.79	0.59	0.83	0.68
Number of observations	46	50	38	40	38	40

Dependent variable: Share of the largest city in total urban population. In Spain we consider the share of Cordoba in all periods. Total urban population is the total population in the country living in cities greater than 5,000 inhabitants. The source for city population data and urban population is Bairoch et al. (1988). Countries considered: Spain, Germany, France, Italy, Portugal, UK, Austria, Belgium, the Netherlands and Switzerland. GDP per capita is taken from Maddison (2003). Wages are city real wages, grams of silver per day, averages; the source is Allen (2001). Land area refers to the 1870 political borders (Malanina, 2009). Waterways include the total length in kilometers of navigable rivers, canals, and other inland bodies of water (Source: CIA World Factbook). We measure road density as the number of locations where a Roman road crossed. As in Bosker et al. (2012), we identify locations where two (or more) Roman roads crossed as hub locations.

Table 3. The impact of the Spanish Reconquista on Granada's urban primacy

	[1]	[2]	[3]	[4]	[5]	[6]
	800-1300	1300-1800	800-1300	1300-1800	800-1300	1300-1800
Spain	**-0.31**	**0.14**	**-0.23**	**-0.26****	**0.09**	**-0.41****
	(0.22)	**(0.34)**	**(0.14)**	**(0.1)**	**(0.25)**	**(0.18)**
Spain*Time trend	0.04**	-0.04	0.05***	-0.01	0.05***	0.01
	(0.02)	(0.02)	(0.01)	(0.01)	(0.02)	(0.02)
Hub city	-0.07	0.17***	-0.17**	0.07	-0.17**	0.02
	(0.11)	(0.04)	(0.08)	(0.1)	(0.07)	(0.09)
Port city	0.08	-0.02	0.23***	-0.04	0.25***	-0.01
	(0.09)	(0.07)	(0.08)	(0.09)	(0.08)	(0.08)
Log (Total urban population,t)	-0.2***	-0.02	-0.22***	-0.04	-0.23***	-0.04
	(0.04)	(0.04)	(0.04)	(0.04)	(0.03)	(0.03)
Log (Road density)	0.006	0.005	-6.51	-0.74	10.25	-0.97***
	(0.32)	(0.27)	(5.97)	(0.91)	(6.19)	(0.23)
Log (Per capita GDP, t)	1.61	1.3				
	(7.45)	(2.12)				
Log (Per capita GDP, t)^2	-0.1	-0.09				
	(0.59)	(0.15)				
Log (Craftsmen wage, t)			-19.7	-2.82		
			(18.87)	(4.76)		
Log (Crafstmen wage, t)^2			4.4	0.61		
			(4.07)	(1.11)		
Log (Building laborers wage, t)					61.08*	-6.89***
					(30.71)	(1.81)
Log (Building laborers wage, t)^2					-18.32*	2.08***
					(9.11)	(0.59)
Log (Land area)	0.05	0.12***	-0.02	0.06	-0.05	0.07
	(0.04)	(0.03)	(0.1)	(0.05)	(0.13)	(0.04)
Log (Waterways)	-0.03	-0.02	-0.02	-0.04**	0.008	-0.02
	(0.02)	(0.01)	(0.02)	(0.02)	(0.02)	(0.01)
Log(Road density)*Log(Per capita GDP)	0.01	-0.04***				
	(0.02)	(0.01)				
Log(Road density)*Log(Per capita GDP)^2	-0.004	0.006				
	(0.009)	(0.006)				
Log(Road density)*Log(Building craftsmen wage)			6.03	0.58		
			(5.35)	(0.88)		
Log(Road density)*Log(Building craftsmen wage)^2			-1.39	-0.12		
			(1.19)	(0.21)		
Log(Road density)*Log(Building laborers wage)					61.08*	1.11***
					(30.71)	(0.33)
Log(Road density)*Log(Building laborers wage)^2					-18.32*	-0.32***
					(9.11)	(0.11)
R^2	0.78	0.76	0.83	0.57	0.87	0.67
Number of observations	46	50	38	40	38	40

Dependent variable: Share of the largest city in total urban population. In Spain we consider the share of Granada in all periods. Total urban population is the total population in the country living in cities greater than 5,000 inhabitants. The source for city population data and urban population is Bairoch et al. (1988). Countries considered: Spain, Germany, France, Italy, Portugal, UK, Austria, Belgium, the Netherlands and Switzerland. GDP per capita is taken from Maddison (2003). Wages are city real wages, grams of silver per day, averages; the source is Allen (2001). Land area refers to the 1870 political borders (Malanina, 2009). Waterways include the total length in kilometers of navigable rivers, canals, and other inland bodies of water (Source: CIA World Factbook). We measure road density as the number of locations where a Roman road crossed. As in Bosker et al. (2012), we identify locations where two (or more) Roman roads crossed as hub locations.

Table 4. The impact of the Spanish Reconquista on Seville's urban primacy

	[1]	[2]	[3]	[4]	[5]	[6]
	800-1300	1300-1800	800-1300	1300-1800	800-1300	1300-1800
Spain	**0.24**	**-0.12**	**-0.2**	**-0.41*** **	**0.09**	**-0.52*** **
	(0.22)	**(0.28)**	**(0.16)**	**(0.11)**	**(0.25)**	**(0.18)**
Spain*Time trend	0.02	-0.02	0.04**	0.000	0.03	0.02
	(0.02)	(0.02)	(0.01)	(0.01)	(0.02)	(0.02)
Hub city	-0.07	0.17***	-0.17**	0.07	-0.17**	0.03
	(0.11)	(0.04)	(0.08)	(0.1)	(0.07)	(0.09)
Port city	0.08	-0.01	0.23***	-0.04	0.25***	-0.01
	(0.09)	(0.07)	(0.08)	(0.09)	(0.08)	(0.08)
Log (Total urban population,t)	-0.2***	-0.02	-0.22***	-0.03	-0.23***	-0.04
	(0.04)	(0.04)	(0.04)	(0.04)	(0.03)	(0.03)
Log (Road density)	0.02	-0.004	-6.45	-0.73	10.19	-0.98***
	(0.31)	(0.27)	(5.98)	(0.91)	(6.14)	(0.23)
Log (Per capita GDP, t)	1.66	1.45				
	(7.44)	(2.12)				
Log (Per capita GDP, t)^2	-0.11	-0.1				
	(0.59)	(0.15)				
Log (Craftsmen wage, t)			-19.43	-2.75		
			(18.88)	(4.77)		
Log (Crafstmen wage, t)^2			4.34	0.6		
			(4.07)	(1.12)		
Log (Building laborers wage, t)					60.85*	-6.94***
					(30.51)	(1.79)
Log (Building laborers wage, t)^2					-18.26*	2.1***
					(9.06)	(0.58)
Log (Land area)	0.06	0.12***	-0.02	0.06	-0.05	0.07
	(0.04)	(0.03)	(0.11)	(0.05)	(0.13)	(0.04)
Log (Waterways)	-0.03	-0.01	-0.02	-0.04**	0.007	-0.02
	(0.02)	(0.01)	(0.02)	(0.02)	(0.02)	(0.01)
Log(Road density)*Log(Per capita GDP)	0.01	-0.04***				
	(0.02)	(0.01)				
Log(Road density)*Log(Per capita GDP)^2	-0.004	0.007				
	(0.008)	(0.006)				
Log(Road density)*Log(Building craftsmen wage)			5.98	0.57		
			(5.36)	(0.89)		
Log(Road density)*Log(Building craftsmen wage)^2			-1.37	-0.12		
			(1.2)	(0.21)		
Log(Road density)*Log(Building laborers wage)					-12.26	1.13***
					(7.3)	(0.32)
Log(Road density)*Log(Building laborers wage)^2					3.65	-0.33***
					(2.16)	(0.11)
R^2	0.77	0.76	0.82	0.57	0.87	0.87
Number of observations	46	50	38	40	38	38

Dependent variable: Share of the largest city in total urban population. In Spain we consider the share of Seville in all periods. Total urban population is the total population in the country living in cities greater than 5,000 inhabitants. The source for city population data and urban population is Bairoch et al. (1988). Countries considered: Spain, Germany, France, Italy, Portugal, UK, Austria, Belgium, the Netherlands and Switzerland. GDP per capita is taken from Maddison (2003). Wages are city real wages, grams of silver per day, averages; the source is Allen (2001). Land area refers to the 1870 political borders (Malanina, 2009). Waterways include the total length in kilometers of navigable rivers, canals, and other inland bodies of water (Source: CIA World Factbook). We measure road density as the number of locations where a Roman road crossed. As in Bosker et al. (2012), we identify locations where two (or more) Roman roads crossed as hub locations.

Table 5. Diagnostics for spatial dependence

Cordoba						
	Per capita GDP		Craftsmen wage		Building laborers wage	
Test	800-1300	1300-1800	800-1300	1300-1800	800-1300	1300-1800
Spatial error model:						
Moran's I	0.528	0.291	0.449	0.584	0.369	0.530
Robust Lagrange multiplier	0.871	0.392	0.417	0.989	0.670	0.172
Spatial lag model:						
Robust Lagrange multiplier	0.043	0.111	0.417	0.392	0.049	0.027
Granada						
	Per capita GDP		Craftsmen wage		Building laborers wage	
Test	800-1300	1300-1800	800-1300	1300-1800	800-1300	1300-1800
Spatial error model:						
Moran's I	0.483	0.293	0.456	0.583	0.311	0.530
Robust Lagrange multiplier	0.673	0.390	0.198	0.998	0.899	0.173
Spatial lag model:						
Robust Lagrange multiplier	0.022	0.107	0.969	0.386	0.266	0.028
Seville						
	Per capita GDP		Craftsmen wage		Building laborers wage	
Test	800-1300	1300-1800	800-1300	1300-1800	800-1300	1300-1800
Spatial error model:						
Moran's I	0.482	0.288	0.452	0.582	0.313	0.532
Robust Lagrange multiplier	0.712	0.390	0.212	0.998	0.870	0.179
Spatial lag model:						
Robust Lagrange multiplier	0.030	0.118	0.932	0.385	0.235	0.029

Note: p-values. The null hypothesis in all tests is that there is zero spatial autocorrelation.