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Centre for Economic Policy Research
33 Great Sutton Street, London EC1V 0DX, UK
Tel: +44 (0)20 7183 8801
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Abstract

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JEL Classification: H75, I25, N33, O10, O30, Z12

Keywords: Muslim rule, education, Literacy, Self-government, Merchant class, Spain

Francesco Cinnirella - francesco.cinnirella@unibg.it
University of Bergamo and CEPR

Alireza Naghavi - alireza.naghavi@unibo.it
University of Bologna

Giovanni Prarolo - giovanni.prarolo@unibo.it
University of Bologna and CEPR

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Islam and Human Capital in Historical Spain*

Francesco Cinnirella, Alireza Naghavi, Giovanni Prarolo†

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This paper studies the impact of Muslim rule on human capital development. Using a unique novel dataset containing yearly data on Muslim presence in the period 711-1492 and literacy rate in 1900 for about 7500 municipalities in Spain, we estimate the local impact of the length of Muslim rule in the medieval period on literacy rate. Our findings reveal a very robust negative relationship between length of Muslim rule and levels of human capital. This result is robust to the inclusion of other possible confounding factors such as the *Reconquista* and the Inquisition. We argue that the characteristics of Islamic law discouraged the formation of a strong merchant class and subsequently impeded the development of forms of local self-government. This translated into lower levels of human capital for regions longer under Muslim rule. Indeed, panel estimates on a sample of cities provide evidence that locations under Muslim domination missed out on the critical junctures of institutional changes which led to a stagnation in the accumulation of human capital.

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†Cinnirella: University of Bergamo, Danish Institute for Advanced Study, CESifo, CEPR and CAGE (email: francesco.cinnirella@unibg.it); Naghavi: University of Bologna, Johns Hopkins University SAIS Europe, and LdA (email: alireza.naghavi@unibo.it); Prarolo: University of Bologna, CEPR and LdA (email: giovanni.prarolo@unibo.it).

1 Introduction

The Muslim world today observes a substantial gap with respect to the world technology frontier and suffers from low levels of human capital.[1] A potential historical explanation for this drastic lag is suggested to be resistance by the religious leaders to scientific learning and innovation, which posed a threat to their authority by undermining their teachings, societal influence, and financial support from the state (Chaney, 2011). An alternative rationale is the nature of Islamic legal institutions, which by not favoring private capital accumulation and large-scale production slowed down the process of economic development (Kuran, 2010).[2] Paradoxically, the medieval Islamic world surpassed the West and China in scientific and technological production for many centuries, rejecting the hypothesis that Islam is inherently against science and progress (Huff, 2003). A perfect historical example of this is Muslim Spain, where Umayyads' Caliphate of Cordoba became the civilization capital of the West and the home of science, attracting a great number of scholars and scientists (Halilovic, 2017). This makes Spain a peculiar case to gain a better understanding of how Islam impacts human capital development and study whether Muslim rule has depressed the latter in the very region where it reached the peak of its progress.

In this paper we exploit variations in the length of Islamic rule in medieval Spain to study whether and to what extent Islam affected the successive economic development of early-modern Spain, or retarded the implementation of the new class of institutions that was developing in continental Europe. We use unique new data on the detailed length of Muslim rule in Spain for the period 711-1492 for about 7,500 municipalities, which are then linked to the 1900 population census to observe literacy rates. Our investigation reveals a strongly negative and robust relationship between the length of direct Muslim influence and education. We propose a potential channel that can help to explain the diverging path of Muslim versus non-Muslim Spain, in the region where it reached its heights and its early demise. In the critical juncture of the commercial revolution, the rise of the merchant class endorsed self-governed organizations (corporations) such as merchant guilds, which led to the growth of self-governance skills and in turn trust, human capital, and innovation (Greif, 2006; van den Heuvel, 2007; Ogilvie, 2011, 2014). These self-governing communes were initially designed for the purpose of mutual protection against forced expropriation by territorial overlords (Angelucci and Meraglia, 2013). The Islamic institutional complex delegated this function of corporations to public foundations called *waqfs*, which were inalienable endowments created by a person who granted land or other immovable property in perpetuity for the advancement of a charitable or pious purpose. Doing so raised transactions costs and created disincentives for the merchant class, depressing long-run prospects for education by hindering the creation of a suitable organization for small scale diffused business, and, in turn, the acquirement of self-governing skills (Kuran, 2016).

Standard reduced-form estimates show that the length of Muslim rule during Islamic domination is negatively related to literacy rates in 1900. The results are very robust to the intro-

[1] A recent article on the Economist (January 26, 2013) notes that only in 2005 Harvard University produced more scientific papers than 17 Arabic-speaking countries combined. More generally, forty-six Muslim countries combined produced only 1.17 percent of the world's scientific literature between 1997 and 2007.

[2] See Kuran (2018) for an exhaustive discussion on the relationship between Islam and economic performances.

duction of several geographic and other confounding factors. In particular, we present several robustness checks which discard the process of the *Reconquista* and the consequent distribution of land as potential mechanism. Presence of Jews and the intensity of the Inquisition also do not seem to affect our results. Our findings also survive upon the introduction of the type of jurisdiction as control, namely whether the location had a *villa* status (towns with special privileges) or if it was a lordship under clergy, secular, royal, or military order. Exploiting data on the occupational structure of Spanish municipalities, we put our hypothesis into test and find a significantly lower population of traders (merchants) in Spanish municipalities that were longer under the Muslim empire.

The rise of the merchant class in Europe nurtured the medieval self-governing guilds. de la Croix et al. (2018) argue that medieval corporate (guild) institutions can explain the economic ascent of Europe relative to regions that relied on the transmission of knowledge within clans. Given the potential for market failure due to incomplete contracts in weak political systems, guilds created a functional governance system (Epstein and Prak, 2008). Generally, a European town in the middle ages was a federation of small self-governing groups: merchants and craft guilds which together constituted the municipal organization (Pleszczynski, 2018). By the 13th century, most European principalities had representative bodies to approve taxation and self-governed democratic corporations (communes) were represented in all of them (Greif, 2006). It is difficult to find a trace of such *civic spirit* in Islamic lands. The Muslim cities of the Middle Ages were rarely defined as municipal institutions and lacked the spirit of local organization, which was fundamental for the development of medieval Europe (Lewis, 1937). When Europe consisted of more than 4000 self-governing cities by the 12th century, regions under the Muslim rule even in the 19th century were ruled from the capital. Muslim cities lacked *corporate personhood* and could not contract as a collective entity, limiting their efficacy relative to self-governing cities (Kuran, 2018).

The European merchant class benefited also from the invention of the printing press (Dittmar, 2011). Indeed, the spread of printed manuals on bookkeping, commercial arithmetics, and business practices contributed to fostering merchants' skills. We thus test also the hypothesis that Spanish cities which stayed longer under Muslim domination had a lower probability of adopting early a printing press. Indeed, combining the city-level dataset of Bosker et al. (2013) with information on the location of printing presses in Spain in 1500 from Rubin (2015) we find that a longer exposure to Muslim domination significantly decreases the probability of adopting early the printing press.

To further examine the proposed channel that can explain our reduced-form results, we make use of the panel dimension of the city-level dataset of Bosker et al. (2013) which, among others, provides information on institutional variables such as the presence of forms of self-government, i.e. communes. Accounting for city-fixed effects and city-specific urbanization trends, we find that cities under Muslim rule between 1200-1500 did not develop any form of self-government. Crucially, we show that this gap is persistent over time: cities with a longer exposure to Islamic domination in the period 711-1492 are systematically less likely to have any form of self-government until the early modern period. Our results thus suggest that by being under the Islamic rule in the era of the commercial revolution, municipalities in Spain might

have missed out a critical juncture which persistently hampered their economic development until the early modern period.

2 Related Literature

Our paper is related to various strands of literature. First, it contributes to the literature on the long-run effects of the Spanish *Reconquista*. Oto-Peralias and Romero-Avila (2016) argues that the rate of speed of the *Reconquista* affected political inequality which, in turn, negatively affected modern income levels. The logic is that a comparatively larger frontier expansion (i.e. a faster process of *Reconquista*) created favorable conditions for an elite which excluded large segments of the population from economic opportunities.[3] This has negative consequences for long-term economic development. In a similar fashion, Beltran-Tapia and Martinez-Galarraga (2018) study how landownership inequality, resulting from different phases of the *Reconquista*, negatively affected education in pre-industrial Spain. Using data at the district level, they adopt an instrumental variable approach in which the different phases of the *Reconquista* are used as instruments to identify exogenous variation in landownership inequality. Oto-Peralías (2019) studies the long-term impact of towns jurisdictions in Spain. During the *Reconquista* the Christian kingdoms granted lordships, an example of delegation of public functions to private agents. Oto-Peralias shows that towns granted to nobles after the *Reconquista* are relatively poorer today. He argues that state capacity and in particular the lower provision of public goods is the main intervening factor.

Chaney and Hornbeck (2016) study the population dynamic effect of the mass expulsion of the Moriscos (converted Muslims) in Spain in 1609. They find a delayed process of Malthusian dynamics. Interestingly, Christians were able to return to pre-expulsion output levels relatively quickly, consistent with the notion that Christian migrants adapted to the economic conditions and location-specific human capital. Vidal-Robert (2014) looks at the long-term economic consequences of the Spanish Inquisition. Using data on inquisition trials for the universe of municipalities in Catalonia he shows that more inquisitorial activity is negatively associated to city growth. By exploring potential mechanisms, Vidal-Robert finds that inquisitorial activity is negatively associated with the adoption of new technologies. Vidal-Robert (2013) studies how the Spanish Crown used the Inquisition as a repressive tool to minimize the threat of rebellion.

Beltran-Tapia et al. (2019) analyze the evolution of literacy rates in Spain from 1860 to 1930. As in our case, they also collected data on literacy rates at municipal level from population censuses. In particular, they explore the role of the *Ancien Regime* and the passing of the Moyano Law on education in explaining regional differences in literacy. As clearly stated by the authors, they cannot explain the large differences that already existed in 1860 and persisted until 1900. We propose a possible mechanism which can explain the large differences in literacy in Spain in the early modern period.

[3] Oto-Peralias and Romero-Avila (2017) analyzes the border of the Emirate of Granada to show how historical frontiers can lead to persistent differences in economic inequality. Using a regression discontinuity design the authors find that municipalities on the Castilian side had more economic inequality in the eigtheenth century due to a high concentration of economic and political power in the hands of the elites.

Our paper relates also to the literature on the cultural and institutional factors that explain the economic divergence between Christian and Islamic world. According to Rubin (2017) the divergence between Christian and Muslim societies originates from the legitimizing role of religion. At some point during the Middle Ages, whereas the Church's political influence in legitimizing rulers diminished substantially, rulers in the Muslim societies continued to rely on religious authorities to legitimize their power. These religious authorities opposed pro-market institutions and the spread of new ideas which could have undermined their authority. The spread of the printing press and its role in the diffusion of the Reformation is an example of how the interaction of ideas and new information technology can undermine an established authority like the Catholic Church (Rubin, 2015). Chaney (2016) reconstructing book production of Islamic authors identifies a strong decline in Islamic science around the year 1100. He argues that this decline is related to the collapse of a secular bureaucracy and the political empowerment of religious leaders who altered the educational system favoring the spread of religious education (*Madrasas*). Bosker et al. (2013) constructed a large dataset of cities in the Arab world and Europe which contains several religious and institutional variables for the period 800-1800. Regarding the divergence between Europe and Arab world, they argue that the centralized institutions that governed exchange between Muslim cities was highly efficient during the "golden age" when the Islamic Caliphate reached its maximum territorial extension. The same set of institutions was unable to generate long-term economic growth once the Caliphate started to disintegrate and trade overseas became more important.

3 Conceptual Framework and Potential Channels

Our research puts forward the idea that Islam negatively influenced the formation of human capital in Spain through its institutional features. The growth of literacy in the early modern period can be associated with the willingness of municipalities to support local education, suggesting that cities with a stronger local government are more predisposed to achieving higher literacy rates (Strauss, 1984). The dissuading characteristics of Islamic lands in fostering the formation of the merchant class kept these areas alienated from skills required to implement forms of local self-government and thereby human capital development. This section elaborates on a possible explanation for the persistent role of Islamic rule on education and the differential long-run development of human capital within Spain.

The commercial revolution in Europe is often considered a critical juncture that provided the region a unique chance for economic growth (Cantoni and Yuchtman, 2014). The commercial nature of the phenomenon made certain preconditions, such as easing business transactions and building foundations for the creation of a strong merchant class, essential for exploiting the opportunity. A barrier was formed in areas of Europe ruled by the Muslim empire, where the state often used blessing of religious authorities to gain legitimacy among the population. The need for this bond was especially crucial for the post-Umayyad caliphates in Spain due to the lack of bloodline, which led to clear observations of the state enforcing religious laws (Greif, 2002). This included regulations against the collection of interest (*riba*), which raised transaction costs and limited the accumulation of wealth by the commercial elite (Michalopoulos

et al., 2016). Other areas of Europe including parts of Spain under Christian rule at the time left the door open for merchant bankers to engage in commercial practices and partnerships by overlooking usury laws which were also in place under Christianity (Rubin, 2011).

The rise of the merchant class in Europe is associated with a movement of the population from agricultural estates to towns during the 10th-13th century, with the aim of switching profession toward trade and shifting ownership from land to movable property. Commercial opportunities were particularly abundant at height of the commercial revolution in 12-13th century (Lopez, 1971), reaching its peak in non-Muslim Spain in the post-*Reconquista* era during the 12-14th century to mark the beginning of intensive trade within the Iberian Peninsula and with the rest of Europe (Ardzrooni, 1913). As trade revived, the power and social standing of the merchants grew, giving stimulus to the *incorporation* movement in medieval Europe. Merchants contributed to the legal transformation by establishing the Mercantile law. They elected the judges in commercial courts, who adjudicated commercial disagreements (Kuran, 2005).

While merchants gained power and incentives during the commercial revolution in Europe, the Muslim regions missed this critical juncture and experienced a structural stagnation of commercial partnerships in the region. The traditional Islamic institutional complex had the adverse effect of encouraging merchants to convert their wealth into real estate and, thus, potentially to charitable endowments known as the *waqf*. Founding *waqf* gained popularity among high officials not only as a religious deed, but also as a strategy to shelter wealth in a weak property rights environment (Kuran, 2016). The result was an outflow of mercantile wealth from private profit oriented sectors, which limited partnerships and hampered the emergence of corporations. In other words, the *waqf* hindered the formation of self-governed decentralized communities or Western style "municipalities" (Kuran, 2004). The effectiveness of municipalities in forming a strong local government and in providing local services, such as public education, was thus negatively affected by their history and the length of the Muslim domination.

The significance of the merchant class elsewhere outside Muslim rule led to the counterpart institutions known as communes, which were decentralized corporations such as guilds established in the interest of merchants. The suitable prevailing preconditions made merchant guilds thrive as self-governed institutions that contributed to the transmission of technological knowledge, provided property rights, and enforced contracts (de la Croix et al., 2018). Thus, guild activity affected market competition, commercial security, human capital and technological innovation. By the 13th century, there was an array of guilds of local traders and long-distance merchants across Europe, and commerce demanded literacy. Guilds also promoted a social capital of trust, and helped innovators generate monopoly rents in the output market enabling them to capture some gains from innovation, a similar concept to patents (Ogilvie, 2019; Kuran, 2016).

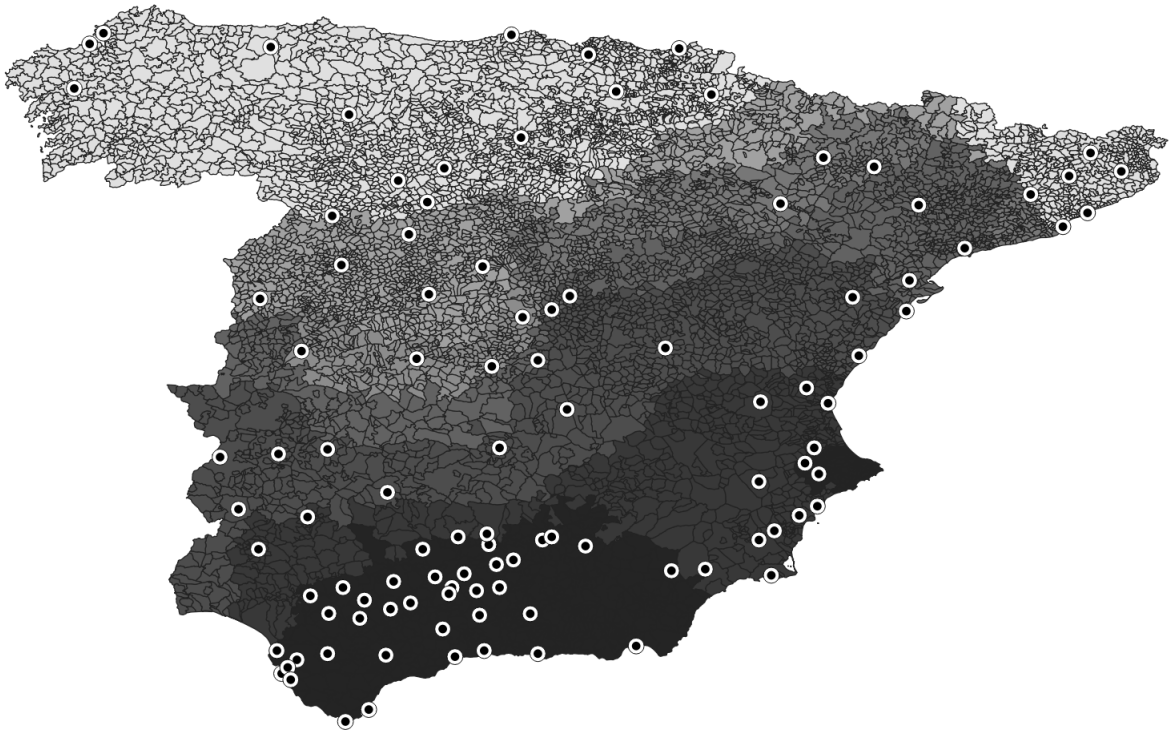
While self-governance skills were instilled in non-Muslim merchants through guilds, weakness of incentives for developing a commercial organization suitable for banking, insurance, and large-scale-trade failed the creation of this competency in the Muslim world. A dull environment for organizational innovation that originated from the *waqf* limited the rise of otherwise successful merchants who could have induced the institutional adaptation required for a sound provision

of education. In the spirit of Kuran (2018), we argue that Islam's effects on human capital development through its peculiar institutions are not limited to its impact on Muslims and could persist in influenced areas in Europe even if a region is no longer under Muslim rule.

4 Data and Methods

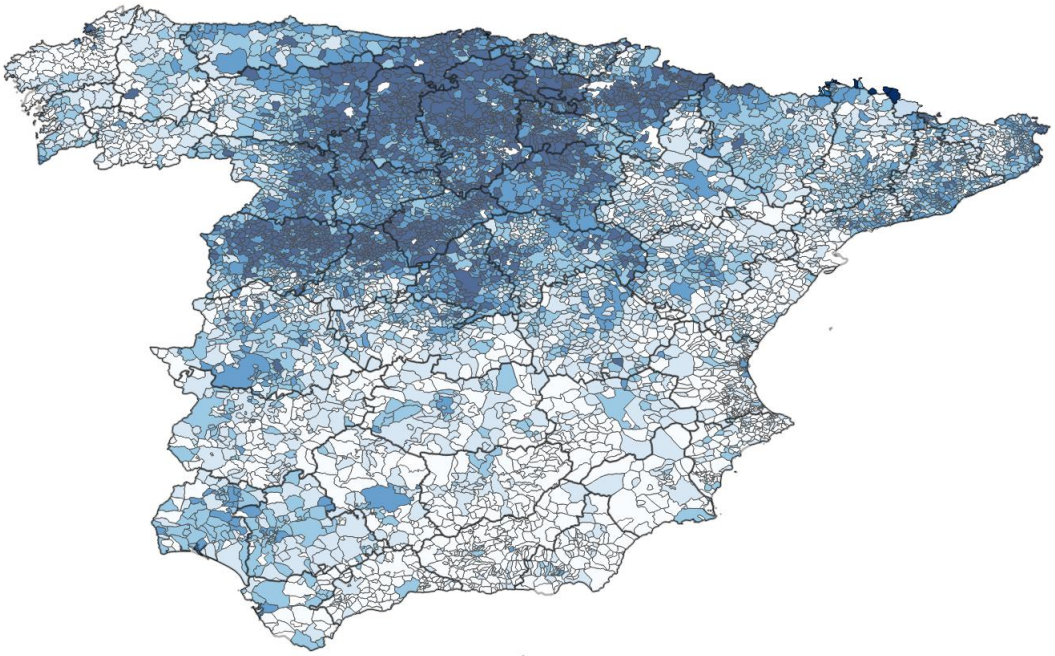
In terms of data collection and construction, this work contributes to the literature in two dimensions. First, we systematically locate over time and space the presence of Muslim rulers in Spain over eight centuries (from 711 until 1492) as our main explanatory variable. We do it on a yearly basis starting from year 1000, based on the original maps in Reed (2014) and further elaborated by Cervellati et al. (2019). This information is available at the pixel level (roughly 10x10 km) and is then aggregated at the municipality level to construct a dataset with the length of exposure to Muslim rule (see Figure 1). Second, from the Spanish census of year 1900 we digitize literacy rates (for men and women) at municipality level as our main dependent variable (see Figure 2).

FIGURE 1: Length of Muslim domination over the Iberian peninsula



Note: The figure depicts the timespan each location has been ruled by Muslim civilizations since year 711. Lighter shades correspond to shorter domination. The darker shade is the area under Islam until year 1492. Dots show the cities used in the city-level analysis (Bosker et al., 2013)

FIGURE 2: Literacy rates



Note: The figure depicts literacy rates at municipal level from 1900 census. Lighter shades correspond to lower literacy rates. Thicker lines represent province borders.

We collect and construct several control variables at the municipality level, as failing to include them in our regression framework would give rise to omitted variable bias, given the non-experimental nature of our treatment. Human capital measures can, in fact, be shaped by many different economic variables, both from the demand and the supply side. First we include a now standard measure of land quality, the caloric suitability of terrain available from Galor and Ozak (2016).[4] This variable could enter both positively or negatively, depending on whether the income effect (higher income should induce people to acquire more education) or the substitution effect (higher income from agricultural production could relatively reduce occupation in industry, where more skills are needed) dominates. We take from the same source data on precipitations and temperature. As a proxy for communication networks we construct each municipality's minimal distance from sea and (main) rivers and we also construct the distance from Roman and medieval roads. Altitude and ruggedness of the terrain are also included as controls for remoteness and, in general, bad conditions for developing human capital. Finally, we also control for the size of the municipalities as larger areas might have been disadvantaged in the provision of schools.

The main results and robustness checks are obtained by simple regressions of cross-sectional municipality-level data using Conley-corrected standard errors (at 50 km), in order to take into account the spatial autocorrelation of the data, which if not properly addressed could be of harm to inference according to Kelly (2019).[5]

[4]We use the pre-1500 version, while using the post-1500 does not change our results.
[5]Our main results remain significant when increasing the distance up to 200 km.

5 Baseline Results

TABLE 1: Muslim rule and human capital - Baseline results

Dep. var.:	Literacy rate							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Duration Muslim rule	-0.035***	-0.031***	-0.040***	-0.037***	-0.032***	-0.030***	-0.030***	-0.030***
	(0.005)	(0.005)	(0.004)	(0.004)	(0.006)	(0.006)	(0.006)	(0.006)
Caloric suitability (pre 1500)		0.010***	0.007***	0.005**	0.005***	0.003*	0.003*	0.003*
		(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Rain			-0.015***	-0.017***	-0.019***	-0.011*	-0.011*	-0.010*
			(0.005)	(0.005)	(0.005)	(0.005)	(0.006)	(0.005)
Temperature				-0.014***	-0.026**	-0.024**	-0.024**	-0.022**
				(0.003)	(0.012)	(0.011)	(0.011)	(0.010)
Altitude					-0.008	-0.004	-0.003	-0.002
					(0.007)	(0.006)	(0.006)	(0.006)
Ruggedness						-0.027***	-0.027***	-0.028***
						(0.007)	(0.007)	(0.007)
Distance to water							-0.693	-1.064
							(3.622)	(3.561)
Area								-1.144***
								(0.307)
Observations	7539	7539	7539	7539	7539	7539	7539	7539
R-squared	0.89	0.90	0.91	0.91	0.91	0.91	0.91	0.92

Notes: OLS estimates. Conley standard errors in parenthesis. *** denotes statistical significance at the 1% level, ** at 5% level, and * at 10% level.

Baseline results of the relationship between the length of Muslim rule (in centuries) in the medieval period and literacy rates in 1900 are shown in Table 1. In column 1 we show the unconditional bivariate correlation. We find a significant and large negative coefficient. In the next columns we progressively include geographic controls to test the extent to which the relationship between length of Muslim rule and literacy rate is affected. In fact, we find that caloric suitability is significantly positively correlated with literacy rates, pointing to an income effect playing a major role, while only marginally changing our coefficient of interest (column 2). Municipalities with higher precipitation rates and higher temperatures are negatively correlated with literacy rates (columns 3 and 4). Altitude is not significantly related with literacy whereas there is a significant negative relationship with ruggedness (columns 5 and 6). Standard macro proxies of trading activity, such as distance from rivers and the sea seem not to have an effect on literacy (column 7), while in column 8 we find that the municipality area correlates negatively with literacy, something we discuss later on.

Importantly, the coefficient of interest for the Muslim rule is very stable across the different specifications around the value of 0.03. In terms of magnitude, taken at face value, the coefficient suggests that an additional century of Muslim rule is associated with 3 percentage points lower literacy rates. Since average literacy rate in 1900 is about 36%, this is more than 8% of the mean value.[6]

[6] A possible concern is that the relationship of interest is mainly driven by large cities. If we drop the five largest municipalities in our sample (Madrid, Barcelona, Bilbao, Sabadell, and Valencia), the results are virtually identical (not shown). OLS regressions weighted by population also deliver very similar results.

6 Alternative Explanations

6.1 The *Reconquista*

There is a recent literature which studies, directly or indirectly, the impact of the Christian *Reconquista* on economic outcomes in Spain. Oto-Peralias and Romero-Avila (2016) investigates the long-run consequences of the *Reconquista* on modern regional economic development. The authors find that a faster rate of the *Reconquista* had a negative effect on today's per capita income in Spain. The rationale of their results is that a faster rate of *Reconquista* implied a larger territorial expansion. Military orders and landed elites played a crucial role in the colonization of such extended frontier leading to large inequality in the distribution of resources with negative consequences for long-term economic development. In a similar vein, Beltran-Tapia and Martinez-Galarraga (2018) find that inequality in the distribution of landownership has a negative impact on literacy rates for 464 districts in 1860 Spain. The authors instrument inequality of land access with the different phases of the *Reconquista* following a similar logic as in Oto-Peralias and Romero-Avila (2016).

According to Oto-Peralias and Romero-Avila, the first phase of the *Reconquista*, i.e. the repopulation of the Duero Valley, did not involve a large territory. The distinctive feature of the colonization process was the predominance of private initiative with a more balanced occupation of land and a minor or no role for military elites (Oto-Peralias and Romero-Avila, 2016, p. 414). Therefore in these areas the speed of the *Reconquista* and the consequent distribution of land should not have an adverse impact on education — or at least should play a minor role. Finding a negative relationship between length of Muslim rule and literacy for the municipalities included in these areas would indicate that the speed of the *Reconquista* and the successive distribution of land have no bearing on our findings.

In column 1 and 2 of Table 2 we restrict the sample to municipalities which have been reconquered by 1062 at the latest, which is the year indicated by Oto-Peralias and Romero-Avila (2016) after which the frontier expansion was comparatively larger. The estimates in column 1 show that the relationship between the length of Muslim rule and literacy rates is significantly negative and of similar size also for this period. Furthermore, in column 2 we include as control the share of landless peasants in 1860, which is the variable used by Beltran-Tapia and Martinez-Galarraga (2018) in their study.[7] The results show that a more unequal ownership of land is significantly negatively related to levels of human capital also in these regions with a more egalitarian initial allocation of land.[8] Our relationship of interest is almost unaffected which strongly suggests that both the speed of the *Reconquista* and the distribution of land (in 1860) cannot explain our main result.

A further way to test whether the *Reconquista* confounds our result is to split the sample between Castile and Aragon. The logic behind this approach is similar to the one exposed above. Due to its smaller area, the repopulation of Aragon was organized by the King and the nobility played a minor role. In fact, the repopulation of Aragon preserved Muslim agricul-

[7] Please note that this variable varies at the district level ($n = 464$). We are very thankful to Francisco Beltran-Tapia and Julio Martinez-Gallaraga for sharing their data on landless peasants.

[8] This result is entirely consistent with previous studies on the relationship between landownership inequality and accumulation of human capital such as Galor et al. (2008) and Cinnirella and Hornung (2016).

tural technologies and tended to respect the Muslim population which favored their integration (Oto-Peralias and Romero-Avila, 2016). Following this argument, Beltran-Tapia and Martinez-Galarraga (2018) argue that the *Reconquista* is not a valid instrument for land inequality in the context of Aragon. In columns 3 and 4 of Table 2 we show estimates separately for Castile and Aragon, respectively. While we find the point estimate for Aragon to be larger compared to Castile, the significant negative relationship between length of Muslim rule and literacy holds. It is important to note that this result is conditional on the share of landless peasants.

TABLE 2: Length of Muslim rule and literacy: Accounting for the *Reconquista*

Dep. var.: Literacy rate	Reconquista pre 1062		Split	
	(1)	(2)	(3)	(4)
			Castile	Aragon
Duration Muslim rule	-0.029**	-0.024**	-0.015*	-0.029***
	(0.014)	(0.012)	(0.009)	(0.009)
Share landless peasants		-0.180***	-0.083	-0.214***
		(0.068)	(0.056)	(0.076)
Geo controls	Yes	Yes	Yes	Yes
Observations	2808	2776	4959	2511
R-squared	0.94	0.94	0.93	0.92

Notes: OLS estimates. Conley standard errors in parenthesis. Geographic controls are: crop suitability, precipitation, average temperature, shortest distance to coast or large river, altitude, ruggedness, and area of the municipality. *** denotes statistical significance at the 1% level, ** at 5% level, and * at 10% level.

6.2 The Inquisition

The Spanish Inquisition is another potential channel which could explain why municipalities with a longer Muslim rule have lower level of human capital accumulation. The Spanish Inquisition started in 1478 to persecute *crypto-Jews* and *Moriscos*, i.e. Jews and Muslims converted to Catholicism. Later, the Spanish kings used the Inquisition as an instrument of persecution to fight any religious and political ideology which could jeopardize the *status quo* and the authority of the king. The Inquisition conducted more than 100,000 trials in the three centuries after its establishment. Vidal-Robert (2014) finds that inquisitorial activity significantly decreased annual population growth for Catalan municipalities until the first half of the nineteenth century, the negative effect vanishing afterwards. Inquisitorial activity might have suppressed the birth or spread of new ideas and cultural attitudes toward innovation. Indeed, Vidal-Robert (2014) finds a negative correlation between inquisitorial activity and modern attitudes towards new technologies. If inquisitorial activity was more pronounced in areas which experienced longer Muslim domination, our main finding could be explained by the negative impact of the Inquisition on the accumulation of human capital. In fact, descriptive statistics on the type of trials show that only about half of the trials had a religious motive. Trials against crypto Jews (27%) were relatively more prevalent than those against Moriscos (16%) and Protestants (3.5%). About half of the trials had social motives such as bigamy, blasphemy, and superstition (Vidal-Robert, 2014, Table 2).

Using data on trials for all Catalan municipalities from Vidal-Robert (2014), we can test to what extent inquisitorial activity can explain our relationship of interest, though for only

a subsample of Spanish municipalities.[9] In particular, we re-run the baseline full specification adding as controls, one by one, the total number of trials, the number of religious trials, the number of trials against Moriscos, and the number of non-religious trials, to check whether our results on Muslim treatment is still robust.[10] The results are presented in Table 3. In column 1 we estimate our baseline model for the sub sample of municipalities in Catalonia. Compared to the results in Table 1, the coefficient for the length of Muslim rule is smaller for Catalonia. Still the relationship is economically substantial as one standard deviation increase in the length of Muslim rule (roughly two centuries) is associated with 18% of a standard deviation in literacy rates. In column 2 we include as control the measure for the density of all types of trials. Interestingly, municipalities in Catalonia with more inquisitorial activity tend to have higher levels of literacy rates. We find the same coefficient if we only consider religious trials density (column 3) or trials against Moriscos (column 4). Finally, in column 5 we consider only non-religious trials density. The sign and significance of the coefficient confirm a positive relationship between intensity of inquisitorial activity and literacy rates. The coefficient for the length of Muslim rule remains significant and of the same magnitude throughout all specifications.

TABLE 3: Length of Muslim rule and literacy: Accounting for the Inquisition

Dep. var.: Literacy rate					
	(1)	(2)	(3)	(4)	(5)
Duration Muslim rule	-0.008*	-0.009***	-0.009***	-0.009***	-0.009***
	(0.005)	(0.003)	(0.002)	(0.002)	(0.003)
Total trials density		0.024**			
		(0.011)			
Religious trials density			0.025***		
			(0.009)		
Moriscos trials density				-0.016	
				(0.015)	
Non-religious trials					0.056***
					(0.017)
Geographic controls	Yes	Yes	Yes	Yes	Yes
Observations	879	879	879	879	879
R-squared	0.92	0.92	0.92	0.92	0.92

Notes: OLS estimates. Conley standard errors in parenthesis. Geographic controls are: crop suitability, precipitation, average temperature, shortest distance to coast or large river, altitude, ruggedness, and area of the municipality. *** denotes statistical significance at the 1% level, ** at 5% level, and * at 10% level.

6.3 Accounting for Jewish Communities

The Iberian peninsula had also relatively large communities of Jews before their expulsion in 1492. Jewish people tended to have a relatively high level of human capital and specialize in trade and money-lending activities. This might have a positive impact on the long-run accumulation of human capital (Pascali, 2016). Yet, if the presence (or persecution) of Jewish communities is related to the length of Muslim rule, this could affect our results and the interpretation thereof. In Table 4 we present specifications that address this issue. In particular,

[9] We are very thankful to Jordi Vidal-Robert for sharing his data on Catalonia.

[10] The number of trials are standardized by the area of the municipality. If we include in the regression the absolute number of trials, results are virtually the same.

we use data on the presence and length of Jewish communities in the period 1100-1500 from Anderson et al. (2017).

TABLE 4: Length of Muslim rule and literacy - Accounting for Jewish communities

Dep. var.:	Literacy rate			
	(1)	(2)	(3)	(4)
Duration Muslim rule	-0.030***	-0.030***	-0.030***	-0.030***
	(0.006)	(0.006)	(0.006)	(0.006)
Jewish community (dummy)	0.088***	0.060***		
	(0.011)	(0.014)		
Length Muslim rule × Jewish community		0.008*		
		(0.004)		
Length Jewish community			0.025***	
			(0.003)	
Distance from Jewish community				-0.042
				(0.033)
Geo controls	Yes	Yes	Yes	Yes
Observations	7539	7539	7539	7539
R-squared	0.92	0.92	0.92	0.92

Notes: OLS estimates. Conley standard errors in parenthesis. Geographic controls are: crop suitability, precipitation, average temperature, shortest distance to coast or large river, altitude, ruggedness, and area of the municipality. *** denotes statistical significance at the 1% level, ** at 5% level, and * at 10% level.

In column 1 we include a binary variable for the presence of a Jewish community in the municipality. Interestingly, we find a strong positive relationship between the presence of a Jewish community in the period 1100-1500 and literacy rates in 1900. However, the negative relationship between Muslim rule and literacy remains unaffected. In column 2 we test whether there is an interaction between Muslim rule and the presence of a Jewish community. The coefficient for the interaction term is positive and significant but small and it does not affect the main effect.

In column 3 and 4 we further explore the impact of Jewish communities. In column 3 we control for the length of Jewish presence in the municipality. Consistently with the results in column 1, we find that a longer presence of a Jewish community is positively related to literacy rates. The negative coefficient for Muslim rule remains unaffected. Finally, in column 4 we control for the distance to the nearest Jewish community. In this last case the results point to a very localized effect of the impact of a Jewish community on literacy (i.e. no geographical spillover outside the municipalities where the Jewish communities resided) and, at the same time, the robustness of the negative relationship between length of Muslim rule and literacy rates.

6.4 Muslim Rule, Jurisdiction, and Occupational Structure

In this section, we shed some light on the relationship between Muslim rule, jurisdictions, and occupational structure of the municipalities. On one hand, we show that the impact of the length of Muslim rule on literacy is not mediated by the type of jurisdiction; on the other hand, differences in the occupational structure of the municipalities seem to be broadly consistent with the notion that municipalities which have been long enough under Muslim rule took a different path of development.

To address these issues we make use of the *Censo de Floridablanca*, a population census conducted in 1786-87 which had primarily the purpose of reconstructing the demographic situation of Spain. Beyond demographic information such as age, gender, and marital status, information on the type of jurisdiction for towns and villages included in each municipality was also reported. In particular, we consider five different categories of jurisdiction: *villas*, military order, royal order, church manor or secular manor.[11] We can thus construct for each municipality the share for the different type of jurisdictions. Due to missing information, we are able to link about 6,917 municipalities with information on jurisdiction.

In Table 5 we report estimates of our baseline model augmented with controls for the different jurisdictions. Interestingly, we find that municipalities with a larger share of *villas*, jurisdictions that enjoyed a certain degree of self-government, have significantly higher literacy rates (column 1). This is also true for municipalities with a larger share of units under royal control (column 3), whereas those with a higher number of towns and villages under a military order, clergy, or secular manor have significantly lower levels of literacy (columns 2, 4, and 5). The "negative" results for clergy and secular manors are consistent with evidence reported in Oto-Peralías (2019), which shows that towns granted to nobles after the *Reconquista* are relatively poor today.[12] The finding that municipalities under military order have a lower levels of development is also consistent with results in Oto-Peralias and Romero-Avila (2017). Concerning our main findings, we find that accounting for the jurisdiction of towns and villages does not impact our coefficient for the duration of Muslim rule.

TABLE 5: Accounting for type of municipality

Dep. var.: Literacy rate						
	(1)	(2)	(3)	(4)	(5)	(6)
Duration Muslim rule	-0.027***	-0.027***	-0.027***	-0.027***	-0.028***	-0.026***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.005)
Villa	0.012**					0.014**
	(0.005)					(0.005)
Military order		-0.027***				-0.026***
		(0.006)				(0.006)
Royal			0.007***			0.006***
			(0.001)			(0.002)
Clergy				-0.011***		-0.010***
				(0.003)		(0.003)
Secular					-0.004***	-0.004***
					(0.002)	(0.001)
Geographic controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6917	6917	6917	6917	6917	6917
R-squared	0.92	0.92	0.92	0.92	0.92	0.92

Notes: OLS estimates. Conley standard errors in parenthesis. Geographic controls are: crop suitability, precipitation, average temperature, shortest distance to coast or large river, altitude, ruggedness, and area of the municipality. *** denotes statistical significance at the 1% level, ** at 5% level, and * at 10% level.

The *Censo de Floridablanca* also reports information on the occupation of the inhabitants. Unfortunately, the occupational categories reported in the census are quite broad and not clearly defined.[13] For example, the category of day laborers (*jornaleros*) does not distinguish between

[11] We are very thankful to Eric Chaney for sharing his data.
[12] In fact, Oto-Peralias also uses the data from *Censo de Floridablanca* in his study.
[13] See the online Supplementary material II in Oto-Peralías (2019).

workers employed in agriculture and those in (proto) industry. Similarly, the category of laborers (*labradores*) includes a wide range of occupations from land owners, share-croppers, and rentiers, although all likely related to agriculture. Other categories reported in the census which will be included in our regression analysis are: manufacturers (*fabricantes*), artisans (*artesanos*), merchants (*comerciantes*), and students (*estudiantes*).[14] We therefore construct the share of people employed in the different occupations over the labor force. Following Oto-Peralías (2019), we construct the labor force as the sum of people reporting an occupation.[15] Because of missing data on occupation, the regression sample is reduced to about 6,929 municipalities.

In Table 6 we report the estimates in which we use the share of people employed in different occupations as dependent variable. In the first column we report the results for merchants, which are particularly interesting for our main findings. Consistent with our interpretation that a longer Muslim domination is negatively related with the presence of a strong merchant class, we find that duration of Muslim rule is indeed negatively related to the share of merchants in the municipality in 1787. As for the size of the coefficient, the point estimate implies that an extra century of Muslim rule is associated with 0.1 percentage points lower share of merchants which is equal to 10% of the sample mean reported at the bottom of the table. In the second column, we also find that the duration of Muslim rule is negatively related to the share of students in the municipality, which is directly related to the notion that a longer Muslim domination had a persistent negative impact on human capital.

As for the other occupations, we find that Muslim rule is negatively related to the share of active population employed as daily worker (column 3). As far as this category includes people working in the proto-industrial sector, this result would be consistent with the argument that a longer Muslim domination led to a less urban economy. However, given the broad categorization of this occupation, any interpretation would be highly speculative. The coefficients in the specifications for farmers (column 4) and manufacturers (5) are statistically insignificant. Finally, we find a positive relationship between the duration of Muslim rule and the share of artisans in the municipality (column 6), in line with the lasting influence of Muslim artisans and craftsmanship in post-*Reconquista* Spain.[16]

Even though the results using data from the *Censo de Floridablanca*, especially those on occupation, have to be taken with caution, the estimates suggest that (*i*) differences in the type of jurisdictions do not affect our relationship of interest; (*ii*) municipalities which experienced a longer Muslim domination tend to have a smaller share of merchants and students even three centuries after Muslims left the Iberian peninsula. As we will see more in detail below, the latter result is consistent with our hypothesis that a longer Muslim domination impeded the formation

[14] There are also several occupations related to the church, a category for the nobles (*hidalgos*), servants (*criados*), and professionals such as notaries (*escribanos*) and lawyers (*abogados*).

[15] There are some instances in which it is reported that all individuals (*todos*) or the rest of individuals (*resto*) are agricultural workers (*labradores*) or daily workers (*jornaleros*). In the former case, we impute the labor force by applying the share of labor force over the total population of the villages and towns belonging to the same municipality. In the latter, we impute the total labor force as above and then subtract all the other occupations to recover the number of people employed in the residual category. In addition, since nobles (*Hidalgos*) and servants (*Criados*) are also problematic as they are over-reported, we exclude them from the computation of the labor force.

[16] The results are virtually the same if the control for the log population in 1787 to account for possible agglomeration effects leading to structural differences among municipalities of different sizes.

TABLE 6: Muslim rule and occupations

	(1) Merchants	(2) Students	(3) Daily workers	(4) Farmers	(5) Manufacturers	(6) Artisans
Duration Muslim rule	-0.001**	-0.002**	-0.030***	-0.007	0.000	0.005**
	(0.000)	(0.001)	(0.008)	(0.040)	(0.001)	(0.002)
Geographic controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6929	6929	6929	6929	6929	6929
R-squared	0.06	0.18	0.77	0.08	0.06	0.39
Mean dep. var.	0.01	0.02	0.37	0.56	0.01	0.07

Notes: OLS estimates. Conley standard errors in parenthesis. The dependent variables are shares of the relative occupation on the labor force. The original categories as reported in the census are *comerciantes* (column 1), *estudiantes* (column 2), *jornaleros* (column 3), *labradores* (column 4), *fabricantes* (column 5), *artesanos* (column 6). Geographic controls are: crop suitability, precipitation, average temperature, shortest distance to coast or large river, altitude, ruggedness, and area of the municipality.
*** denotes statistical significance at the 1% level, ** at 5% level, and * at 10% level.

of a strong merchant class, which demanded higher levels of human capital and fostered the establishment of forms of self-government that supported local education.

7 City Level Analysis

In order to shed more light on the mechanism which explains the robust negative relationship between length of Muslim rule and literacy, we exploit both the cross-sectional and panel dimension of the dataset of Bosker et al. (2013). The dataset is based on that of Bairoch (1988) and contains data on population of European cities having more than 10,000 inhabitants in at least one century during the sample period. They augmented the Bairoch dataset collecting new city-specific information such as geographical, institutional, and religious characteristics.

TABLE 7: Muslim rule and human capital — City cross-sectional evidence

Dep. var.:	Literacy rate				
	(1)	(2)	(3)	(4)	(5)
Duration Muslim rule	-0.044***	-0.044***	-0.044***	-0.044***	-0.046***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)
Roman road		0.020	0.030	0.030	0.018
		(0.024)	(0.025)	(0.025)	(0.024)
Crossing roman roads			0.036	0.037	0.032
			(0.029)	(0.029)	(0.026)
Times plundered				-0.006	-0.013
				(0.028)	(0.032)
Population size (1800)					0.001***
					(0.000)
Geographic controls	Yes	Yes	Yes	Yes	Yes
Observations	103	103	103	103	103
R-squared	0.60	0.61	0.61	0.61	0.65

Notes: OLS estimates. Geographic controls are: crop suitability, precipitation, average temperature, shortest distance to coast or large river, altitude, ruggedness, and area of the municipality. *** denotes statistical significance at the 1% level, ** at 5% level, and * at 10% level.

The Spanish portion of the dataset contains a panel of 103 cities observed every 100 years in the period 800-1800. The advantage of using this dataset is that it contains a number of variables

which can help to identify the cultural or institutional channel(s) to explains why municipalities, which underwent Muslim domination for a longer period, have lower levels of literacy rates. Our hypothesis is that the Muslim domination with its institutional framework impeded the development of the merchant class and forms of self-government in the cities, which affected in the long run the economic development and the demand for human capital. In particular, we conjecture that Spanish cities under Muslim rule missed the window of opportunity consisting in the spread of the communal experience occurring in southern and central Europe during the first centuries of the second millennium AD.

Figure 1 shows the location of the cities in the Bosker et al. dataset used in our analysis. It is important to stress that we do not claim that the sample of Spanish cities in Bosker et al. is representative of the whole Spain. Whereas average literacy in the city sample is the same as in the municipality sample, i.e. 36%, average length of Muslim rule in the full municipality sample is 325 years whereas in the city sample is 455 years. This difference is due to the fact that cities in the south of Spain, especially in the Emirate of Granada, are over represented in the Bosker et al. sample. It is therefore possible that in this setting we over estimate the negative impact of the length of Muslim rule.

As a first step, we rely on a cross-sectional setting and assign to each city the corresponding value for the length of Muslim rule and the corresponding literacy rate in 1900.[17] In column 1 of Table 7 we report cross-sectional estimates to test whether we obtain consistent estimates. The unconditional correlation is reassuring: for the sample of 103 cities, an additional century of Muslim rule is associated with 4.4 percentage points lower literacy rates. This is comparable to the 3.5 percentage points estimated for all municipalities in 1900 reported in Table 1. Accounting for being located in the proximity or at a crossing of roman roads does not change the coefficient of interest (columns 2 and 3), as well as adding the number of times the city has been plundered throughout the centuries (column 4), as it would be in principle possible that cities that have been longer under the Muslim domination suffered a comparatively large number of plundering, ultimately affecting their long run economic development. Finally, we control for population level in 1800 (column 5), which positively explains literacy level while leaving unchanged the point estimate and significance of the length of Muslim rule coefficient.

7.1 Merchants and the Printing Press

As argued by Dittmar (2011), the adoption of print media fostered the development of the merchant class. The printing press played an important role in the acquisition of skills valuable to merchants, for example through the print of merchants' manuals with instruction on accounting, commercial arithmethics, bookkeeping and business practices (Dittmar, 2011, p. 1138). Therefore, consistent with the view that Islamic institutions impeded the development of a merchant class and thus the demand for human capital, we test the hypothesis that the length of Muslim rule is negatively correlated with the probability of adopting the printing press in its early phase

[17] For consistency, we use the geographic controls included in the original dataset, namely elevation, ruggedness, soil quality, a dummy for city location at sea and a dummy for city location at a river.

in Spain.[18] To test this hypothesis we combine the Bosker et al. (2013) city dataset with the location of printing presses in Spain in 1500 from Rubin (2015). Out of the 103 large cities in the Bosker et al. dataset, 18 had a printing press by 1500. OLS estimates are presented in Table 8.[19]

TABLE 8: Length of Muslim rule and the adoption of the printing press in 1500

Dep. var.:	Adoption printing press in 1500					
	(1)	(2)	(3)	(4)	(5)	(6)
Duration Muslim rule	-0.037*	-0.047***	-0.034**	-0.033**	-0.036***	-0.039**
	(0.019)	(0.018)	(0.015)	(0.014)	(0.013)	(0.015)
City population		0.011***	0.007**	0.006*	0.007**	0.007**
		(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Church 1500			0.284***	0.256***	0.241***	0.243***
			(0.095)	(0.092)	(0.088)	(0.088)
University in 1500				0.217	0.194	0.191
				(0.150)	(0.156)	(0.158)
Roman road					0.170**	0.177**
					(0.073)	(0.073)
Emirate of Granada						0.072
						(0.095)
Geographic controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	103	103	103	103	103	103
R-squared	0.25	0.36	0.45	0.47	0.51	0.51

Notes: OLS estimates. Geographic controls are: crop suitability, precipitation, average temperature, shortest distance to coast or large river, altitude, ruggedness, and area of the municipality. *** denotes statistical significance at the 1% level, ** at 5% level, and * at 10% level.

In column 1 we show the unconditional relationship between length of Muslim rule and the probability of having a printing press in 1500. The relationship is negative and highly significant. In the successive specifications we progressively add other important determinants of the early adoption of the printing press. As one can see, the coefficient for duration of Muslim rule is always negative, statistically significant, and stable in magnitude. In particular, in column 2 we include population size as control variable. As expected from demand side considerations, a larger population is positively related to the early adoption of the printing press. Consistent with the findings in Rubin (2015), we also find that bishopric and printing presses are highly positively correlated (column 3). The same applies to cities hosting a university, although the positive coefficient is not statistically significant (column 4), possibly because only a tiny fraction of cities had universities in 1500. We find a positive correlation for cities with a higher propensity to trade, or simply to exchange information more easily, proxied by proximity to a roman road (column 5). One could argue that many of the "zeros" in the early adoption of the printing press originate from cities in the former Emirate of Granada which, by 1500, have been under Catholic Spain only for a few years and had therefore less time to adopt a printing press. In column 6 we include a binary variable for cities that have been under the last Emirate of Granada ($n = 13$). As one can see, this latter dummy shows a statistically null coefficient and the coefficient for Muslim rule is almost unaffected, which suggests that the later adoption

[18] This hypothesis is also consistent with the well-known opposition of the Ottoman Empire to the use of the printing press and that the Islamic world became more conservative and close to innovations starting around 1100.

[19] Due to the low number of observations in this sample we do not implement Conley standard errors.

of the printing press in cities with a longer Muslim rule is not driven by the last stronghold of Islamic domination in Spain.[20]

In sum, even if only suggestive, we provide further evidence consistent with the notion that a longer Muslim domination, by impeding the formation of a merchant class and forms of local self-government, might have also retarded the adoption of a new technology such as the printing press in the sixteenth century.

7.2 Panel Setting

Before moving to the formal panel analysis, we show in Figure 3 the evolution over time of some of the key variables we will discuss below, in particular how group means evolve century by century once we bundle together cities that experienced a zero or a positive Muslim domination. The long-run trend of forms of self-government (upper left panel) suggests that never-Muslim cities have a systematically higher probability of having such institutions and Muslim cities never catch up. For what concerns the presence of a Bishop (or Archbishop), after 1200 Muslim and non-Muslim cities have about the same share (upper right panel). On the contrary, the long-run trend for universities suggest that, starting from 1300, Muslim cities have a higher number of universities compared to never-Muslim cities (lower left panel). Finally, in terms of population size, the figure on the lower right panel indicates that cities with positive Muslim domination have always a larger population and never-Muslim cities catch up eventually in 1800.

The city-level dataset of Bosker et al. allows us to exploit the panel dimension, i.e. variation within cities accounting for time-invariant city specific characteristics and time fixed effects. We proceed in two steps. First, we establish whether Muslim presence in Iberian cities in the first half of the second millennium had an effect on some of the variables we consider key. Figure 3 suggests that self-government started to became visible only later on in previously Muslim cities and they never fully caught up. Second, we formally test for persistence, i.e. whether the past experience of Iberian cities in terms of length of Muslim domination has long lasting impact on the likelihood of being a self-governed city, according to our interpretation one of the key drivers of the lag in literacy rates in 1900. Operatively, we start by estimating model 1 below:

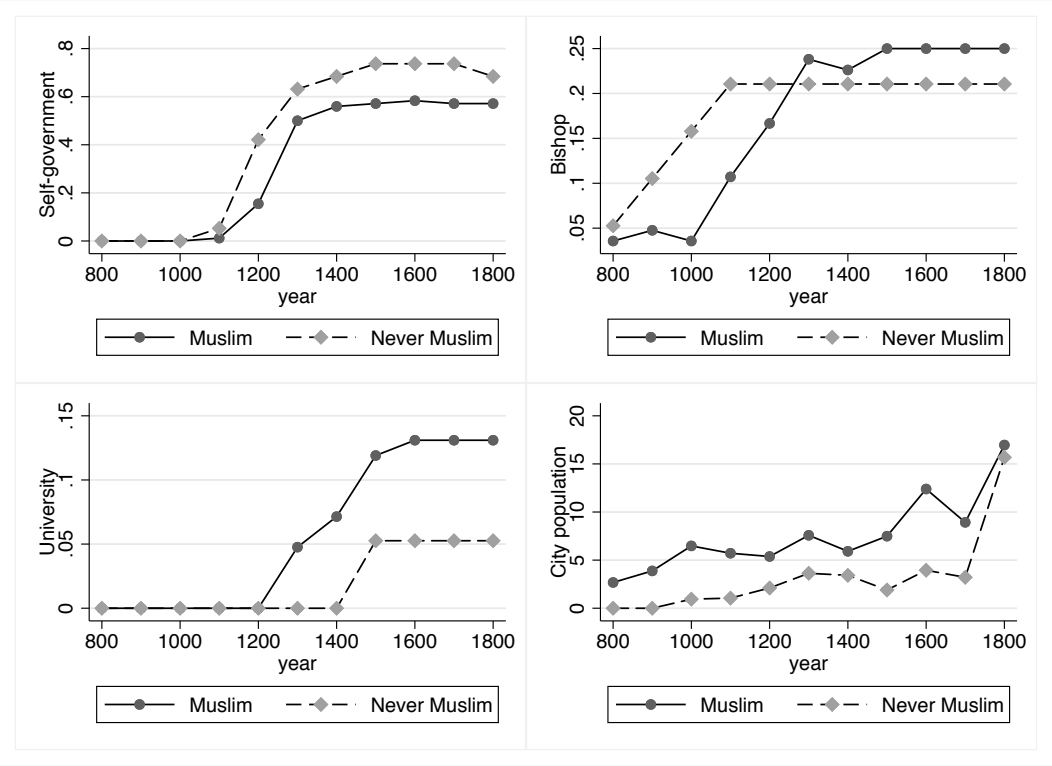
$$y_{it} = \alpha_i + \gamma_t + \beta_{800} \cdot M_{it} + \sum_{\tau=900}^{1400} (\beta_\tau \cdot M_{it} \cdot \mathbb{1}(t = \tau)) + \varepsilon_{it} \tag{1}$$

where y_{it} are our outcome variables, namely a dummy variable for having a form of self-government, for being seat of a bishop/archbishop, for hosting a university, city population; M_{it} is a dummy for being under Muslim rule which varies across cities and over time, $\mathbb{1}(t)$ are indicators for centuries; α_i and γ_t are city and time fixed effects, respectively.[21] Note that such specification allows for a heterogeneous effect of Muslim rule across centuries, captured by the coefficients β_t, where the interpretation of β_{900} to β_{1400} is the standard additive one. It is important to note that the binary variable for being under Muslim rule used in these models

[20] Estimates dropping completely the 13 cities in the former Emirate of Granada provide the same results (available upon request).

[21] Except for the specification with population size as dependent variable, we include in the regression also population-by-year fixed effects to account for differential population growth patterns.

FIGURE 3: Trend of selected outcomes by domination



Notes: The figures depict the evolution of the share of self-governed cities (top left), the share of cities hosting a Bishop (top right), the share of cities hosting a university (bottom left) and city population (bottom right) discriminating between those cities that never fell under the Muslim rules and those that experience some. Data from Bosker et al. (2013).

is already contained in the Bosker et al. (2013) dataset and is, therefore, independent from our measure. It should also be noted that the panel stops at the fifteenth century as, formally, there are no Muslim cities after the fall of the Emirate of Granada in 1492.[22]

The estimates of model 1 are reported in Table 9. The results show a clear pattern only for what concerns having a form of self-government (column 1). In particular, being under Muslim domination in the 13th, 14th, and 15th century decreases dramatically the probability of having a form of self-government. Concerning bishopric/archbishopric (column 2), university (column 3), and population (column 4), we do not find any significant pattern associated with being under Muslim rule, if not population at the very beginning of the period.

The result on self-government is consistent with our hypothesis that Muslim institutions impeded the development of more liberal and democratic forms of self-governments which, in turn, led to lower levels of accumulation of human capital in the long run. Therefore, the panel estimates suggest that cities that stayed longer under Islamic domination missed out on critical junctures of institutional changes which had a long-lasting impact.

The estimates on self-government in column 1 of Table 9 are not surprising since the process of communal self-government and forms of local participative government never took hold in the Islamic world (Bosker et al., 2013). Indeed, in the city sample there is no city under Muslim domination in Spain which ever enjoyed any form of self-government. As stressed above in the

[22]Regarding the notation, the year 1000 refers to the century 1000-1099, the year 1100 to the century 1100-1199 and so on.

TABLE 9: Muslim rule and city characteristics - Panel estimates

Dep. var.:	Self govt	Bishop	University	City pop
	(1)	(2)	(3)	(4)
Muslim	0.126	-0.037	-0.027	-1.260
	(0.100)	(0.094)	(0.031)	(2.357)
Muslim × 900	0.019	-0.013	-0.001	1.504**
	(0.016)	(0.066)	(0.003)	(0.610)
Muslim × 1000	0.034	0.045	0.056	2.808*
	(0.029)	(0.095)	(0.039)	(1.452)
Muslim × 1100	-0.003	-0.133	0.065	2.791
	(0.066)	(0.093)	(0.040)	(2.270)
Muslim × 1200	-0.395***	-0.145	0.099**	1.421
	(0.102)	(0.092)	(0.044)	(2.471)
Muslim × 1300	-0.514***	-0.103	-0.008	11.924
	(0.105)	(0.093)	(0.047)	(9.835)
Muslim × 1400	-0.547***	-0.087	-0.045	10.773
	(0.102)	(0.097)	(0.054)	(6.565)
Year FE	Yes	Yes	Yes	Yes
City FE	Yes	Yes	Yes	Yes
City pop × year FE	Yes	Yes	Yes	No
Observations	1133	1133	1133	1133
R-squared	0.55	0.16	0.16	0.14

Notes: OLS estimates. *** denotes statistical significance at the 1% level, ** at 5% level, and * at 10% level.

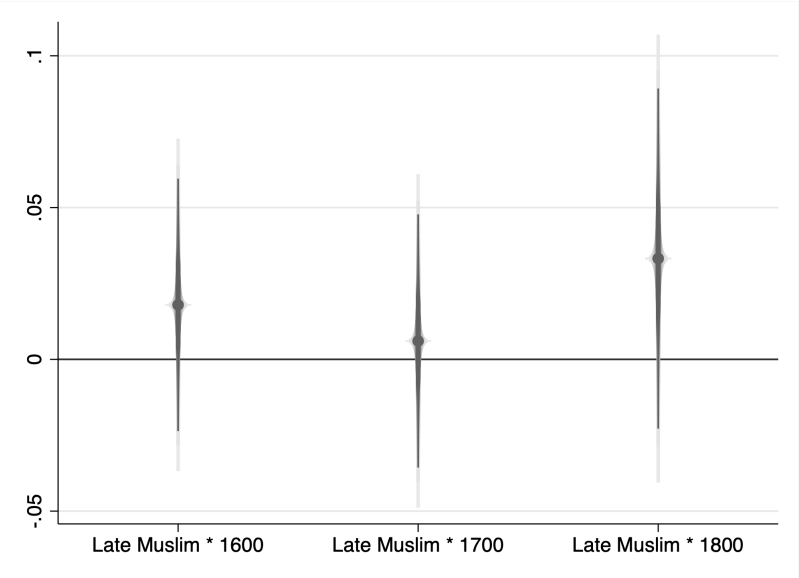
explanation of our two-steps investigation, a more interesting question which helps addressing our main hypothesis, is whether those cities that have been under Islamic domination until 1492 managed to "catch-up", gaining some form of self-government after the Islamic period. In order to address this question we rearrange our data setting up a panel analysis running from 1500 until 1800 and estimate how different lengths of Islamic domination affects the probability of having some form of self-government. In particular we estimate model 2 below:

$$y_{it} = \alpha_i + \gamma_t + \sum_{\tau=1600}^{1800} (\beta_\tau \cdot M_i^H \cdot \mathbb{1}(t = \tau)) + \varepsilon_{it} \tag{2}$$

where y_{it} is a dummy for the status of self-governed city and M_i^H is a dummy for those cities that experienced a long Muslim treatment, i.e. above 5 centuries.[23] The estimated coefficients for the dummies β_{1600}, β_{1700} and β_{1800} are reported in Figure 4. As one can see, the coefficients are *not* different from zero, indicating that cities which remained under Muslim rule until late did not catch up in terms of self-government institutions. Thus, even after the last Islamic stronghold (the Kingdom of Granada) was defeated in 1492, these cities remained persistently less likely to develop any form of participative local government. This result is fully consistent with our reduced-form cross-sectional estimates showing that the length of Muslim rule is strongly and robustly negatively correlated with levels of human capital in 1900.

[23] Note that, also in this case, we use the flow variable Muslim included in the Bosker et al. dataset to construct the variable for long Muslim treatment.

FIGURE 4: Persistence of gap in self-government institution



Note: Estimates of β_{1600}, β_{1700} and β_{1800} with 90% (lighter) and 95% (darker) confidence intervals. Late Muslim is a dummy variable for having being under Muslim rule for at least five centuries.

8 Conclusion

Islamic religion is accused today of being backward in terms of attitudes toward education and openness to innovation. In support of this, it is generally shown that countries with a predominant Muslim population tend to have lower levels of human capital. Some recent studies show that this is not intrinsic to the Islamic religion but it is due to the interpretation of the religious precepts and the attitudes of the religious ruling elites. Considering Spain, however, Muslims are known to have initially enjoyed a comparative advantage in human capital with respect to the conquered Visigoths, turning Muslim Spain into a bridge through which knowledge diffused over to the rest of Europe.

In this paper we exploit variation in the length of Muslim domination across municipalities in medieval Spain to assess how the peculiarities of Muslim rule hampered the adoption of forms of local self-government which later became conducive to the accumulation of human capital. We have digitized unique new data on the length of Muslim rule and literacy rates in 1900 for about 7,500 municipalities in Spain. Reduced-form estimates show an astoundingly robust negative correlation between the length of Muslim rule and literacy rates in the early modern period. We present several robustness checks and tests which can exclude that the different phases of the *Reconquista* and the resulting distribution of landownership are the main mechanisms of our results.

We provide an explanation for the persisting lag in human capital in areas that have been longer under Muslim rule, namely, the impediment to the rise of the merchant class placed by the Islamic institutional complex. The lack of self-governing bodies such as merchant guilds hindered the acquisition of self-governing skills and created a gap in terms of human capital between these lands and the rest of Spain.

Panel estimates for a sub-sample of relatively large cities suggest that, because of the Islamic domination and their institutions, cities missed out critical junctures such as the development of local forms of self-government. We show that this gap persisted until the early modern period, long after the last Islamic stronghold in Granada was defeated in 1492. We argue that the absence of inclusive and democratic local institutions might have hindered the economic development of the cities reducing, in the long run, the demand for human capital.

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