

The Economic Origins of Islam: Theory and Evidence*

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Abstract

This research examines the economic origins of Islam. It empirically demonstrates that Muslim countries, virtual countries and ethnic groups, exhibit highly unequal regional agricultural endowments. This particular type of geography (i) determined the economic aspects of the religious doctrine upon which Islam was formed, and (ii) shaped its subsequent economic performance. The theory argues that the unequal distribution of land endowments conferred differential gains from trade across regions, fostering predatory behavior from the poorly endowed ones. In such an environment it was mutually beneficial to institute a system of income redistribution. However, a higher propensity to save by the rich would exacerbate wealth inequality rendering redistribution unsustainable, leading to the demise of the Islamic unity. Consequently, income inequality had to remain within limits for Islam to persist. This was instituted via restrictions on physical capital accumulation. Such rules rendered the investments on public goods, through religious endowments, increasingly attractive. As a result, capital accumulation remained low and wealth inequality bounded. Geography shaped the set of economically relevant religious principles of Islam affecting its economic trajectory in the preindustrial world.

Keywords: Religion, Islam, Geography, Physical Capital, Human Capital, Land Inequality, Wealth Inequality, Trade.

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1 Introduction

Religion is widely viewed in the realm of social sciences as instrumental for the understanding of socioeconomic processes. Despite its salience, the economic origins of religious doctrines have not been identified, limiting our understanding of the phenomenon and its implications for comparative economic development.

This study sheds light on the geographical origins of Islam. We demonstrate empirically that Muslim countries, virtual countries and ethnic groups, systematically exhibit large inequality in the regional suitability for agriculture. We argue that this particular type of geography determined the economic principles of the Islamic religious doctrine, shaping its subsequent economic performance. In particular, an unequal distribution of agricultural potential conferred differential gains from trade across regions, fostering predatory behavior from the poorly endowed ones. This environment of conflicting interests brought about by an unequal geography, forged Islamic institutions such as *income redistribution*, *rules limiting capital accumulation* and *incentives for religious endowments*.¹

We do not impose these economic rules but allow them to be chosen by the constituents across regions and show how the underlying geography determines the endogenous formation of institutions. Specifically, we demonstrate that in economies characterized by low inequality of land endowments, that is when most regions are productive enough to overcome trade costs, such policies may not rise or persist along the process of development. This occurs because poorly endowed regions are not numerous enough to pose a significant threat to those trading. In this case, trade gains are directed towards accumulating the asset with the highest returns, which in the preindustrial world is physical capital.

On the other hand, it is under increased inequality in land endowments that Islamic institutions arise. Few fertile areas exposed to many poor ones are willing to make concessions. This may manifest itself in the form of income redistribution. However, as the rich have a higher propensity to save and leave capital bequests, income inequality will exacerbate, diminishing the poor's relative standing over time, eventually making redistribution unsustainable. To prevent bequests from exclusively benefiting the heirs of the rich, restrictions on physical capital accumulation may be implemented. By distorting the relative returns to the factors of production, investments in labor productivity through religious endowments become viable. This depicts the case for Islamic lands where an initially high income inequality remained bounded at the cost of a Muslim world ill-equipped to venture into the capital intensive era of

¹Section 2 discusses in detail the role of trade in the formation and expansion of Islam as well as the Islamic economic principles this paper focuses upon, i.e. income redistribution, rules limiting physical capital accumulation and the economic significance of religious endowments, waqfs.

large scale shipping trade and industrialization.

The link between the structure of production and institutional formation was early identified by Marx (1833 [1970]). According to Marx (1833 [1970]), religion is like any other social institutions in that it is dependent upon the economic realities of a given society, i.e. it is an outcome of its productive forces. Similarly, this study argues that since Islam emerged when land dictated productive decisions, the institutional arrangement offered by Islam had to be compatible with the conflicting interests of groups residing along regions characterized by a highly unequal distribution of agricultural potential.

We test the theory's predictions empirically employing new data on land's agricultural suitability at a resolution of 0.5 degrees latitude by 0.5 degrees longitude. In a stage of development when land determines productive capabilities, regional agricultural suitability plays a fundamental role in shaping the potential of a region to engage and profit from trade. Thus, differences in land fertility would arguably map into differential gains from trade across regions. Such disaggregated level data allows for the econometric analysis to be conducted at various levels of aggregation, i.e. across countries, virtual countries and ethnic groups. Specifically, to mitigate the problem of endogenous borders, inherent to the literature on cross-country regressions, we arbitrarily divide the world into geographical entities of a fixed size, called virtual countries. Consistent with the hypothesis that Islamic principles provided an attractive social contract for populations residing across productively unequal regions, we find that Muslim adherence is larger when the share of regions with poor agricultural potential as well as the variance of regional land fertility increase.

Furthermore, taking advantage of information on the traditional locations of ethnicities, we focus on the determinants of Muslim representation across ethnic groups. The results demonstrate that Islam spread successfully among groups historically located in agriculturally poor homelands featuring few relatively fertile regions. It was along these places that the Islamic institutional arrangement would be appealing to the indigenous populations. The results obtain (i) after controlling for country and continental fixed effects (ii) are significant only in explaining Muslim adherence and (iii) obtain for virtual countries and ethnic groups that have not been dominated by any Muslim empire historically, highlighting the geographical origins of Islam.

Related Literature

Religion has been viewed as being both a cause and an outcome of economic development with Weber (1905 [1930]) pioneering the independent role of Protestant ethics in fostering eco-

conomic progress.² In the last decade, the cross-country growth literature has seen an increased interest on the relationship between religion and politico-economic performance. For example, Barro and McCleary (2006a) and Barro and McCleary (2006b) provide an overview regarding the interaction of religion with political economy and show that religious beliefs affect economic growth whereas overall religiosity declines with economic development. Nevertheless, the evidence regarding the impact of Islam on economic and political indicators is at best controversial. Some studies identify a negative effect, see Porta et al. (1997) and Barro and McCleary (2003), whereas others conclude that the effect is positive or insignificant, see Pryor (2007) and Martin et al. (2004).³ The current study contributes to this literature by showing that Muslim adherence is driven by the distribution of agricultural potential across regions, thus, (non) findings relating Islam to economic and political outcomes have to be carefully interpreted.

The results of this research are also directly related to the literature on economic development and institutions. Studies by Engerman and Sokoloff (1997), Acemoglu et al. (2001), Acemoglu et al. (2002), and Engerman and Sokoloff (2002) among others have highlighted the role of geography in shaping the type of institutions (extractive versus growth promoting) that colonizers established during the process of the colonization. Our approach complements this literature by empirically demonstrating that the Muslim world follows a consistent geographic pattern. Islamic principles were devised as a means of governing the divergent interests of highly unequal regions in the beginning of 7th century Arabia. Islam, consequently, expanded and eventually persisted across ethnic groups and territories featuring similarly unequal land endowments. This is a prime example of geography dictating the diffusion and persistence of a set of rules. Another line of research to which the findings are relevant, is a study by Galor and Moav (2004). The authors argue that income inequality in the early stages of development is growth promoting since it leads to wealth being channeled towards those with higher propensity to save, fueling the accumulation of physical capital. In the context of the proposed theory, Islamic economic doctrine in pursuit of keeping an already unequal income distribution within bounds, engineered principles that channeled preindustrial wealth towards public good

²Becker and Woessmann (2009) show in a recent study, however, that the significant association between Protestantism and economic prosperity across counties in late 19th-century Prussia may be attributed to differences in the literacy between protestant and non protestant regions. Along the same lines, Botticini and Eckstein (2005) and Botticini and Eckstein (2007) document how an exogenous change in the Judaic religious doctrine in the 2nd century AD transformed the Jewish human capital towards literacy providing them with a comparative advantage in urban, skilled occupations several centuries later. On the role of the economic environment in affecting religious rules, Cervellati et al. (2008) provide a theory where differences in the religious norms regarding charity versus self-responsibility, i.e. Catholicism versus Protestantism, depend on the relative importance of luck versus effort when individuals invest in human capital and face non-insurable idiosyncratic income shocks.

³Platteau (2009) and Platteau (2008) provides a detailed account of the relationship between religion and politics in Islam arguing that whereas religion is subordinate to politics, it is when the state falls into crisis when both the ruler and his political opponents try to outbid each other by using the religious idiom.

investments in the form of religious endowments.⁴

The rest of the paper is organized as follows. Section 2 describes the role of trade in the formation and expansion of Islam and discusses the elements of its economic doctrine. Section 3 presents the theory. Section 4 discusses the data used and presents the empirical analysis. Finally, section 5 summarizes the key findings and concludes.

2 Islamic Economic Doctrine and Trade

The theory provided rests upon two fundamental building blocks: (i) trade interests were a major driving force in the formation and expansion of Islam, (ii) inequality was a primal feature of pre-Islamic Arabia and the economic principles of Islam had to directly address it. Such conditions necessitated the rise of a religious doctrine focusing on income redistribution, explicit limits on physical capital accumulation and the importance of public good provision through religious endowments.

Arabia has a distinct geography with few places in Yemen, Bahrain, Central Arabia and several scattered oasis in the interior producing agricultural goods, such as frankincense, myrrh, vine, dyes and spices in the eve of Islam. The rest of the peninsula features deserts and semi-arid regions where nomadic life-style was the norm, see Ibrahim (1990). According to Lewis (1993), the series of wars between the Persian and Byzantine empires starting in 503 *AD* had profound effects on the Arabian peninsula. The Perso-Byzantine conflict and the ensuing military and political disorganization made the trade routes between the two empires difficult to use. As a result, trade routes crossing the Arabian peninsula acquired a new commercial importance with Mecca, in particular, benefiting from its location along the route connecting Europe to Yemen. These new trade opportunities coupled with an unequal geography resulted in increased regional feuding, see Grunebaum (1970).⁵ Ibrahim (1990) succinctly summarizes the economic conditions prevailing in the eve of Islam: "An unequal distribution of wealth and resources already existed in and around Mecca. This unequal distribution had the potential to

⁴Galor et al. (2008) show that inequality in the distribution of land *ownership* adversely affected the emergence of human capital promoting institutions during industrialization. This is unlike the case of Islam where the threat posed by those regions unable to directly benefit from trade, brought forward labor productivity enhancing investments through religious endowments.

⁵Increased trade gains coupled with unsafe trade routes prompted early attempts to mitigate conflict in pre-Islamic Arabia. For example, in search for security the Meccan merchants offered the arrangement of *ilaf* according to which they would carry with them commodities produced by other tribes to be sold in markets and fairs. In exchange, these tribes would provide security and protection (*khafara*) for Meccan caravans passing through their territories. Also, within Mecca rich merchants were engaging in alms provision to alleviate poverty. Such attempts coupled with the formation of tribal alliances partially decreased tensions, nevertheless these measures were short-leaved since many tribes were not bound by the institution of *Ilaf* and alliances were constantly switching.

disrupt its network of alliances and trade routes".⁶

It was in this environment Muhammad was born in 570 *AD*. The importance of trade in the formation of Islamic principles can be hardly underestimated. Muhammad himself was a Meccan merchant and the crystallization of the Muslim law after the death of the Prophet was the work of various theologians, judges, commentators and readers of the Qur'an and "traditionists" who relayed traditions (hadith) about the Prophet's life. Cohen (1970) surveys the biography of these people regarding their economic background during the formative year of Islam till end of the 11th century, and shows that the majority, i.e. over 70%, were merchants and craftsmen. Also, Ibrahim (1990) argues that merchant interests were evident in the treaties signed with the cities that were conquered during the Arab expansion, with clauses explicitly demanding the setting up of new markets for Muslims.⁷

Poverty alleviation and redistribution feature prominently among the Islamic principles. In Islam, acts of charity are voluntary (sadaqa) and obligatory (zakat). Zakat is a religious obligation and is part of the Five Pillars of Islam.⁸ The Qur'an requires a believer of sufficient economic means to give a fixed fraction of her accumulated income for alms. Zakat is allocated among the needy, the poor, those in debt, travelers, the zakat collector and for slaves or captives.

During the early history of Islam, zakat was collected and distributed by the government appointed officials, in a centralized manner and it was effective in alleviating poverty. Over time however, its centralized collection was less frequently enforced and adherence to it was left to at the local authorities, see Kuran (2008b). Interestingly, Kuran (2001) notes that the third Caliph Uthman turned the obligation to pay zakat essentially into a tax on agricultural output. Jalili (2006) recognizes that although the tax systems differ considerably among the Shiite and the four Sunni Schools (Malekite, Shafeite, Hanafite and Hanbalite) they share common key objectives with respect to alleviating poverty and improving income distribution.

An additional dimension along which Islamic doctrine features a host of detailed principles is relative to the limits imposed on the accumulation of capital and wealth in general.

⁶Interestingly, Aswad (1963) notes that Muhammad's message was first accepted in Medina as a result of Medina's oasis cultivators facing increased conflict from nomads in the periphery.

⁷Others have linked the success of Islamic expansion to its platform of state formation. For example, Crone (1987) highlights that Islam was only offering a programme of Arab state formation and conquest. This point of view, however, does not take into account that even if conquest was the primary reason, in order to unite conflicting local interests as those among tribes in pre-Islamic Arabia, a set of rules aligning such opposing interests had to emerge. Indeed, several scholars, see Aswad (1963), Khazanov (1993), Watt (1953), Donner (1981), have pointed to the leverage of Islam in integrating rival kinship-based groups to a higher authority. This was implemented through the creation of the Ummah, i.e. the Muslim community, providing the necessary means to incorporate the Bedouins into a supratribal unity. Hodgson and Burke (1993) stresses that the interests of merchants who wanted to gain access to the widest possible network of trade routes coupled with the casteless and egalitarian message of Islam contributed to its massive expansion.

⁸For a discussion on how the doctrines of salvation and damnation provide different incentives for performing economic activities and charitable deeds in Hinduism, Buddhism, Christianity, and Islam, see McCleary (2007).

The role of inheritance laws, anti-usury laws and the prohibition on the rise of the corporation are three characteristic examples. Regarding the inheritance laws, see Kuran (2008a), Qur'an specifies that two-thirds of one's wealth be allocated to various family members, including very distant relatives making it a rather egalitarian distribution system.⁹

Islamic law by recognizing only natural persons blocked the emergence of more complex organizational forms restricting the mobilization and pooling of resources. In a recent paper, Harris (2009) studies the evolution of two economic institutions that organized early-modern Eurasian trade, that of the corporation and the commenda and concludes that whereas the latter originated in Arabia and was adopted later in Western Europe and Asia, the corporation ended up as a uniquely European institution that was only imported in the Muslim world in the 19th century.¹⁰ As a consequence, pre-industrial enterprises in the Muslim world remained relatively small and short-lived. Kuran (2006) and Harris (2009) argue that among the reasons that disfavored the introduction of larger and more formal organizational entities was the community vision of early Islam that made early scholars reluctant to entertain concepts prone to facilitate factionalism.

Islamic law did not only impose limits on the evolution of equity investment contracts. Perhaps, the most widely known Muslim economic doctrine is the prohibition against *riba*, which most Muslim scholars have interpreted as "interest". *Riba* in the pre-Islamic days was a system whereby the principle kept redoubling every time a borrower could not pay it back. Such arrangement would frequently lead to imprisonment or enslavement of the borrower. As a result of the *riba*-ordinance of the Qur'an, Islam was formally committed to the eradication of interest in loan contracts. Kuran (2004b) argues that in practice, money lending continued, however uncertainty about the legitimacy of interest, combined with the lack of corporate law, imposed significant transactions costs on both lenders as well as borrowers.¹¹

⁹Interestingly, equitable inheritance laws coupled with the fact that more wealthy individuals were allowed to have more wives and consequently children, was an additional force against the concentration of wealth and the increase in inequality. For a thorough discussion on the economics principles of Islam see Kuran (2004a). Also Kuran (2003) argues that a by-product of such inheritance laws was an increase in the costs of dissolving a business partnership following a partner's death rendering business enterprises small, simple, and generally ephemeral.

¹⁰According to Harris (2009) the basic commenda was a bilateral contract, involving only two parties, an investing party and a traveling party. It was an equity investment contract, specifying investments and payoffs and it is a predecessor of the limited partnership. Corporation on the other hand, is an association of individuals that has a legal entity distinct from those of its members, with the capacity to own property separately and contract with third parties in its corporate capacity. It raised capital for the purpose of conducting business. Entry and exit to membership in the corporation could be voluntarily and based on a payment. At the turn of the 17th century, the joint-stock corporation became the major institution used for organizing European trade with Asia.

¹¹There was substantial controversy among early Muslims regarding the scope of this prohibition or even on the definition of "interest", see Rahman (1964) for a detailed discussion. Nevertheless, in the Islamic lands, Christians and Jews who were not subject to similar restrictions, systematically engaged in money lending.

In the context of the proposed theory, such restrictions on interest bearing loans as well as on the formation of more efficient organizational forms, distorted the relative returns to the factors of production against capital accumulation and in favor of labor productivity investments. In fact, the Qur'an declares that the opposite of *riba* is *sadaqah* which is spending to the benefit of people, that is, investing in assets enhancing the welfare of the community, see Rahman (1964). In Islam the institution that emerged to allow for investing in such public functions was the *waqf*, i.e. an inalienable endowment created by a person who granted land or other immovable property in perpetuity for the advancement of a charitable or pious purpose, see Kuran (2001) for a comprehensive account of the *waqf* system.¹²

The purpose of the *waqf* was served by the property itself or by the income generated via utilization of the property. The common interpretation in the Hanafi School of Islamic law was that the property was not owned by anyone as long as it remained *waqf* property. *Waqf* is voluntary and unlike *zakat* that catered to the immediate needs of the poor, *waqfs* by providing public goods were enhancing the population's productive capacity. This was done by providing education, health care and public utilities. Shatzmiller (2001) stresses that "What conferred a unique historical significance on the *public waqf*, was the fact that for hundreds of years it provided the only regular financial support for the *medresa*, a provider of higher education." Other examples of *waqfs* include mosques, free accommodations for the poor and/or traders, building and maintenance of water conduits and other public services that would benefit the community.

The earliest *waqfs* appear in the first decades of Islam. By the 18th and 19th century aggregate estimates on land *waqfs* reveal their enormous economic standing. In Turkey three quarters of the country's arable land, half of the agricultural land in Algeria, one third in Tunisia and sizeable fractions in many other Muslim countries were under *waqf*. Although similar estimates for assets other than land are not available, it is known that the *waqf* system controlled a vast array of urban assets.¹³

We do not argue that the economic principles discussed above are unique to the Islamic religion. Indeed, similar principles of redistribution, limits on capital accumulation and donations to religious endowments may be found in other religions like Judaism and Christianity, at certain points in history, but in the course of time they became less focal. We do argue, though, that these principles arose and persisted in Islam because of a geography characterized

¹²There are two types of *waqfs* the purely public ones and the family *waqf*. The key difference being that unlike the public one whose services would be purely serving the community, in case of the family *waqf* a fraction of wealth generated by the endowment would be directed to the family members of the donor or the donor himself.

¹³According to Kuran (2001), the Islamic *waqf* emerged as a result of volatile property rights, where religious endowments provided a credible commitment device to give property owners economic security in return for social services and lower taxation. Also, by allowing the *waqf* donor to designate the manager of the *waqf* granted him a way to circumvent the strict inheritance laws.

by high inequality in agricultural suitability which shaped the economic aspects of the Islamic religious doctrine. Interestingly, Christianity emerged in current day Israel and Palestine which feature a prominently unequal distribution of land endowments. These common geographical origins may explain the similarities in the doctrine between Christianity and Islam. However, the fact that Christianity eventually persisted in regions with a radically different geography, i.e. Western Europe and the Mediterranean, this arguably influenced its economic predicaments. For example, although Christianity did enforce rigorously the prohibition on interest primarily on consumption loans, over time and particularly with the Protestant Reformation attitudes towards usury were relaxed, see Lewison (1999).¹⁴ Also, perhaps more importantly, in Christianity inheritance laws were preserving inequality allowing such laws as that of primogeniture, see Bertocchi (2006), and there were no restrictions on the formation of the corporation effectively facilitating the mobilization of resources and the accumulation of physical capital.

Having discussed the role of trade and geography in the emergence and spread of Islam as well as the economic principles that characterize the Islamic religious doctrine we now turn in the proper exposition of the model.

3 The Model

Consider an overlapping-generations economy in which economic activity extends over infinite discrete time. In every period, each region produces a single homogeneous good. The good is produced using land quality which is a technology parameter, effective labor and physical capital. Regional output grows over time due to the accumulation of effective labor and physical capital, while land quality is exogenous and fixed. The stock of physical capital in every period is the output produced in the preceding period net of consumption and investment in labor productivity.

In every period t a unit mass of individuals live in regions characterized by different land qualities T_r , where $r = \{P, R\}$ refers to poor and rich land quality. There is a one to one mapping between regions and individuals, so regional and per capita quantities coincide.¹⁵ Without loss of generality we set $T_R = 1$ so relative land quality equals $v_0 = \frac{T_R}{T_P} = \frac{1}{T_P} > 1$. The fractions of low quality and high quality regions are λ and $(1 - \lambda)$, respectively. Each individual has one child and migration across regions is not allowed, so regional population is stationary.¹⁶ We consider all the individuals living in the low (high) quality areas as the

¹⁴Regarding the effect of the Ottoman Empire on the Reformation within Europe see Iyigun (2008).

¹⁵Allowing for endogenous fertility would not change the predictions of the model. In a Malthusian environment where higher incomes translate into higher fertility, regions with better land quality would be more densely populated. In this case, the differential regional participation in trade would arise from more populated areas being able to share the fixed costs of trade among a larger group of people.

¹⁶The predictions of the theory would remain intact if we were to allow for labor mobility and property rights

representative poor (rich) agent of mass λ and $(1 - \lambda)$ respectively.

The agents may decide to sell their regional output at a foreign market if profitable. Such trade involves the transfer of goods abroad to take advantage of higher prices $p \geq 1$, while incurring a cost $\mu < 1/2$, as a fixed amount of goods lost during transportation.¹⁷ If an agent does not find it profitable to trade, he may challenge those who engage in trade. In this case she incurs a cost equal to $\theta < 1/2$, where θ is the fraction of goods the raider loses in the end of the raid. Hence, merchants face a risk of losing a fraction of their goods in an organized ambush. We refer to such confrontation between raiders and traders as conflict hereafter, whose outcome is determined by the size and the relative wealth of each side.

3.1 Production of Final Output

Production in each region displays constant-returns-to-scale with respect to the reproducible factors of production. The output produced at time t in region r , is $y_{r,t}$:

$$y_{r,t} = T_r \{[(1 - \alpha)h_{r,t}]^\rho + (\alpha k_{r,t})^\rho\}^{\frac{1}{\rho}}; \alpha \in (0, 1), \rho \in (0, 1], r = \{P, R\}.$$

where T_r is land quality in region r , $h_{r,t}$ and $k_{r,t}$ represent the regional effective labor and the amount of physical capital employed at period t in region r . Note that given the one to one mapping between individuals and regions, regional and per capita quantities coincide.

To simplify things we focus on the case of $\rho = 1$. Marginal product of effective labor and capital are equal to the wage rate per unit of effective labor w_r and the rate of return to capital R_r respectively. With perfect substitutability implied by $\rho = 1$, the producers' inverse demand for factors of production is:

$$\begin{aligned} w_r &= (1 - \alpha)T_r \\ R_r &= \alpha T_r \end{aligned} \tag{1}$$

that is constant over time in each region r . We assume that capital depreciates fully every period and that

$$\alpha > \frac{1}{2}, \tag{C1}$$

implying that capital is relatively more productive than labor.

3.2 Individuals' Wealth and Preferences

Each individual lives two periods. An adult at time t is an individual of generation t . In the first period, agents are economically idle. In the second period, they supply inelastically over land. Doing so, wage income would be equalized across regions but land rents would remain systematically larger in the high quality regions preserving the qualitative forces governing the evolution of the economy.

¹⁷Labib (1969) stresses that the prosperity of Islam mainly depended on trading its agricultural and handicraft production.

their effective labor $h_{r,t}$ in region r where they are born, earning the prevailing wage rate w_r . Moreover, they may receive physical capital bequests, $s_{r,t-1}$, from their parents, generating an income that is the return rate on capital R_r times the amount of physical capital left. Each agent's gross income is therefore

$$I_{r,t}^G = w_r h_{r,t} + R_r s_{r,t-1}, \quad (2)$$

which can be consumed locally or traded abroad. Moreover, the rich can transfer a part of their gross income to the poor in order to avoid the risk of being raided.

An individual's preferences are defined over consumption in the second period of his life, $c_{r,t}$, and potential gross income of his offspring, $I_{r,t+1}^G$.¹⁸ We assume that people consume up to a satiation level \tilde{c} , after which, they maximize utility on the basis of the gross income of their heirs. Consider a utility function $U(c_t; I_{t+1}^G)$ defined as

$$U(c_t; I_{t+1}^G) = c_t + \beta I_{t+1}^G \quad (3)$$

together with the constraint $c_t \leq \tilde{c}$, where $\beta < 1$. As it will become apparent this utility function is adopted to capture the spirit of Kaldorian-Keynesian saving behavior i.e., bequests and savings are an increasing function of wealth.¹⁹

3.3 Optimal Consumption and Transfers

In this section we look at the optimization problem of rich and poor agents given their net income.²⁰ Agents may trade in each period t once local production has taken place and gross income $I_{r,t}^G$ is realized. The amount of goods available for trade by each agent is simply his gross income $I_{r,t}^G$ minus the fixed trade cost μ . Throughout the analysis agriculturally poor regions are unable to directly engage in trade, i.e.

$$I_{P,t}^G < \mu < \tilde{c}, \forall t \quad (C2)$$

Also, in order for trade opportunities to act as a trigger in generating divergent income paths across regions, it is also assumed that in absence of trade no individuals leaves bequests, i.e.

$$1 - \alpha < \tilde{c}. \quad (C3)$$

¹⁸Alternatively, parents may care about the *net* income of their children. As it will become evident this would make adults anticipate and derive utility from the expected level of inequality. Allowing for such behavior would not alter the qualitative results.

¹⁹Allowing for a more standard utility function, like $U_{r,t} = \beta \ln c_{r,t} + (1-\beta) \ln I_{r,t+1}^G$, would deliver qualitatively similar results. However, in this case the adult's income threshold of investing in children's income (either through savings or effective labor enhancing investments) becomes endogenous to the anticipated factor returns, making the analysis more cumbersome without adding further insights. More generally, the predictions would go through as long as there are non-convexities in either the production side or in the utility function producing an economic environment where inequality increases over time.

²⁰See section 3.4 on how gross income $I_{R,t}^G$ evolves into net income $I_{R,t}^N$ through the process of trade and conflict.

It follows that without trade and under (C3) regional incomes remain constant.

3.3.1 Physical and Human Capital Bequests

Effective labor may accumulate over time through investments, $e_{r,t}$, in public goods that enhance labor productivity, i.e. waqfs. Unlike capital bequests that are individual specific, public goods by nature provide benefits across all regions of the economy. The following law of motion describes how effective labor evolves over time:

$$h_{t+1} = 1 + \gamma[(1 - \lambda) e_{R,t} + \lambda e_{P,t}], \quad (4)$$

Each individual is endowed with one unit of labor in absence of any waqf investment and $0 < \gamma < 1$ captures the marginal benefit of waqf. Note that when poor do not invest in waqfs, $e_{P,t} = 0$, then λ may be interpreted as the dilution effect, that is public goods' benefits being diluted among a larger set of regions that do not invest.

It follows from (3) that an adult allocates her net income towards own consumption up to the level of \tilde{c} , and devotes her remaining income to maximize the potential gross income of her child in (2). In deciding how to best finance a child's gross income, an adult anticipates future wage rates and capital returns and optimally splits bequests between physical capital $s_{r,t}$ and a waqf investment, $e_{r,t}$. Investment in physical capital delivers a marginal benefit equal to R_r whereas from (4) the marginal benefit of investing in waqf is $\gamma(1 - \lambda) w_R$ for a rich individual and $\gamma\lambda w_P$ for a poor one. If net income is $I_{r,t}^N \leq \tilde{c}$, it is entirely spent on consumption, while if $I_{r,t}^N > \tilde{c}$, utility (3) is maximized subject to budget constraint:

$$s_{r,t} + e_{r,t} \leq I_{r,t}^N - \tilde{c}, \quad (5)$$

where $I_{r,t}^N - \tilde{c}$ is net income after consumption.

In the following section we characterize the optimal behavior of agents in the rich regions, depending on the constraints on capital accumulation (the behavior of the poor follows a similar pattern).

3.3.2 Anti-Riba Regulation and Investment in Public Waqf

Kuran (2008) argues that anti-riba laws for the Muslims were equivalent to increasing transactions costs which coupled with the absence of the corporation in the Islamic law limited the return on physical capital for Muslim adherents.²¹ Consequently, the net return on capital

²¹The lower return on capital investment implied by the anti-riba law may be theoretically rationalized as follows: Since a debt-contract with fixed interest rate is not possible, an agent who lends his money to generate physical capital in presence of moral hazard and adverse selection, he must monitor each investment he is financing. Such costs decrease the net return from investing in physical capital. Hence, as monitoring costs increase the agents may find it optimal to switch from investing into physical capital into labor enhancing investments.

investments becomes, R_r^N where $R_r^N = \delta R_r$, with $\delta \in [0, 1]$, captures the distortion in the marginal product of physical capital induced by the restrictions on contracts involving capital investments. The comparison between the two forms of investment boils down to evaluating the returns from capital savings and public good investments, i.e. $\delta R_R \leq w_R \gamma (1 - \lambda)$.

Returns to factors of production are independent of the quantity of factors employed. So, individuals from fertile regions prefer savings over public waqf as long as:²²

$$\delta > \frac{1 - \alpha}{\alpha} \gamma (1 - \lambda) \equiv \delta_R$$

This is trivially true for $\delta = 1$ since $\frac{1 - \alpha}{\alpha} \gamma (1 - \lambda) < 1$ holds given (C1) and $\gamma < 1$. Consistent with the historical evidence, we assume that limits on capital accumulation render investments in labor productivity more attractive i.e.:

$$\delta < \delta_R < 1. \quad (6)$$

Below we study the bequest behavior of parents as a function of the riba regime in which they live, i.e. with or without restrictions on capital investments.

When riba is allowed (i.e. $\delta = 1$), rich only bequeath physical capital when bequests are positive:

$$s_{R,t}^*(I_{R,t}^N) = \begin{cases} 0 & \text{if } I_{R,t}^N < \tilde{c} \\ I_{R,t}^N - \tilde{c} & \text{if } I_{R,t}^N > \tilde{c} \end{cases}. \quad (7)$$

When riba is not allowed, i.e. (6) holds, the rich invest in public goods. In this case optimal investment in these effective labor enhancing projects becomes:

$$e_{R,t}^*(I_{r,t}^N) = \begin{cases} 0 & \text{if } I_{R,t}^N < \tilde{c} \\ I_{R,t}^N - \tilde{c} & \text{if } I_{R,t}^N > \tilde{c} \end{cases}. \quad (8)$$

Note that because of (4) the poor benefit from the waqf investment made by the rich and vice versa.

3.4 Trade, Conflict, and Redistribution

In absence of bequests, foreign prices p and the level of land quality determine the ability to engage in trade. Generally, a region trades if and only if $I_{r,t}^G < p(I_{r,t}^G - \mu) \iff I_{r,t}^G > \frac{p\mu}{p-1}$ when there is no risk of conflict. In this section, we discuss the initial stage of the model at $t = 0$. Gross incomes of the rich and the poor are therefore simply $I_{R,0}^G = (1 - \alpha)$ and $I_{P,0}^G = \frac{(1 - \alpha)}{v_0}$ respectively.

²²One can show that under increasing returns in the production of labor productivity, an initial investment in waqf due to the anti-riba law persists once productivity reaches a certain level, even if the anti-riba law is later abolished.

3.4.1 Trade and the Threat of a Raid

When trade becomes a viable option only fertile regions may participate. Poor regions because of (C2) cannot overcome the fixed traded cost, μ . Nevertheless, they may raid the caravans of the rich and obtain part of the goods. The outcome of the confrontation depends on the fighting strength of each side, determined by a retention function $f_r(\lambda, v_t) \in [0, 1] \times [1, \infty)$ whose arguments are: $v_t \equiv I_{R,t}^G/I_{P,t}^G$ and the fraction of poorly endowed regions λ . Note that $I_{R,t}^G/I_{P,t}^G$ is a measure of regional income inequality, which starts at v_0 in the beginning and evolves over time as regional incomes change. Thus, the fighting strength of each side in period 0 is purely determined by geographical conditions. The function $f_r(\lambda, v_t)$ is continuous and differentiable. Without loss of generality we focus on the retention rate of the rich regions, i.e. $f_R(\lambda, v_t) = 1 - f_P(\lambda, v_t)$ which is bounded between zero and one. The properties of $f_R(\lambda, v_t)$ are

$$-\frac{\partial f_R(\lambda, v_t)}{\partial \lambda} > \frac{\gamma}{1 - \gamma} \quad (9)$$

and

$$\frac{\partial f_R(\lambda, v_t)}{\partial v_t} > \frac{(1 - \alpha)(1 - \theta)}{v_0(1 - \alpha - \mu)} \quad (10)$$

so that an increase (decrease) in the share of poor regions (income inequality) sufficiently decreases (increases) the strength of the rich.

We model the trade and raid process as a two stage sequential game where the rich evaluate the profitability of trade conditional on the decision of the poor whether to raid. It follows from (3), (7), and (8) that utility is increasing in net income. So, the rich representative agent would trade if his post-conflict net income $I_{R,t}^{N(c)}$ exceeds his income with no trade $I_{R,t}^G$:

$$I_{R,t}^G < I_{R,t}^{N(c)} \equiv p(I_{R,t}^G - \mu)f_R(\lambda, v_t),$$

which in period 0 can be rewritten as

$$f_R(\lambda, v_0) - \frac{1 - \alpha}{p(1 - \alpha - \mu)} > 0. \quad (11)$$

The inequality shows that trade is more likely to occur as the ability of the rich to retain goods during a raid increases (larger $f_R(\lambda, v_0)$), and gains from trade are meaningful (a higher gross income $1 - \alpha$, higher prices p , or lower trade costs μ). Consistent with the importance of trade in the origins of Islam, the retention rate of the rich in period 0 allows them to engage in trade, i.e. $f_R(\lambda \rightarrow 1, v_0) = \frac{1 - \alpha}{p(1 - \alpha - \mu)}$, $f_R(\lambda \rightarrow 0, v_0) = 1$. Thus, a lower bound on p is assumed that makes (11) hold in period 0 $\forall \lambda \in [0, 1)$:

$$p > \underline{p} \equiv \frac{\tilde{c}}{(1 - \alpha - \mu)\theta}. \quad (C4)$$

Poor regions may plunder the goods being traded. We assume they do so when caravans are on their way to the foreign markets.²³ There is a cost of conflict for the poor that represents resources spent to organize an ambush. In particular, they sustain a loss equivalent to a fraction θ of the goods they seize at the end of the conflict.²⁴ Thus, raiding is only a credible threat if what the poor can obtain exceeds the income of remaining passive and consuming own production, i.e.

$$I_{P,t}^G < I_{P,t}^G + (I_{R,t}^G - \mu)[f_P(\lambda, v_t) - \theta], \quad (12)$$

which can be rewritten as

$$f_P(\lambda, v_0) - \theta > 0. \quad (13)$$

The inequality shows that the poor would only raid if the share of goods they obtain is large enough to overcome the costs of conflict θ .

Lemma 1 *There exists a unique threshold of geographical inequality $\underline{\lambda} \in (0, 1)$ giving $f_P(\underline{\lambda}, v_0) = \theta$, so that a raid is only a meaningful threat for $\lambda > \underline{\lambda}(v_0)$.*

P proof. Since $f_P(\lambda, v_t)$ is continuous, monotonically increasing in λ and since $f_P(0, v_0) = 0$ and $f_P(1, v_0) = 1 - \frac{1-\alpha}{p(1-\alpha-\mu)}$ given (C4), it follows from the *Intermediate Value Theorem* that there exists a unique level of geographical inequality $\lambda \equiv \underline{\lambda}(v_0)$ such that $f_P(\underline{\lambda}, v_0) = \theta \equiv \underline{f}_P$. Hence there exists a $\lambda \equiv \underline{\lambda}(v_0)$ such that if $\lambda > \underline{\lambda}(v_0)$ then $f_{P,0}(\lambda, v_0) > \underline{f}_P$ and the poor raid, whereas if $\lambda < \underline{\lambda}(v_0)$ then $f_{P,0}(\lambda, v_0) < \underline{f}_P$ and there is no conflict. ■

3.4.2 The Zakat Redistribution System

We now introduce the possibility of income redistribution, zakat, and investigate the necessary conditions under which a zakat contract is accepted by both sides.²⁵ We assume that zakat once agreed upon is paid prior to trade. The poor would only accept a zakat payment as a form of compensation to refrain from conflict if the transfer is larger than what they would gain from a raid

$$I_{P,t}^G + \frac{1-\lambda}{\lambda} z (I_{R,t}^G - \mu) \geq I_{P,t}^G + \frac{1-\lambda}{\lambda} [(f_P(\lambda, v_t) - \theta)(I_{R,t}^G - \mu)],$$

where zakat and conflict earnings per poor region is equal to the amount of goods achieved from each individual rich region multiplied by their size $(1 - \lambda)$ and divided by the mass of poor regions, λ . This gives a minimum acceptable zakat rate, \underline{z} , of

$$\underline{z}_t \equiv \underline{z}(\lambda, v_t) = \max\{0, f_P(\lambda, v_t) - \theta\}, \quad (14)$$

²³Recall that the poor cannot afford trade costs, hence similar to their own production they do not trade the goods they obtain from a raid.

²⁴Assuming that rich also bear a θ conflict cost does not change the results.

²⁵We abstract from partial coalition formation, i.e. the rich bribing some poor regions into power-sharing, thus limiting the strength of the remaining poor regions to a sufficiently low level.

which is increasing in $f_P(\lambda, v_t)$, thus increasing in λ and decreasing in v_t and θ as long as $\underline{z}_t > 0$. Note that at $t = 0$, \underline{z}_0 only becomes positive at \underline{f}_P , which looking at (13) occurs at the exact level of geographical inequality $\underline{\lambda}(v_0)$, that is when the poor start finding it optimal to raid.

A zakat system would only go through if it also makes the rich better off. The maximum zakat rate the rich would be willing to pay can be found by comparing their post-trade income under conflict with that under a zakat regime:

$$p(1 - z)(I_{R,t}^G - \mu) \geq f_R(\lambda, v_t)p(I_{R,t}^G - \mu),$$

which gives

$$\bar{z}_t \equiv \bar{z}(\lambda, v_t) = f_P(\lambda, v_t) < 1. \quad (15)$$

and is increasing in λ and decreasing in v_t . Note that at $t = 0$ conflict occurs only when $f_P(\lambda, v_0) > \underline{f}_P$. Below this threshold there is no conflict so the maximum zakat rate of the rich is 0.

It is easy to see from (14) and (15) that $\underline{z}_t < \bar{z}_t$ always holds. Consistent with the initial days of Islam, a zakat rate of \underline{z}_0 is enforced when agreed upon by both sides as long as \underline{z}_0 is non-negative i.e. $\lambda > \underline{\lambda}(v_0)$.

Lemma 2 *Using (14) and (15), in period $t = 0$ a zero zakat rate obtains for $\lambda \leq \underline{\lambda}(v_0)$, while for $\lambda > \underline{\lambda}(v_0)$ there exists a positive zakat rate of \underline{z}_0 increasing in λ , which is beneficial for both sides.*

P proof. Follows by directly comparing (14) to (15) and the properties of $f_P(\lambda, v_t)$. ■

Given the structure of trade and redistribution, we can now define the net income of the rich as

$$I_{R,t}^N = \begin{array}{ll} p \left(I_{R,t}^G - \mu \right) & \text{no conflict} \\ f_R(\lambda, v_t)p \left(I_{R,t}^G - \mu \right) & \text{conflict} \\ (1 - \underline{z}_t)p \left(I_{R,t}^G - \mu \right) & \text{zakat} \end{array} . \quad (16)$$

The net income of the poor is always equal to their gross income, plus zakat earnings, with the latter being equivalent to their potential gains from conflict. To avoid a counterintuitive overproportional transfer from the rich to the poor, we assume that the zakat transfer received by each poor region $Z_t = \frac{1-\lambda}{\lambda}\underline{z}_t \left(I_{R,t}^G - \mu \right)$ does not exceed the minimum amount required to

convince them to forgo raiding, $\underline{z}_t \left(I_{R,t}^G - \mu \right)$, i.e.²⁶

$$Z_t = \begin{cases} \underline{z}_t \left(I_{R,t}^G - \mu \right) & \text{for } \lambda \leq 1/2 \\ \frac{1-\lambda}{\lambda} \underline{z}_t \left(I_{R,t}^G - \mu \right) & \text{for } \lambda > 1/2 \end{cases}. \quad (17)$$

The net income of the poor is therefore

$$I_{P,t}^N = I_{P,t}^G + Z_t. \quad (18)$$

3.5 Geography and the Rise of Islam

We now turn to conditions that give rise to the emergence of Islam as an endogenous institution. We refer to Islam as a contract containing an income redistribution system, i.e. zakat, along with regulations limiting capital accumulation inducing public good investments, i.e. waqfs, by the rich.²⁷

The timing of the arrangement is modelled as follows. An Islamic pact is offered in period 0 and must be accepted by both sides to go through. The rich calculate their utility under Islam $U_{R,0}^\xi$ with both zakat and anti-riba in place and compare it to their outside option $U_{R,0}^c$, which is conflict for all $\lambda > \underline{\lambda}(v_0)$. Recall that the rich always prefer to pay the zakat rate \underline{z}_t to avoid conflict as long as raiding is a credible threat. While the poor are indifferent between conflict and receiving \underline{z}_t , they are always strictly better off with a full Islamic pact that includes a waqf-inducing anti-riba regime. They use the threat of conflict to establish Islam with their bargaining power increasing in λ . To see whether or not Islam goes through one may compare the utility of the rich with and without Islam.

We start by finding the level of net income under conflict $I_R^{N(c)}$ that gives $I_R^{N(c)} = \tilde{c}$, above which the rich leave capital bequests. This solves

$$f_R(\lambda, v_0) - \frac{\tilde{c}}{p(1-\alpha-\mu)} > 0, \quad (19)$$

in period $t = 0$, and with equality gives $\lambda \equiv \tilde{\lambda}^c(v_0)$ so that capital bequests are positive if $\lambda < \tilde{\lambda}^c(v_0)$ and zero otherwise. In addition, looking at (11) and (19) along with (C3) and (C4) assures that $\underline{\lambda}(v_0) < \tilde{\lambda}^c(v_0) < 1$.²⁸ Bequests are more likely to be positive as $f_R(\lambda, v_0)$ increases, a higher initial gross income $1 - \alpha$, higher prices p , and lower trade costs μ .

²⁶Although not modelled explicitly here, this can be thought of as increasing transaction (collection) costs that arise when the number of rich regions cross a certain level, i.e. $(1 - \lambda) \geq 1/2$.

²⁷In the context of the theory, we do not argue that the Islamic economic doctrine is the only contract that may emerge, we do show nevertheless that environments of high geographical inequality are a necessary condition for the emergence and persistence of such rules.

²⁸Relaxing the assumption (C4) we could also have $\underline{\lambda} > \tilde{\lambda}^c$, which implies an economy without institutions for small λ , and a direct switch to Islam at the point when conflict starts, i.e. $\underline{\lambda}$.

Lemma 3 *Under conflict there exists a unique threshold of geographical inequality $\tilde{\lambda}^c(v_0) \in [\underline{\lambda}, 1]$ giving $f_{R,t}(\tilde{\lambda}^c, v_0) = \frac{\tilde{c}}{p(1-\alpha-\mu)}$ so that capital bequests are only positive for $\lambda < \tilde{\lambda}^c(v_0)$.*

P roof. Since $f_{R,t}(\lambda, v_t)$ is continuous with $f_R(\underline{\lambda}, v_0) = 1 - \theta$ and $f_R(\lambda \rightarrow 1, v_0) = \frac{1-\alpha}{p(1-\alpha-\mu)}$, given (C3), (C4), (7), (11), (16) and (19), it follows from the *Intermediate Value Theorem* that there exists a share of poor regions $\lambda \equiv \tilde{\lambda}^c(v_0) \in (\underline{\lambda}, 1)$ such that $f_{R,0}(\tilde{\lambda}^c, v_0) \equiv \frac{\tilde{c}}{p(1-\alpha-\mu)} = \tilde{f}_{R,0}^c$. Also, since $f_{R,0}(\lambda, v_0)$ is monotonically decreasing in λ , this $\tilde{\lambda}^c$ is unique. So, if $\lambda < \tilde{\lambda}^c(v_0)$ then $f_{R,0}(\lambda, v_0) > \tilde{f}_{R,0}^c$ and capital savings by the rich are positive, whereas if $\lambda > \tilde{\lambda}^c(v_0)$ then $f_{R,0}(\lambda, v_0) < \tilde{f}_{R,0}^c$ and optimal bequests are zero. ■

Similarly, one may derive the threshold of poor regions below which investments are positive under an Islamic contract, by solving for the net income under Islam, $I_R^{N(\xi)}$, that guarantees consumption equal to \tilde{c} . The only difference from the previous case is the additional gain from avoiding conflict. The following inequality solves for $\tilde{\lambda}^\xi(v_0)$ below which bequests under Islam are positive:

$$f_R(\lambda, v_0) - \frac{\tilde{c}}{p(1-\alpha-\mu)} + \theta > 0 \quad (20)$$

Substituting for p from (C4), one can show that (20) always holds, hence waqf bequests by the rich are always positive under Islam. Note that while $I_R^{N(c)} > \tilde{c}$ no longer holds for $\lambda > \tilde{\lambda}^c$, $I_R^{N(\xi)} > \tilde{c}$ still obtains due to the extra term θ . To derive under which conditions Islam is accepted as an institution we compare the utility of the rich under conflict and capital bequests to that under Islam and labor productivity enhancing investments, that is:

$$G(\lambda, v_0) = U_{R,t}^c(\lambda, v_0) - U_{R,t}^\xi(\lambda, v_0) = \alpha[p(I_{R,t}^G - \mu)f_{R,t}(\lambda, v_0) - \tilde{c}] - \gamma(1-\alpha)(1-\lambda)[p(I_{R,t}^G - \mu)(f_{R,t}(\lambda, v_0) + \theta) - \tilde{c}] \quad (21)$$

Looking at (21), it is straightforward to show that Islam is accepted for all $\lambda > \tilde{\lambda}^c(v_0)$ where the alternative is no bequests. In this range, the only option for the rich to enhance their utility through bequests to their offspring is to accept Islam and invest in public waqfs. Therefore, the rest of this section focuses on the values $\lambda < \tilde{\lambda}^c(v_0)$ to find the minimum fraction of poor regions above which Islam is accepted in period $t = 0$.

Islam brings static gains by preventing conflict. The difference between what the rich are willing to pay to avoid conflict and what they actually pay, i.e. the difference between \underline{z}_t and \bar{z}_t in (14) and (15), is the economic value added by Islam and amounts to θ . On the dynamic side, switching to Islam and public goods investments as opposed to capital bequests brings about a loss to the rich due to the higher marginal product of physical capital compared to waqf, see (C1). Therefore, the trade-off is between static gains *vis-à-vis* a dynamic loss. Consider a marginal increase in the proportion of poor lands (λ increases). A larger λ translates into lower

utility due to a lower proportion of goods that remain to the rich (lower $f_R(\lambda, v_0)$) whether they engage in conflict or avoid a raid through zakat. However, this marginal loss is smaller in the case of Islam because of the lower returns to waqf relative to capital. This makes Islam a more attractive option. On the other hand, a higher λ discourages Islam by creating a dilution effect as waqf benefits become diluted among more poor regions. For a higher degree of geographical inequality to make Islam more attractive this dilution effect must be lower than the rate at which overall bequests fall. More formally, using Lemma 3, one may show that:

Proposition 1 *There exists a unique threshold $\lambda^\xi(v_0) \in [\underline{\lambda}(v_0), \tilde{\lambda}^c(v_0)]$, implicitly defined as $f_R(\lambda^\xi, v_0) = \frac{\tilde{c}}{p(1-\alpha-\mu)} + \theta \frac{\gamma(1-\alpha)(1-\lambda^\xi)}{\alpha-\gamma(1-\alpha)(1-\lambda^\xi)}$, such that a full Islam contract, i.e. zakat plus an anti-riba law, is agreed upon by the rich in period $t = 0$ if $\lambda \geq \lambda^\xi(v_0)$, and rejected if $\lambda < \lambda^\xi(v_0)$.*

P proof. Consider equation (21):

(1) Given the property of the retention function (9), $G(\lambda, v_0)$ is continuous and monotonically decreasing in λ :

$$\frac{dG(\lambda, v_0)}{d\lambda} = \frac{df(\lambda, v_0)}{d\lambda} [\alpha - \gamma(1-\alpha)(1-\lambda)] p(I_{R,0}^G - \mu) + (1-\alpha)\gamma \{ [f(\lambda, v_0) + \theta] p(I_{R,0}^G - \mu) - \tilde{c} \}.$$

The first term on the RHS is negative because of $\frac{df(\lambda, v_0)}{d\lambda} < 0$ and (C1), while the second term is positive. Given (9), $G(\lambda, v_0)$ decreases with λ , i.e. the marginal benefit of switching to waqf (expressed as the lower rate at which waqf bequests fall compared to capital) dominates the marginal reduction in waqf benefits brought about by the dilution among more poor regions (second term on RHS).

(2) $G(\underline{\lambda}, v_0) > 0$ due to no conflict at $\lambda = \underline{\lambda}(v_0)$ and (C1)

(3) $G(\tilde{\lambda}^c, v_0) < 0$ due to zero bequests under conflict and positive under Islam

it follows from the *Intermediate Value Theorem* that there exists a unique level of geographical inequality $\lambda \equiv \lambda^\xi(v_0)$ such that $f_R(\lambda^\xi, v_0) = \frac{\tilde{c}}{p(1-\alpha-\mu)} + \theta \frac{\gamma(1-\alpha)[1-\lambda^\xi(v_0)]}{\alpha-\gamma(1-\alpha)[1-\lambda^\xi(v_0)]} \equiv f_{R,t}^\xi$ and $U_{R,t}^\xi(\tilde{\lambda}^\xi, v_0) = U_{R,t}^c(\tilde{\lambda}^c, v_0)$. Hence, there exists a $\lambda \equiv \lambda^\xi(v_0)$ such that if $\lambda > \lambda^\xi(v_0)$ then $G(\lambda, v_0) < 0$ and Islam goes through, whereas if $\lambda < \lambda^\xi(v_0)$ then $G(\lambda, v_0) > 0$ and conflict takes place. ■

In summary, when poor regions take up a small fraction of an economy, i.e. for $\lambda < \underline{\lambda}(v_0)$, there is no threat of a raid and no institutions are founded. For intermediate levels of geographical inequality, i.e. $\underline{\lambda}(v_0) < \lambda < \lambda^\xi(v_0)$ redistribution only regime emerges. Finally, once the share of poor regions is large enough, the rich accept Islam because the threat of conflict is effective and potential losses are high. Islam is accepted (a) for $\lambda^\xi(v_0) < \lambda < \tilde{\lambda}^c(v_0)$ because gains from the prevention of conflict dominate losses from the lower returns of waqf, and (b) $\lambda > \tilde{\lambda}^c(v_0)$ because the rich will otherwise not be able to leave any bequests after

conflict. As a consequence, once trade becomes feasible in period $t = 0$, Islam is founded for $\lambda > \lambda^\xi(v_0)$, the rich pay zakat, and leave bequests in the form of public waqfs.

3.6 Dynamic analysis

The previous section established that in presence of regional differential gains from trade, the relative share of poor regions is a fundamental determinant of the emergence of various institutions such as a redistributive zakat scheme, limits on physical capital accumulation, and investments in public goods, i.e. waqfs, aimed at increasing labor productivity. We now conduct a dynamic analysis describing the evolution of institutional arrangements under different initial geographical conditions.

3.6.1 Evolution with no Islamic Institutions

In this type of economy, the share of the poor regions is relatively small, $\lambda < \underline{\lambda}(v_0)$, so that there is no threat of conflict. Therefore, regions evolve along different paths and no institutions arise. The zakat rate \underline{z}_t is equal to zero in this region and the gross income of rich and poor follow the dynamics described by:

$$\begin{cases} I_{R,t+1}^G = (1 - \alpha) + \alpha[p(I_{R,t}^G - \mu) - \tilde{c}] \\ I_{P,t+1}^G = I_{P,0}^G = \frac{(1-\alpha)}{v_0} \end{cases} \quad (22)$$

where we have used condition (C2) and equations (5), (7), (16) and (18). Gross income of the rich increases every period due to condition (C4) and as long as $p < 1/\alpha$, reaches the steady state level, $I_{R,S}^G$,

$$I_{R,S}^G = (1 - \alpha) + \alpha \left(\frac{p(1 - \alpha - \mu) - \tilde{c}}{1 - \alpha p} \right), \quad (23)$$

This may be decomposed into the labor income (first term) plus the the returns on capital times the steady state level of capital bequests. In this case income inequality in period $t + 1$ is:

$$v_{t+1} = \frac{I_{R,t+1}^G}{I_{P,t+1}^G} = v_0 \left(1 + \frac{\alpha}{1 - \alpha} [p(I_{R,t}^G - \mu) - \tilde{c}] \right)$$

and increases over time till it reaches a steady state level of

$$v_S = v_0 \left[1 + \frac{\alpha}{1 - \alpha} \left(\frac{p(1 - \alpha - \mu) - \tilde{c}}{1 - \alpha p} \right) \right] \quad (24)$$

where $v_S = \frac{I_{R,S}^G}{I_{P,S}^G}$, the numerator is (23) and the denominator comes from the second expression in (22). If $p > 1/\alpha$, both the income of the rich and with it inequality explode in the long run when there are no institutions.

In an economy with an intermediate intensity of poor regions $\underline{\lambda}(v_0) < \lambda < \lambda^\xi(v_0, I_{R,t}^G)$, the threat of an ambush makes a zakat system attractive as a means of avoiding conflict. Since a regime featuring only redistribution is not the focus of the analysis and to limit the possible scenarios, we focus on the case when redistribution does not allow the poor regions to leave bequests. For this to obtain it is sufficient to show that in period 0 net income of the poor given by (18) remains below \tilde{c} and the total amount of redistribution falls with the gross income of the rich.²⁹ Substituting \underline{z}_t with (14) in (18) using (17), the net income of the poor in period 0 is below \tilde{c} as long as $f_R(\lambda, v_0) > 1 - \theta - \frac{\lambda}{1-\lambda} \frac{\tilde{c} - \frac{(1-\alpha)v_0}{(1-\alpha-\mu)}}{v_0}$. Substituting $f_R(\lambda, v_0)$ in the LHS of the inequality with the minimum value it could take from (11), this is satisfied as long as

$$\frac{(1-\alpha) + \frac{\lambda}{1-\lambda} p(\tilde{c} - \frac{(1-\alpha)v_0}{(1-\alpha-\mu)})}{p(1-\alpha-\mu)} > 1 - \theta, \quad (25)$$

which due to (C3) is always true for large enough values of initial land inequality v_0 .³⁰ In this case, the equations that describe the dynamics are:

$$\begin{cases} I_{R,t+1}^G = (1-\alpha) + \alpha([1 - \underline{z}_t]p(I_{R,t}^G - \mu) - \tilde{c}) \\ I_{P,t+1}^G = I_{P,0}^G = \frac{(1-\alpha)}{v_0} \\ \underline{z}_t = \max\{0, 1 - f_R(\lambda, v_t) - \theta\} \end{cases} \quad (26)$$

where we have used condition (C2) and equations (7), (14), (16). Under these conditions the gross income of the poor remains constant whereas the gross income of the rich $I_{R,t}^G$ grows over time along with income inequality v_t . So, redistribution diminishes over time and may be abandoned after a finite number of periods.³¹ The dynamics in the latter case are driven by (22) giving a steady state level of income equal to (23) for $p < 1/\alpha$ and an explosive growth and inequality for higher prices.

²⁹The negative relationship between the total amount of zakat and rich income may be shown by taking the derivative of the amount of zakat received by the poor under a redistribution only regime, Z_t , with respect to the gross income of the rich: $\frac{\partial Z_t}{\partial I_{R,t}^G} = -\frac{v_0}{(1-\alpha)} \frac{\partial f_R}{\partial v}(I_{R,t}^G - \mu) + (1 - f_R(\lambda, v_t) - \theta)$ where we have used the fact that under capital accumulation $v_t = \frac{v_0}{(1-\alpha)} I_{R,t}^G$ so that $\frac{\partial f_R}{\partial I_{R,t}^G} = \frac{v_0}{(1-\alpha)} \frac{\partial f_R}{\partial v}$. For the derivative above to be negative, $\frac{\partial f_R}{\partial v} > \frac{(1-f_R(\lambda, v_t) - \theta)(1-\alpha)}{(I_{R,t}^G - \mu)v_0}$ must hold. Since the RHS is decreasing in $I_{R,t}^G$ and $f_R(\lambda, v_t)$, a sufficient condition for this to hold is when $I_{R,t}^G = I_{R,0}^G = (1-\alpha)$ and $f_R(\lambda, v_t) = 0$. So, (10) guarantees that total zakat transfers fall as the gross income of the rich increase over time.

³⁰The inequality turns to $\frac{(1-\alpha) + \frac{\lambda}{1-\lambda} p\tilde{c}}{p(1-\alpha-\mu)} > 1 - \theta$ for large v_0 , and is always true for $\lambda > 1/2$ since $LHS > 1$ because $\tilde{c} > (1-\alpha-\mu)$ and $RHS < 1$. Note that from (17) $\frac{\lambda}{1-\lambda} = 1$ for $\lambda \leq 1/2$.

³¹It can also be the case that in the long run zakat is still in place, that is at the steady state level of income of the rich a positive amount of zakat is still preferred. It can be shown that this happens whenever $f_R(\lambda; I_{R,S}^G) < 1 - \theta$, where we have used the expression of $I_{R,S}^G$ obtained from (26). However, this result does not alter the main analysis carried on in this and the next section.

3.6.2 Evolution under the Islamic Doctrine

A full Islamic contract comprises of an anti-riba law together with a zakat transfer from the rich to the poor. We know from proposition 1 that an Islamic institution is initially founded when the share of poor lands surpasses a threshold level of $\lambda > \lambda^\xi(v_0)$. The anti-riba law sways the rich to divert funds from physical capital to public good investments that enhance labor productivity of all agents. It is important to note that due to the public nature of waqf, inequality under Islam does not change along the process of development, making the zakat rate also constant for any combination of v_0 and λ . However, the bequest and the Islam thresholds, referred to as $\tilde{\lambda}_t^c \equiv \tilde{\lambda}_t^c(v_0, I_{R,t}^G)$ and $\lambda_t^\xi \equiv \lambda^\xi(v_0, I_{R,t}^G)$ henceforth, may change due to $I_{R,t}^G$ increasing over time.

Corollary 1 *Substituting the gross income in period 0 with the gross income in period t , $I_{R,t}^G$, in the RHS of $f_R(\tilde{\lambda}^c, v_0)$ in Lemma 3 and $f_R(\lambda^\xi, v_0)$ in proposition 1, the two expressions become $f_R(\tilde{\lambda}_t^c) = \frac{\tilde{c}}{p(I_{R,t}^G - \mu)}$ and $f_R(\lambda_t^\xi) = \frac{\tilde{c}}{p(I_{R,t}^G - \mu)} + \theta \frac{\gamma(1-\alpha)(1-\lambda_t^\xi)}{\alpha - \gamma(1-\alpha)(1-\lambda_t^\xi)}$ respectively. Since $\frac{\partial f_R(\tilde{\lambda}_t^c)}{\partial I_{R,t}^G} < 0$ and $\frac{\partial f_R(\lambda_t^\xi)}{\partial I_{R,t}^G} < 0$, it follows that the threshold values $\tilde{\lambda}_t^c$ and λ_t^ξ rise over time as $I_{R,t}^G$ increases. Intuitively, a larger gross income eases the constraint to leave bequests for the rich in presence of conflict and discourages the persistence of Islam.*

P roof. Proposition 1 shows that $\lambda_0^\xi(v_0, I_{R,0}^G)$ exists and is unique. Under the Islamic contract inequality is constant at v_0 , so $\lambda^\xi(v_0, I_{R,t}^G)$ depends on gross income of the rich, and can be written implicitly using (21) as the value of λ that satisfies the following implicit function

$$G(\lambda_t^\xi, I_{R,t}^G) = U_{R,t}^c(\lambda_t^\xi, I_{R,t}^G) - U_{R,t}^\xi(\lambda_t^\xi, I_{R,t}^G) \equiv 0. \quad (27)$$

By the Implicit function theorem

$$\frac{d\lambda_t^\xi}{dI_{R,t}^G} = -\frac{\frac{\partial G(\lambda_t^\xi)}{\partial I_{R,t}^G}}{\frac{\partial G(\lambda_t^\xi)}{\partial \lambda}} \quad (28)$$

which is positive as the denominator is negative from (9) when substituting $I_{R,t}^G$ for $I_{R,0}^G$, and the numerator is

$$\frac{\partial G(\lambda_t^\xi)}{\partial I_{R,t}^G} = \frac{\tilde{c}[p(I_{R,t}^G - \mu) - I_{R,t}^G]}{p(I_{R,t}^G - \mu)^2} + \theta \frac{\gamma(1-\alpha)(1-\lambda_t^\xi)[1 - p\gamma(1-\alpha)(1-\lambda_t^\xi)]}{\alpha - \gamma(1-\alpha)(1-\lambda_t^\xi)}$$

which is positive as long as the steady state income of the rich under Islam is finite, i.e. $p < 1/(\gamma(1-\alpha)(1-\lambda_t^\xi))$. This gives $\frac{d\lambda_t^\xi}{dI_{R,t}^G} > 0$, while $\frac{\partial \tilde{\lambda}_t^c}{\partial I_{R,t}^G} > 0$ follows by directly inspecting the expression in the Corollary and using the properties of $f_R(\lambda, v_t)$. ■

Given Corollary 1, as long as $\lambda > \lambda_t^\xi$ then Islamic rules are accepted in every period and the economy evolves according to the dynamic equations

$$\begin{cases} I_{R,t+1}^G = (1 - \alpha)(1 + \gamma(1 - \lambda))[(1 - \underline{z}_0)p(I_{R,t}^G - \mu) - \tilde{c}] \\ I_{P,t+1}^G = \frac{I_{R,t+1}^G}{v_0} \\ \underline{z}_0 = \max\{0, 1 - f_R(\lambda, v_0) - \theta\} \end{cases} \quad (29)$$

where we have used condition (C2) and equations (8), (14), (16) and (18). Note that income inequality is constant and equal to v_0 along the process of development, so is the zakat rate. Gross income of the rich increases in every period and eventually reaches the steady state level

$$I_{R,S}^G = (1 - \alpha) \left(1 + \gamma(1 - \lambda) \frac{p(1 - \alpha - \mu)(1 - \underline{z}_0) - \tilde{c}}{1 - p(1 - \alpha)\gamma(1 - \lambda)(1 - \underline{z}_0)} \right) \quad (30)$$

that is the wage rate times the steady state level of investment in public goods (the ratio in the parenthesis, which can be referred to as h_S). It is positive and larger than initial gross income $(1 - \alpha)$ from (C4).

The gross income of the poor also increases under Islam because of the enhanced labor productivity arising through waqf investments. Poor's income is maximized in the steady state with $I_{P,S}^G = \frac{I_{R,S}^G}{v_0}$. So, using (2) and (C2), $\frac{1-\alpha}{\mu}h_S < v_0$ is a sufficient condition to preclude the participation of poor into trade activities along the process of development $\forall t \geq 0$. Additionally, we know from (25) that the poor are not in the position to leave bequests at $t = 0$. A constant zakat rate \underline{z}_0 assures that this is also the case under Islam, where the poor enjoy a steady state net income of $I_{P,S}^N = I_{P,S}^G + Z_S(\underline{z}_0, I_{R,S}^G)$.

Corollary 1 shows that the Islamic contract may be abandoned as the gross income of the rich increases. However, Using Proposition 1, one may derive the value of geographical inequality λ_S^ξ where for values above λ_S^ξ the rich remain loyal to Islam in the steady state, by simply substituting the rich's steady state level of gross income under Islam (30) into (27).

Proposition 2 *There exists a unique threshold $\lambda_S^\xi \in [\lambda_0^\xi, 1]$, where Islam is accepted by the rich both in the short and in the long-run for $\forall \lambda \geq \lambda_S^\xi$.*

P proof. To check for the existence and uniqueness of $\lambda_S^\xi < 1$, first take the limit of (30) to get $\lim_{\lambda \rightarrow 1} I_{R,S}^G = 1 - \alpha$. Also substituting $\lambda^\xi = 1$ into expressions $f(\tilde{\lambda}_t^c, v_0)$ and $f_R(\lambda^\xi, v_0)$ in Lemma 3 and Proposition 1 respectively, we see that both values converge to $\frac{\tilde{c}}{p(1-\alpha-\mu)}$. From (C3) and (11) we know that $f_R(1, v_0) < \frac{\tilde{c}}{p(1-\alpha-\mu)}$, so that in the limit case of $\lambda \rightarrow 1$ the rich would prefer the Islam contract, i.e. $G(1, I_{R,S}^G) < 0$ in (27). Next, consider $G(\lambda_0^\xi, I_{R,t}^G)$. From Proposition 1 it is equal to zero at $t = 0$, while Corollary 1 shows that it is strictly larger than 0 in the subsequent periods, i.e. $\frac{\partial G(\lambda)}{\partial I_{R,t}^G} > 0$. It follows that $G(\lambda_0^\xi, I_{R,S}^G) > 0$. Finally, we know from Proposition 1 that $\frac{dG(\lambda, v_0)}{d\lambda} < 0$. It follows from the *Intermediate Value Theorem* that there exist a unique $\lambda \equiv \lambda_S^\xi > \lambda_0^\xi$ such that if $\lambda > \lambda_S^\xi$ then $G(\lambda, v_0) < 0$ and Islam persists

in the long run, whereas if $\lambda < \lambda_G^\xi$ then $G(\lambda, v_0) > 0$ and Islam gets abandoned after being adopted in $t = 0$. ■

Proposition 2 establishes the existence of an interval, in which Islam is sustainable in the long run. We can conclude that Islam is initially founded and is abandoned in the long run for $\lambda_0^\xi < \lambda < \lambda_G^\xi$, while it is founded and persists for $\lambda_G^\xi < \lambda < 1$. In the former case, once the contract is abandoned, the economy evolves into the zakat-only case, with the zakat institution itself being eventually abandoned under our specifications.

Finally, steady state regional income inequality under Islam, v_0 , is always lower than that under capital accumulation in (24). Also, comparing (30) to (23) reveals that the steady state income of the rich regions is always lower under Islam because of (i) the lower return from public good investments and (ii) the fraction of gross income transferred to the poor in the form of zakat. Moreover, the income of the rich decreases as λ increases both because of the dilution of waqf benefits and a larger zakat rate z_0 .

To summarize, in absence of Islamic rules territories characterized by a large share of poorly endowed regions would be trapped in a state of eternal feuding. So, while the emergence of Islam allowed these economies to escape a conflict trap and flourish in the pre-industrial world, these very institutions resulted in negligible capital accumulation shaping the economic trajectory of the Islamic lands.

4 Empirical section

4.1 The Data Sources

The ideal index for capturing the differential gains from trade across regions, could be derived by examining the regional distribution of productive activities conducive to trade in the eve of the Islamic expansion. A quest for such detailed data is bound to be an overwhelming endeavor. To overcome this issue we employ an alternative strategy. Given that Islam surfaced at a point in time when land was the single most important input in the production process and in absence of historical data, we use contemporary disaggregated data on the suitability of land for agriculture, to proxy for the regional productive endowments. In a stage of development when land dominates production decisions, the regional agricultural suitability plays a fundamental role in shaping the potential of a region to engage and profit from trade. Thus, differences in regional land fertility would arguably map into differential gains from trade across regions. Naturally, fertile areas able to produce a surplus would trade, whereas poorly endowed ones would not be able to do so.

According to the theory, Islamic economic principles would have been historically more likely to be accepted by the local populations in places characterized by a large proportion of

regions unable to enjoy any trade benefits, i.e. a larger λ in the context of the theory. Hence, to capture the degree of regional inequality we employ data on the natural suitability of land for agriculture.

This global data set on agricultural suitability was assembled by Ramankutty et al. (2002) to investigate the effect of the future climate change on contemporary agricultural suitability.³² It provides information on land quality characteristics at a resolution of 0.5 degrees latitude by 0.5 degrees longitude, representing an average region of about 55 km. by 35 km. In total there are 66004 observations.

Each observation takes a value between 0 and 1 and represents the probability that a particular grid cell may be cultivated. In order to construct this index, the authors (i) derive empirically the probability density function of the percentage of croplands around 1990 with respect to climate and soil characteristics and (ii) combine it with data on climate and soil quality at the resolution of 0.5 by 0.5 decimal degrees to predict the regional suitability for agriculture across the globe.

The climatic characteristics are based on mean-monthly climate conditions for the 1961–1990 period and capture (i) monthly temperature (ii) precipitation and (iii) potential sunshine hours. All these measures weakly monotonically increase the suitability of land for agriculture. Regarding the soil suitability the traits considered are a measure of the total organic content of the soil (carbon density) and the nutrient availability (soil pH). The relationship of these indexes with agricultural suitability is non monotonic. In particular, low and high values of pH limit cultivation potential since this is a sign of soils being too acidic or alkaline respectively. Note that the derived land suitability does not take into account irrigation availability and topography.

Using these raw global data we construct the distribution of land quality at the desired level of aggregation, i.e., across countries, ethnic groups and virtual countries.

In the cross-country analysis, the dependent variable employed is the fraction of the Muslim population as early as the 1900 *AD* at the country level. With respect to the cross-ethnic group analysis the dependent variable is the fraction of the Muslim population and of other religious denominations within an ethnic group. The data come from the World Religion Database (WRD) which provides estimates of Muslim adherence in 2005 for an ethnic group within a country.³³ These estimates are derived from the World Christian Database and are

³²See Appendix B for a summary and description of the variables and the data sources used in this study.

³³WRD classifies as Muslims the followers of Islam, in its 2 main branches (with schools of law, rites or sects): Sunnis or Sunnites (Hanafite, Hanbalite, Maliki, Shafiite), and Shias or Shiites (Ithna- Ashari, Ismaili, Alawite and Zaydi versions); also Kharijite and other orthodox sects; reform movements (Wahhabi, Sanusi, Mahdiya), also heterodox sects (Ahmadiya, Druzes, Yazidis), but excluding syncretistic religions with Muslim elements, and partially-islamized tribal religionists.

subsequently adjusted based on three sources of data on religious affiliation: census data, demographic and health surveys and population survey data.^{34,35}

The theory links the spread of Islam to the underlying geography of a set of regions. So, when testing the theory across ethnic groups one needs to identify the land endowments of the traditional homeland of an ethnic group, i.e. the distribution of land quality across territories along which an ethnic group has been historically located. To identify the location of ethnic groups' homelands we use the information available at the Global Mapping International's (GMI) World Language Mapping System. This database maps explicitly the traditional homelands of ethnic groups found in the 15th edition of the Ethnologue database on languages around the world.³⁶

In the virtual country analysis the fraction of Muslims is estimated using information on both the location of ethnic groups from (GMI) and their respective population and Muslim adherence in 2005 from (WRD).

In absence of historical estimates of Muslim representation at an ethnic group or virtual country level, we are constrained in using contemporary data. Doing so, the dependent variable partially encompasses recent conversions into Islam as converting out of Islam by committing apostasy or ridda is subject to punishment in several Islamic countries.³⁷The Qur'an explicitly forbade the forced conversion of other monotheists. So, historically in territories that came under the direct rule of a Muslim empire, the most effective means of encouraging the non-Muslim populations to convert was through lower taxes and increased societal status, see Chaney (2008) and Bulliet (1979). Regarding places that did not belong to the Muslim empire, Muslim merchants have played an important role in the spread of Islam. For example, although Insoll (2003) cautions against broad generalizations regarding the reasons behind Islamization of Sub-Saharan Africa, he singles out the role of Muslim merchants in introducing Islam to

³⁴The data and information regarding the available statistics are accessible at: <http://www.worldreligiondatabase.org/>

³⁵Hsu et al. (2008) show that the country level estimates for Muslim representation in (WRD) are highly correlated (above 0.97) with similar statistics available from World Values Survey, Pew Global Assessment Project, CIA World Factbook, and the U.S. Department of State. At the ethnic group level there are no comparable statistics.

³⁶The data are available at www.gmi.org. The location of each ethnic group is identified by a polygon. Each of these polygons delineates the traditional homeland of an ethnic group; populations away from their homelands (e.g. in cities, refugee populations, etc.) are not mapped. Also, the World Language Mapping System does not attempt to map immigrant languages. Finally, ethnic groups of unknown location, widespread ethnicities i.e. ethnic groups whose boundaries coincide with a country's boundaries and extinct languages are not mapped and, thus, not considered in the empirical analysis. The only exception for not mapping widespread languages is the case of English language which is mapped for the United States.

³⁷Fox and Sandler (2008) find that among 39 countries with Muslim adherence of at least 50%, 25 have conversion restrictions either out of the majority religion or into a minority religion, whereas 18 have both types of restrictions. Also, Barro et al. (2009) show in a sample of 40 countries containing no predominantly Muslim countries, the larger is the percentage of Muslim adherence the lower are religious-conversion rates.

the indigenous communities. These merchants offered access to an expansive network of trade opportunities. In the context of the theory, such large potential trade benefits coupled with the degree of inequality in agricultural endowments shaped the rate at which different regions in Sub-Saharan Africa and elsewhere adopted the Islamic principles.

4.2 Cross-Ethnic Group Analysis

We start the empirical investigation at the ethnic group level. The spread of Islam and its institutions is a historical process that took place mainly before the formation of modern states and the emergence of nationalism. Consequently, using countries as the unit of empirical analysis is subject to the criticism that what we may identify is not a causal effect of geography on the adoption of Islam, but the fact that modern political boundaries, for example those imposed by European colonizers after the fall of the Ottoman empire, shaped the observed unequal distribution of land endowments across Muslim countries. Also, the very individual histories of modern day countries have largely engineered both their current borders as well as the composition of religious views by promoting or demoting religious uniformity.

In order to overcome these critical issues we investigate empirically the role of geography in shaping Muslim representation across ethnic groups. Establishing that ethnic groups residing along unequally distributed agricultural endowments sustain larger Muslim populations will greatly enhance the validity of the proposed hypothesis and alleviate any concerns related to the border and country formation inherent to any cross-country analysis.

To capture the intensity of poorly endowed regions we use the global data on the suitability of land for agriculture to estimate the share of regions with less than 10% agricultural potential, that is, the share of regions within each country having at most a 10% probability of cultivation due to soil and climatic limitations.³⁸ The prediction is that countries with more regions incapable of directly profiting from trade, i.e. a higher λ in the context of the theory, would find Islam an attractive solution to mitigating and overcoming the high geographical inequality.

Map 1a in Appendix A shows the traditional homelands of two ethnic groups in Ethiopia. The Amhara occupy the northern part whereas in the southwestern part of current day Ethiopia the Somali people are traditionally located. Map 1b illustrates the regional land quality within these two ethnic groups. The green colored regions are those with at least 10% of agricultural potential whereas the yellow colored ones are below this threshold. Amharic areas are characterized by uniformly fertile land endowments. On the other hand, 72% of Somali's homeland is dominated by agriculturally poor regions. In a stage of development when land fertility trans-

³⁸In the end of each empirical section we show that the results are qualitatively and quantitatively similar using alternative thresholds to define low fertility regions.

lates into differential gains from trade one would expect that the unequal distribution of land quality within the Somali group would make the Islamic principles more likely to be accepted within this group, whereas the relatively uniform fertile endowment within the Amhara would make Islam less likely to emerge. According to the (WRD), Somali were 100% Muslim in 2005 whereas within the Amharic group only 1% was adhering to Islam with the majority of 99% belonging to Christianity.³⁹

Table 1a presents the summary statistics of the variables employed in the cross-ethnic group analysis.⁴⁰ An average ethnic group has 21% of its population adhering to Islam in 2005, spans on average 54 thousand square kilometers and 18% of a group’s territory is agriculturally poor, i.e. has an agricultural potential below 10%. Table 1b shows the raw correlations among the variables of interest. Muslim representation at an ethnic group level is positively related to the share of low land quality regions and strongly negatively related to the distance from Mecca. For the cross-ethnic group analysis the following specification is adopted:

$$\%Muslim_i = a_0 + a_1\%low_lq_i + a_2X_i + \eta_i \quad (31)$$

The key theoretical prediction is that the larger the share of poorly endowed regions, $\%low_lq$, the higher the probability for the respective group to have adopted Islamic principles. The main prediction is corroborated across alternative specifications of Table 2.⁴¹ In the first column of Table 2 the $\%low_lq$ enters positively and is statistically significant. One standard deviation increase in the fraction of poor regions increases Muslim representation within an ethnic group by 5% in 2005. Ethnicities located further from where Islam originated, denoted by $dmecca$, have lower Muslim population today. This finding may be dually interpreted. Regions closer to Mecca by virtue of proximity would receive a larger Arab population during the Arab expansion increasing the overall Muslim representation. Also, Mecca is located near the various preindustrial trade routes linking Europe to Asia, so the further an ethnic group would be located from Mecca, the lower its gains from trade reducing the need for adopting the trade enhancing properties of Islamic institutions.

In all specifications we explicitly control for country and continental fixed effects each ethnic group belongs to. Such inclusion of powerful controls, not possible in a cross-country framework, allows to take into account any systematic elements related to the state histories of

³⁹Note that the (WRD) provides estimates for Muslim, Christian, Buddhist, Hindu etc. adherence per ethnicity at the country level and the (GMI) maps the locations that these groups may be traditionally found within a country.

⁴⁰We focus on ethnic groups with at least 5 regional observations. Additionally, to mitigate the measurement error inherent in the mapping of ethnicities’ homelands, an ethnic group must occupy at least 100 square kilometers of a single region in order for the latter to be included in the ethnic group’s homeland. Using alternative thresholds does not affect the results.

⁴¹The results presented here are OLS estimates with the standard errors clustered at the country level.

existing countries and, thus, produce reliable estimates of the effect of geographic inequality on Muslim adherence. A series of dummies representing the identity of the European colonizers is also included in all specifications (the estimates are not shown for brevity). These controls capture the distinct country wide colonizing patterns that might be correlated both with the introduction of Christianity, and thus indirectly correlated with Muslim adherence, and the geographical endowment of a certain country.

The positive and significant estimate on the standard deviation of land fertility, denoted by *sd_lq*, implies that ethnic groups' homelands exhibiting variable agricultural suitability systematically bring forward and sustain larger Muslim adherence. This is consistent with the prediction that for Islam to emerge, there must be differences in the productive potential across areas. Naturally, this is more likely to occur as the variance of regional agricultural fertility increases. One standard deviation increase in *sd_lq* increases Muslim representation by 5% contributing significantly to the emergence and persistence of Islam across ethnic groups.⁴² Additional geographical controls like: average land quality, *avg_lq*, the area of an ethnic group, *areakm2*, the percentage of regions within an ethnic group with no access to permanent water resources like rivers and lakes, denoted by *%nowater*, mean elevation, *elev*, distance from the equator, *abs_lat*, and distance from the coast, *sea_dist*, do not systematically affect Muslim adherence.

In regression 2 we introduce two dummy variables at the country level. The first captures whether a country had a state religion as of 2000, *staterel00*, which enters insignificantly, and *shist600ad* which takes the value of 1 if a country's experience with statehood in the 7th century AD is above the median. Ethnic groups residing within the territories of modern day countries that in the eve of Arab expansion had a more extensive experience with statehood exhibit a larger Muslim populations today.

The last two columns of Table 2 split the sample of countries between the New and the Old World. The theory focuses on the endogenous adoption from indigenous populations of the Islamic principles as trade opportunities exacerbated regional geographical inequalities following the fall of the Roman Empire. These conditions were largely present in the Old World. However, when countries from the New World joined the transatlantic trade their institutions were engineered by the colonizers themselves rather than the indigenous population that was severely disrupted, see Acemoglu et al. (2002). As a result, within the New World geography

⁴²Michalopoulos (2008) shows that ethnic groups are traditionally located across homogeneous land qualities, with places characterized by diverse land endowments sustaining more ethnic groups. This is consistent with the finding that Muslims are predominantly located in low quality regions. However, the crucial difference between an average ethnic group and Muslim groups is that conditional on the fraction of poor agricultural regions, Muslim representation is higher in regions exhibiting large variation in regional endowments. This highlights the importance of inequality in the distribution of land endowments in bringing forward and sustaining Muslim adherence.

should not have an effect on the adoption and spread of the Islamic religion. Indeed, this is what is shown in column 4 of Table 2, whereas column 3 shows the strong effect of an unequal geography in bringing forward and sustaining larger Muslim populations within the Old World.

4.2.1 Muslim Empires and Other Religions

The theory provided, identifies the geographic conditions under which Islamic principles would be adopted from indigenous populations. However, groups of people coming under the direct rule of a Muslim empire might face other incentives for converting to Islam, see Chaney (2008) and Bulliet (1979). For example, the lower tax rates granted to Muslims over non-Muslims in Muslim Empires or the status achieved by switching to the ruler's religion, might differentially affect conversion rates across types of land endowments. Similarly, instances of forced conversion or religious persecution during the Muslim expansion, might have shaped the observed religious affiliation. Additionally, one might argue that the identified relationship between geography and Muslim adherence is not particular to the Muslim religion but it may either be a feature of all monotheistic religions or an outcome of some other major religion following the opposite geographic pattern, that is another religion being consistently found in places with low variance of land quality and a small share of poor regions. To mitigate such plausible concerns one need to look into ethnic groups that have not been under the direct rule of any Muslim empire and ask whether the "Islamic" geography is systematically associated with other religious denominations. This is done in the specifications of Table 3.

We ask how geography affects religious affiliation in the Old World across ethnic groups that have not been at any point in history under the direct rule of Muslim empires like the Umayyads, the Abbasids, the Fatimids, the Ghaznavids, the Seljuqs, the Mughals, the Safavids and the Ottomans.⁴³ Such restriction produces a sample of 944 ethnic groups. Tables 4a and 4b present the summary and the correlation between geographical features and adherence rates to various religious denominations. Reassuringly, column 1 of table 3 shows that ethnic groups with large Muslim adherence in the Old World and out of the direct control of a Muslim empire, consistently exhibit a high frequency of poor quality regions, $\%low_lq$, and a large variability in regional agricultural fertility, sd_lq , i.e. have an underlying geography that would make Islamic principles more likely to be adopted. Conditional on country, continental and colonizer's identity fixed effects, a one standard deviation increase in $\%low_lq$ and sd_lq increases Muslim representation by 13%.

In columns 2 to 4 we use as dependent variable the percentage of people within an ethnic group adhering to 3 other major religions i.e. Christianity, Buddhism and Hinduism respec-

⁴³This is done by identifying the set of modern day countries that these empires dominated in the past and exclude them from the analysis.

tively, whereas the share of non-religious is used in column 5. The insignificant relationship between inequality in geographical endowments as captured by the share of poor regions and the variance of land quality on the one hand, and the adherence rate to any of other major religion on the other, implies that the geographic factors identified are a driving force unique to the formation of Muslim adherence across ethnic groups.

4.2.2 Robustness Checks on Cross-Ethnic Group Analysis

The share of poorly endowed regions, $\%low_lq$, within an ethnic group so far has been set below 10% of agricultural potential. To make sure that there is nothing inherent in the choice of this threshold we use alternative thresholds of defining a low land quality area. These are 20%, 15% and 5% denoted by $\%low_lq20pc$, $\%low_lq15pc$ and $\%low_lq5pc$ respectively. Table 5a presents the summary statistics and Table 5b shows that these new statistics are highly correlated with the measure already used.

Table 6 performs a series of robustness checks on the cross ethnic group analysis using these alternative indexes as the share of poor land quality regions. Note that the additional regressors, not shown for brevity, are identical to those used in column 2 of Table 2 which is replicated for convenience in the first column of table 6. In columns 2, 3 and 4 the poor regional shares with the different fertility thresholds are introduced. Across all specifications a larger fraction of poor land quality areas as well as more variable land endowments have a systematically positive effect on Muslim adherence at an ethnic group level, demonstrating the robustness of the findings to alternative indexes of geographical inequality.

This section shows that Islam was more eagerly adopted by ethnic groups historically residing on unequally distributed agricultural endowments. According to the theory it was along these regions that the institutional arrangements of Islam would be more likely accepted among indigenous populations in the preindustrial world. Considering that (i) inequality in land endowments is significant in shaping only Muslim adherence (ii) after controlling for country fixed effects and (iii) the results hold for ethnic groups that historically were not subject to the direct rule of any Muslim empire, enhances the plausibility of the proposed theory.

These findings uncover the so far neglected crucial role of geographical inequality in shaping the differential adherence to the Islamic religion across ethnic groups and shed new light on the geographical origins and spatial distribution of Muslims within modern day countries.

4.3 Cross-Virtual Country Analysis

So far, the empirical analysis has focuses on the role of geography in shaping Islamic representation across ethnic groups. The theory's predictions however, do not require a specific unit

of analysis and in fact are amenable to understanding the spread of Islamic principles across arbitrary sets of contiguous regions. The decision, for example, to adopt Islam may depend not only on the distribution of land quality within a group’s homeland but also on the overall distribution of land quality of the larger area to which a group belongs. This is the empirical strategy pursued in this section. We arbitrarily divide the world into geographical entities of a fixed size, called virtual countries and we ask how the distribution of land quality in these places shapes local Muslim adherence.

The way that the artificial countries are constructed is the following. First, we generate a global grid where each cell is 2.5 degrees longitude by 2.5 degrees latitude and then we intersect it with the global data on land quality. Map 2 in Appendix A shows the resulting virtual countries and Map 3 zooms in one of those. This virtual country belongs to 4 modern day countries. The northern part belongs to Syria, a tiny piece of land in the northwestern part is Lebanese, the southern part to Jordan and a small part in the East to Iraq. Note that since the dimensions of the virtual countries are in decimal degrees the actual area of each cell is declining further from the equator, so the size of each virtual country and its distance from the equator are necessary controls.

For each artificial country, we construct the distribution of land quality using information on land agricultural suitability at the regional level of 0.5 by 0.5 decimal degrees. In order to derive an estimate of Muslim adherence within an artificial country we weigh the Muslim population of each ethnic group found within a virtual country by the fraction of the area each ethnic group traditionally occupies in this grid.⁴⁴ The artificial country in Map 3 has a Muslim representation of 99% with 76% of its regions being poorly endowed for agricultural activities.

In the regression analysis virtual countries of at least 10000 square kilometers are included yielding an average virtual country of $areakm2 \approx 44000$ square kilometers. The resulting sample size is 1925 observations with a median of 25 regions. A virtual country falls on average into 7 ethnic groups, $\#groups$. Descriptive statistics and the raw correlation between the

⁴⁴For example, the Muslim adherence in 2005 for the virtual country depicted in Map 3 is as follows: There are in total 11 ethnic groups in this grid. The dominant one is the Najdi Spoken Arabic group in Syria which is found in 56% of this virtual country’s area with 99% Muslims, the Najdi Spoken Arabic in Lebanon with 32% area coverage and 99% Muslims, the North Levantine Spoken Arabic in Syria with 7% area coverage and 93% Muslims, the Levantine Bedawi Spoken Arabic in Jordan found in 2.5% of this virtual county with 99% Muslims, the Najdi Spoken Arabic in Iraq with 1.3% area coverage and 99% Muslims, the North Levantine Spoken Arabic in Lebanon found in 0.69% of the virtual country with 58% Muslims, the Adyghe group in Syria with 0.4% of territorial coverage and 99% Muslims, the South Levantine Spoken Arabic group in Jordan covering 0.1% with 92% Muslims, the Western Neo-Aramaic group in Syria covering 0.01% with 92% Muslims. For two groups in Syria, i.e. the Mesopotamian Spoken Arabic group with a coverage of 2.2% and the Levantine Bedawi Spoken Arabic with a coverage of 4.7% we do not have data on the religious affiliation so are not included in the analysis. Using this information on land coverage and Muslim proportions we calculate for each artificial country the probability of picking a Muslim adherent in 2005. Similar is the procedure followed for calculating adherence to other religious denominations.

variables used in the regressions are presented in Tables 7a and 7b. In each virtual country, there are on average 22% of Muslims and the pairwise correlations of the share of poor land quality regions, $\%low_lq$, and Muslim adherence is large and positive.

For the cross-virtual country regressions the following specification is adopted⁴⁵:

$$\%Muslim_i = a_0 + a_1\%low_lq_i + a_2X_i + \eta_i \quad (32)$$

Column 1 of table 8 shows that the fraction of low land quality regions as well as the variance of regional fertility, sd_lq , systematically shape the religious adherence across virtual countries towards Islam. A one standard deviation increase in $\%low_lq$ and lq_sd increases Muslim representation by 16% contributing significantly to the formation of Muslim communities. The partial scatter plot between the share of regions with low agricultural potential and Muslim adherence in 2005 *AD* using as controls those of regression 1 is produced in Figure 1 and shows the strong positive relationship. By taking advantage of the arbitrarily drawn borders of these geographical entities, controls for country, continental and colonizer's identity fixed effects are included in all specifications.⁴⁶ Average land quality, avg_lq , and the area of virtual country, $areakm2$, are not statistically significant whereas the more countries a virtual country falls into, $\#_cntry$, the higher is Muslim adherence. This finding may be suggestive of national borders drawn along regions with large Muslim populations and/or a consequence of modern day Muslim countries being systematically smaller than a non-Muslim country.⁴⁷

The distance from Mecca of each artificial country negatively affects Muslim intensity. Likewise, virtual countries further away from the equator, located at higher altitudes, $elev$, and having more ethnic groups, $ln\#groups$, sustain smaller Muslim populace. Finally and perhaps surprisingly, virtual countries characterized by a larger fraction of regions without access to permanent water bodies, $\%nowater$, systematically exhibit fewer Muslims in 2005.

In specifications 2 and 3 of Table 8 we focus on different cuts of the data. In particular, in column 2 the sample consists of virtual countries of the Old World. Similar to the ethnic group findings, an unequal geography shapes Muslim intensity across virtual countries in Africa, Asia and Europe with the point estimates of land quality variability and the share of poor land

⁴⁵The results presented here are OLS estimates with the standard errors adjusted for spatial autocorrelation following Conley (1999). This correction requires the choice of a cutoff distance, beyond which artificial countries do not influence each other. After projecting the world into the euclidean space using the Plate Carrée projection I use a cutoff distance of 6000 km. Results are similar using 3000 km., 7000 km., and 8000 km.

⁴⁶For virtual countries falling into more than one country they are assigned the value of zero across the country and colonizer's fixed effects. Alternatively, for these virtual countries one could assign as country dummies instead of zeros the fraction of the virtual country's area that falls into each country. Doing so does not change the results.

⁴⁷The cross-country analysis in the next section shows that larger modern-day countries have lower Muslim representation.

endowments increasing in magnitude. In column 3, in order to alleviate concerns related to conversion into Islam across places within a Muslim empire we further restrict the sample into virtual countries of the Old World beyond the control of any Muslim empire. Doing so we are able to estimate the role of geography in shaping Muslim penetration across territories where religious coercion and tax discrimination in favor of Muslims is a lesser concern. In this sample geographic inequality, as measured by a large share of poor regions and heterogeneous land endowments, systematically increases Muslim adherence at a virtual country level.

In the last 3 columns of table 8 we use as dependent variable the adherence in other religious denominations. Despite the large negative raw correlation between Muslim and Christian adherence across virtual countries (-0.64), column 3 shows that although the signs on the share of poor quality regions and land quality variability reverse, the estimates are insignificant. This implies that land inequality does not systematically determine Christian shares across virtual countries.⁴⁸ Similar non-findings regarding the effect of unequal geography obtain for the share of Buddhists and non-religious. These specifications show that the geographic pattern that increases Muslim intensity is not a significant force in determining adherence rates across different religious groups.

4.3.1 Robustness Checks on Virtual-Country Analysis

In this section we perform a series of robustness checks using alternative thresholds of defining a poorly endowed region. Tables 9a presents the summary statistics and Table 9b shows that these statistics are highly correlated with the measure of low land quality regions already employed.

Table 10 uses these alternative measures of poorly endowed regions as the main regressor. Note that the additional regressors, not shown for brevity, are identical to those used in column 2 of Table 8 which is replicated in the first column of table 10. In columns 2, 3 and 4 the poor regional shares with the different quality thresholds are introduced. Across all specifications the larger the fraction of low land quality regions as well as more variable land endowments both have a systematically positive impact on Muslim adherence across virtual countries.

This section establishes that across sets of contiguous regions those exhibiting a larger share of poor land areas and higher variability of agricultural suitability bring forward and sustain larger Muslim populations. Considering that these results (i) obtain at an arbitrary level of aggregation, (ii) are significant only in explaining Muslim adherence, (iii) hold after

⁴⁸Controlling for the share of Muslims within a virtual country the point estimates on *%low_lq* and *sd_lq* drop substantially. On the other hand, in the Muslim adherence regressions in column 3, when including explicitly the share of Christians the estimates on geographical inequality remain both quantitatively and qualitatively significant.

controlling for country and continental fixed effects, and (iv) obtain for virtual countries non-subject to any Muslim empire historically, highlight the geographical origins of Islam.

4.4 Cross-Country Analysis

In the last part of the empirical section we investigate the relationship between Islam and land inequality across modern day countries. Regional observations within a country extend from a single observation for Monaco to 12279 for Russia. The median is 82. Map 4a in Appendix A shows that existing countries vary widely in the share of poor agricultural endowments. The descriptive statistics and the raw correlations between the variables of interest are presented in Tables 11a and 11b. A country has on average 22% of poor agricultural lands, $\%low_lq$, whereas in 1900 AD an average country had about 21% of Muslims. These two variables have a correlation of 0.50.

Maps 4a and 4b juxtapose the regional agricultural inequality at a country level with the distribution of Muslim representation in 1900 AD. A visual inspection reveals a rather telling parallel. Countries with a larger share of poor agricultural endowments are characterized by a larger adherence to the Islamic religion.

To estimate the effect of geographical inequality on Muslim adherence the following specification is adopted:

$$\%Muslim1900_i = a_0 + a_1\%low_lq_i + a_2X_i + \eta_i \quad (33)$$

where $Muslim1900_i$ is the fraction of the population adherent to Islam in 1900 AD.

The results of the main specification (33) are presented in column 1 of Table 12.⁴⁹ A one standard deviation increase in the fraction of poorly endowed regions, $\%low_lq$, increases the fraction of the Muslim population by 19%. Figure 2 presents the partial scatter plot of regression 1 between the share of regions with low agricultural potential and Muslim representation in 1900AD. The variance of a country's agricultural endowment, sd_lq , enters positive and significant. An heterogeneous distribution of agricultural suitability implies that there are differential gains from trade based on local agricultural production and, thus, it is consistent with the theoretical prediction that Muslim principles are more likely to be adopted in places with large differences in the productive potential. A one-standard deviation increase in the variance of land quality increases Muslim representation by 5% contributing significantly to the formation of Islamic identity.⁵⁰ The average land quality, avg_lq , is insignificant whereas

⁴⁹We focus on countries with at least 10 regional observations to ensure that our findings are not driven by insufficient data.

⁵⁰Quadratic terms of the share of poor regions and of the variance of land quality are consistently insignificant. Similarly, historical population density in 1000 AD enters highly insignificant.

in larger countries, *areakm2*, Muslim representation decreases. To the extent that geographical distance increases the costs of enforcing social norms in general, then larger places would be less likely to adopt Muslim institutions.⁵¹ In the same specification a set of continental dummies is included. As expected countries in Western Europe, Pacific and the Americas, have fewer Muslims, whereas those in the Middle East and Northern Africa, *reg_mena*, have a larger Muslim populace.⁵²

In column 2 the distance from Mecca of each country's centroid, *dmecca*, is accounted for. It enters negatively suggesting that modern day countries further away from where Islam was founded, i.e. Mecca, have systematically a lower representation of Muslim populations. In the 3rd column of table 12, additional geographical controls that might be correlated both with the share of poor quality regions and the Muslim adherence are introduced. The mean elevation, *elev*, within a country is negative and significant. The mean distance to the nearest coastline or sea-navigable river, denoted by *sea_dist*, comes up strongly positive and significant. This finding might be explained as follows: regions with easy water access are able to take advantage of trade by directly using the water passages. On the other hand, as distance from the sea increases, then in order to reach the markets, more regions have to be crossed, increasing the probability of being raided, for any level of geographical inequality. The distance from the equator, denoted by *abs_lat*, has a strong negative effect on Muslim representation. The fraction of regions within a country without access to a permanent water body, like rivers or lakes, denoted by *%nowater*, is also added in the regression. This is an alternative index that may capture inequality in the distribution of water resources. It enters positively as expected, however it is insignificant and thus dropped from the analysis. These geographical controls do not change the economic and statistical significance of inequality in agricultural endowments, highlighting the robustness of our findings.

In column 4 of Table 12 we control for differences in the historical contingencies across countries. The first variable captures whether a country in 1900 AD had a state religion, *staterel1900*, whereas *shist600ad* proxies for the experience of each country with statehood, in the eve of the Islamic expansion in the 7th century AD. State religion enters negatively and it is insignificant. On the other hand, the positive though marginally insignificant coefficient on *shist700ad* suggests that Islam targeted and expanded in places which at the beginning of the 7th century were characterized by an extensive previous experience with some form of centralized governance. Conditional on historical and geographical controls, one standard deviation

⁵¹Generally, it has been shown both theoretically and empirically the role of geographic proximity among individuals in providing the tools to reduce information and enforcement problems within networks. See Fafchamps and Lund (2003) and Karlan et al. (2008).

⁵²The omitted category includes countries in Eastern Europe and Asia.

increase in the share of regions with poorly endowed lands increases Muslim representation by 17%.

The last two columns of Table 12 split the sample of countries between the New and the Old World. Consistent with the pattern identified in the cross-ethnic group regressions and as expected, geography is a fundamental determinant of Muslim adherence across countries in the Old World, and plays no role in explaining contemporary Muslim representation across countries in the New World.

Table 14 performs a series of robustness checks on the cross country analysis using alternative indexes for the share of land quality regions. Table 13a presents the summary statistics and Table 3b shows that these new statistics, *%lq15pc*, *%lq20pc*, *%lq5pc*, are highly correlated with the measure already used. Note that the additional regressors, not shown for brevity, are identical to those used in column 4 of Table 12. The latter is replicated in the first column of table 14. In columns 2, 3 and 4 the poor regional shares with the different quality thresholds are introduced. Across all specifications the larger the fraction of low land quality regions as well as more variable land endowments both have a systematically positive effect on Muslim adherence, demonstrating the robustness of the findings to alternative indexes of geographical inequality.

This section corroborates the pattern uncovered in the cross-ethnic and cross-virtual country analysis i.e. a large share of poorly endowed places and a high variance of agricultural suitability bring forward larger Muslim populations. These findings demonstrate the key role of geographical inequality in determining adherence to the Islamic religion across modern day countries.

5 Conclusion

This research sheds new light on the origins of Islam. It identifies that Muslim lands are characterized by a particular type of geography and provides a unified theory that links geography to the formation of the Islamic principles and its impact on the economic performance in the pre-industrial era.

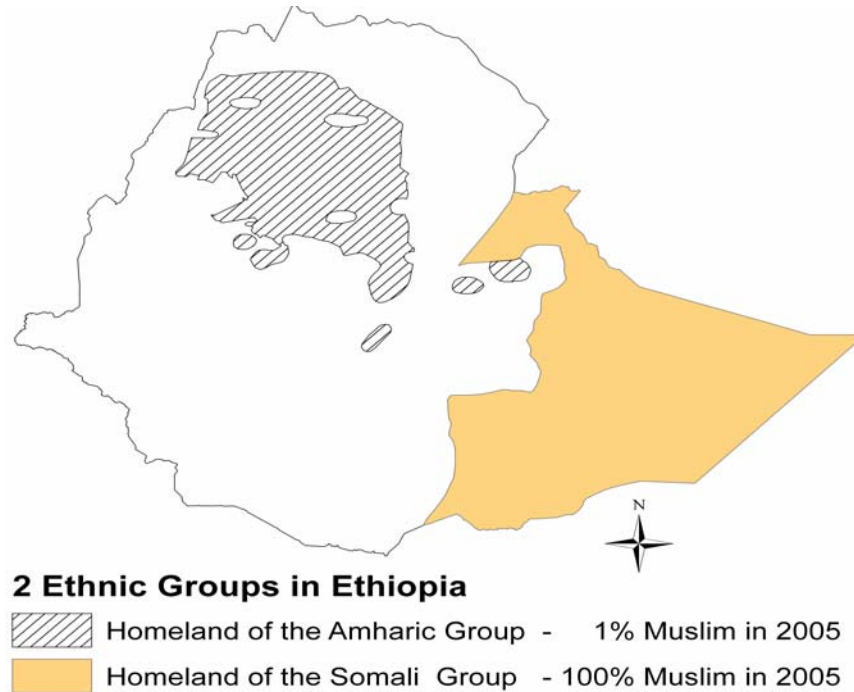
Constructing detailed data on the distribution of land quality across countries, ethnic groups and virtual countries, we show that places characterized by a large fraction of poorly endowed regions and variable agricultural potential systematically sustain larger Muslim communities. The virtual country analysis is of particular significance since the relationship between geographic inequality and Muslim adherence obtains at an arbitrary level of aggregation, explicitly avoiding the endogeneity of current countries' borders and after controlling for continental and country fixed effects. These results are further validated by looking into how the

distribution of agricultural suitability shapes Muslim adherence within ethnic groups. Ethnic groups located on unequal land endowments exhibit a larger Muslim representation. Further evidence shows that the identified significant impact of unequal agricultural endowments on religious affiliation is unique to the Muslim denomination and it obtains for virtual countries and ethnic groups that historically have not been part of any Muslim empire. Overall the empirical analysis highlights the prominent role of an unequal geography in shaping the spread and persistence of Islam.

These findings are consistent with the theory provided. We argue that geography forged the Islamic economic doctrine affecting the economic performance of Islamic lands. In particular, the unequal distribution of land endowments conferred differential gains from trade across regions, fostering predatory behavior from the poorly endowed ones. In such an environment, it was mutually beneficial to institute a system of income redistribution. However, a higher propensity to save by the rich would exacerbate wealth inequality rendering redistribution unsustainable, leading to the demise of the Islamic unity. Consequently, wealth inequality had to remain within limits for Islam to persist. This was instituted by increasing the costs of physical capital accumulation rendering the investments on labor productivity enhancing public goods, through religious endowments, increasingly attractive. The Islamic economic principles allowed the Muslim lands to escape from a state of constant feuding and flourish in the preindustrial world limiting the potential for growth in the eve of large scale shipping trade and industrialization.

6 Appendix A

Map 1a: Location and Muslim Representation across Groups in Ethiopia
The Case of the Amharic and Somali Ethnicities



Map 1b: Regional Land Quality across Groups in Ethiopia
The Case of the Amharic and Somali Ethnicities

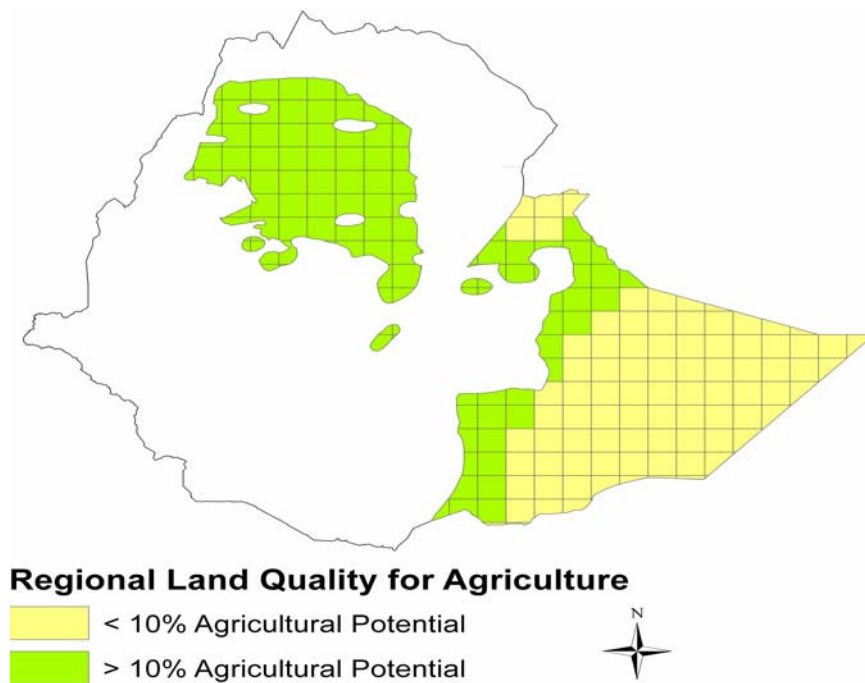


Table 1a: Summary Statistics for the Cross-Ethnic Group Analysis

<i>_stats</i>	%Muslim	%low_lq	avg_lq	areakm2	dmecca	sd_lq	elev	sea_dist	%nowater	shist600ad	staterel00
<i>mean</i>	0.21	0.18	0.41	0.54	5.93	0.12	0.68	0.57	0.45	1.33	0.24
<i>sd</i>	0.37	0.34	0.24	3.07	3.40	0.09	0.76	0.48	0.31	0.47	0.43
<i>max</i>	1.00	1.00	0.99	80.47	15.68	0.50	5.29	2.53	1.00	2.00	1.00
<i>min</i>	0.00	0.00	0.00	0.01	0.44	0.00	-0.67	0.00	0.00	1.00	0.00

See Appendix B for variables' definitions

Table 1b: The Correlation Matrix for the Cross Ethnic Group Analysis

	%Muslim	%low_lq	avg_lq	areakm2	dmecca	sd_lq	elev	sea_dist	%nowater	shist600ad	staterel00
%Muslim	1.00										
%low_lq	0.29	1.00									
avg_lq	-0.20	-0.72	1.00								
areakm2	0.02	0.11	-0.05	1.00							
dmecca	-0.34	-0.03	-0.01	0.01	1.00						
sd_lq	0.03	-0.24	0.39	0.11	-0.06	1.00					
elev	0.00	0.21	-0.08	0.00	-0.06	0.25	1.00				
sea_dist	0.05	0.10	-0.17	0.04	-0.27	-0.05	0.31	1.00			
%nowater	-0.20	-0.07	0.15	0.02	0.14	0.08	-0.12	-0.12	1.00		
shist600ad	0.15	0.06	0.18	0.01	-0.23	0.16	0.24	-0.08	0.00	1.00	
staterel00	0.19	0.13	0.02	-0.01	0.06	0.04	0.09	-0.10	0.02	0.36	1.00

See Appendix B for variables' definitions

Table 2: Cross Ethnic Group Analysis - Muslims in 2005 AD

VARIABLES	(1) %Muslim	(2) %Muslim	(3) %Muslim	(4) %Muslim
%low_lq	0.144*** (0.049)	0.144*** (0.049)	0.170*** (0.062)	0.001 (0.001)
sd_lq	0.551*** (0.152)	0.551*** (0.152)	0.630*** (0.207)	0.002 (0.003)
avg_lq	-0.079 (0.108)	-0.079 (0.108)	-0.120 (0.143)	0.001 (0.002)
areakm2	-0.002 (0.002)	-0.002 (0.002)	-0.005*** (0.001)	0.000*** (0.000)
dmecca	-0.099*** (0.018)	-0.099*** (0.018)	-0.125*** (0.020)	-0.000 (0.000)
%nowater	-0.037 (0.044)	-0.037 (0.044)	-0.036 (0.057)	0.001 (0.001)
elev	-0.033 (0.024)	-0.033 (0.024)	-0.044 (0.037)	-0.000 (0.000)
abs_lat	0.000 (0.004)	0.000 (0.004)	0.005 (0.007)	-0.000 (0.000)
sea_dist	0.043 (0.050)	0.043 (0.050)	0.013 (0.047)	-0.000 (0.000)
shist600AD		0.098*** (0.034)	0.150 (0.098)	0.000 (0.000)
staterel00		0.023 (0.021)	0.047 (0.079)	-0.001 (0.001)
Observations	1599	1599	1304	295
R^2	0.65	0.65	0.64	0.19

*** p<0.01, ** p<0.05, * p<0.1

Standard errors in parentheses are clustered at the country level,
All specifications include country and continental fixed effects and
a dummy for the Colonizer's identity, (3) focuses on Africa, Asia
and Europe, (4) focuses on the Americas and the Pacific
See Appendix B for variables' definitions

Table 3: Cross Ethnic Group Analysis - Other Religions in 2005 AD

VARIABLES	(1)	(2)	(3)	(4)	(5)
	%Muslim	%Christian	%Buddhist	%Hindu	%Non-Religious
%low_lq	0.280*** (0.086)	-0.107 (0.071)	0.028 (0.037)	0.013 (0.018)	-0.023 (0.019)
sd_lq	0.356** (0.144)	0.093 (0.141)	0.149 (0.096)	-0.020 (0.025)	0.040 (0.040)
avg_lq	-0.060 (0.131)	-0.056 (0.120)	-0.137** (0.064)	0.054 (0.047)	0.008 (0.021)
areakm2	-0.009*** (0.003)	0.007 (0.004)	0.004 (0.005)	-0.000 (0.000)	0.012*** (0.002)
dmecca	-0.162*** (0.025)	0.129*** (0.027)	0.010 (0.013)	-0.005 (0.005)	0.003 (0.004)
%nowater	-0.018 (0.058)	0.017 (0.041)	0.060** (0.024)	-0.010 (0.008)	0.005 (0.005)
elev	-0.123*** (0.024)	0.078** (0.030)	0.122** (0.047)	-0.025 (0.025)	-0.016** (0.007)
abs_lat	0.013* (0.007)	-0.006 (0.005)	-0.001 (0.004)	0.001 (0.001)	0.002 (0.001)
sea_dist	0.010 (0.077)	-0.017 (0.065)	-0.030 (0.038)	0.009 (0.014)	-0.015 (0.014)
shist600AD	-0.128 (0.091)	-0.109 (0.082)	0.269** (0.103)	0.100*** (0.027)	0.104*** (0.023)
staterel00	-0.170*** (0.042)	0.040 (0.047)	0.171*** (0.020)	0.120*** (0.005)	-0.094*** (0.007)
Observations	944	944	944	944	944
R^2	0.58	0.71	0.48	0.48	0.62

Standard errors in parentheses are clustered at the country level, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Sample focuses on ethnic groups within the Old belonging to countries that have not been part of a Muslim Empire. All specifications include country and continental fixed effects and a dummy for the Colonizer's Identity. See Appendix B for variables' definitions

Table 4a: Summary Statistics for the Cross-Ethnic Group Analysis - Main Religions

<i>_stats</i>	%Muslim	%Christian	%Hindu	%Buddhist	%Non-Religious	%low_lq	avg_lq	areakm2	sd_lq	dmecca
<i>mean</i>	0.21	0.43	0.03	0.03	0.02	0.18	0.41	0.54	0.12	5.93
<i>sd</i>	0.37	0.39	0.16	0.16	0.06	0.34	0.24	3.07	0.09	3.40
<i>max</i>	1.00	1.00	1.00	1.00	0.57	1.00	0.99	80.47	0.50	15.68
<i>min</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.44

See Appendix B for variables' definitions

Table 4b: The Correlation Matrix for the Cross Ethnic Group Analysis - Main Religions

	%Muslim	%Christian	%Hindu	%Buddhist	%Non-Religious	%low_lq	avg_lq	areakm2	sd_lq	dmecca
%Muslim	1.00									
%Christian	-0.54	1.00								
%Hindu	-0.09	-0.21	1.00							
%Buddhist	-0.11	-0.22	-0.03	1.00						
%Non-Religious	-0.10	0.02	-0.04	0.04	1.00					
%low_lq	0.29	-0.16	-0.03	0.05	0.07	1.00				
avg_lq	-0.20	0.06	0.16	-0.03	0.05	-0.72	1.00			
areakm2	0.02	0.01	-0.01	0.02	0.16	0.11	-0.05	1.00		
sd_lq	0.03	0.00	0.01	0.05	0.16	-0.24	0.39	0.11	1.00	
dmecca	-0.34	0.20	-0.10	0.01	-0.03	-0.03	-0.01	0.01	-0.06	1.00

See Appendix B for variables' definitions

Table 5a: Summary Statistics for Alternative Thresholds of Poor Land Quality -Ethnic Group Analysis

<i>_stats</i>	%Muslim	%low_lq	%lq15pc	%lq20pc	%lq5pc	sd_lq
<i>mean</i>	0.19	0.17	0.20	0.22	0.14	0.12
<i>sd</i>	0.36	0.33	0.34	0.36	0.30	0.09
<i>max</i>	1.00	1.00	1.00	1.00	1.00	0.49
<i>min</i>	0.00	0.00	0.00	0.00	0.00	0.00

See Appendix B for variables' definitions

Table 5b: Correlation Matrix for Alternative Thresholds of Poor Land Quality - Ethnic Group Analysis

	%Muslim	%low_lq	%lq15pc	%lq20pc	%lq5pc	sd_lq
%Muslim	1.00					
%low_lq	0.27	1.00				
%lq15pc	0.27	0.98	1.00			
%lq20pc	0.28	0.94	0.98	1.00		
%lq5pc	0.28	0.97	0.92	0.87	1.00	
sd_lq	0.05	-0.25	-0.22	-0.21	-0.28	1.00

See Appendix B for variables' definitions

Table 6: Robustness Checks for the Ethnic Group Analysis
Alternative Land Quality Thresholds for Poor Regions

	(1)	(2)	(3)	(4)
VARIABLES	%Muslim	%Muslim	%Muslim	%Muslim
%low_lq	0.144*** (0.049)			
%lq20pc		0.116** (0.046)		
%lq5pc			0.184*** (0.049)	
%lq15pc				0.168*** (0.051)
sd_lq	0.551*** (0.152)	0.560*** (0.153)	0.503*** (0.147)	0.530*** (0.149)
Observations	1599	1599	1599	1599
R^2	0.65	0.65	0.65	0.65

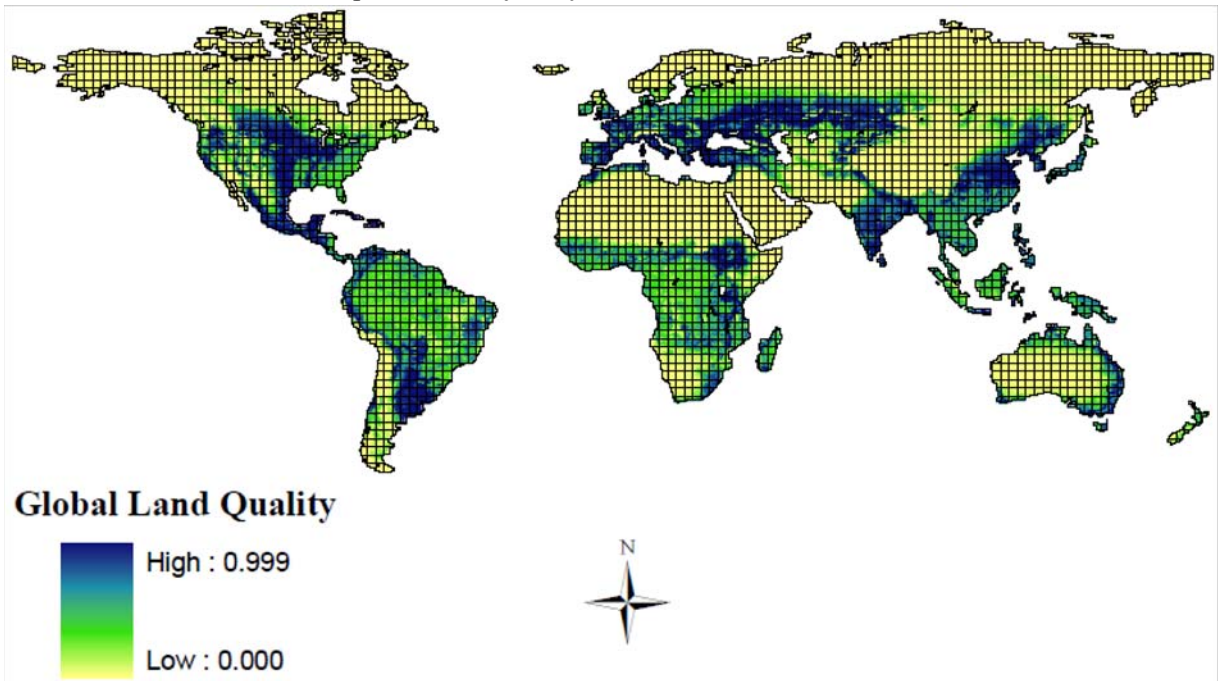
Standard errors in parentheses are clustered at the country level,

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

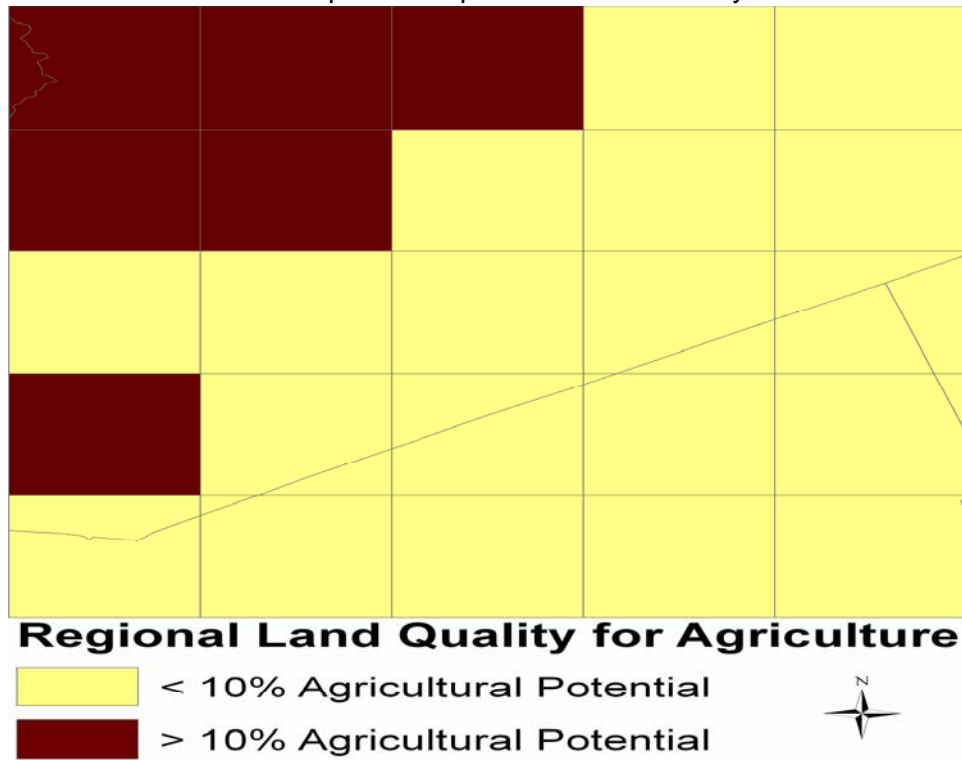
All specifications include the controls of specification (2) of Table 2

See Appendix B for variables' definitions

Map 2: Land Quality Across Virtual Countries



Map 3: Example of a virtual country



This Virtual Country falls between Iraq, Jordan, Lebanon and Syria. In 2005, 99% of the population are Muslim adherents

Table 7a: Summary Statistics for the Cross-Virtual Country Analysis

<i>_stats</i>	%Muslim	%Christian	%Buddhist	%Non-Religious	%low_lq	sd_lq	dmecca	avg_lq	#groups	in_cntry
<i>mean</i>	0.22	0.49	0.05	0.08	0.40	0.10	6.50	0.33	6.73	0.63
<i>sd</i>	0.38	0.39	0.16	0.11	0.45	0.09	3.47	0.30	11.67	0.48
<i>max</i>	1.00	1.00	1.00	0.70	1.00	0.47	15.36	0.99	165.00	1.00
<i>min</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	1.00	0.00

See Appendix B for variables' definitions

Table 7b: The Correlation Matrix for the Cross Virtual Country Analysis

	%Muslim	%Christian	%Buddhist	%Non-Religious	%low_lq	sd_lq	dmecca	avg_lq	#groups	in_cntry
%Muslim	1.00									
%Christian	-0.64	1.00								
%Buddhist	-0.15	-0.31	1.00							
%Non-Religious	-0.24	0.00	0.07	1.00						
%low_lq	0.24	-0.14	0.03	-0.12	1.00					
sd_lq	-0.06	0.07	-0.01	0.09	-0.63	1.00				
dmecca	-0.53	0.37	-0.02	0.10	-0.16	0.06	1.00			
avg_lq	-0.19	0.10	-0.02	0.20	-0.85	0.57	0.11	1.00		
#groups	-0.01	-0.02	0.02	-0.20	-0.26	0.18	-0.02	0.18	1.00	
in_cntry	-0.17	0.11	-0.01	0.06	0.14	-0.18	0.22	-0.10	-0.23	1.00

See Appendix B for variables' definitions

Table 8: Muslim World in 2005 - Virtual Country Analysis

	(1)	(2)	(3)	(4)	(5)	(7)
VARIABLES	%Muslim	%Muslim	%Muslim	%Christian	%Buddhist	%Non-Religious
%low_lq	0.259*** (0.062)	0.338*** (0.075)	0.391*** (0.149)	-0.250 (0.153)	-0.021 (0.023)	-0.035 (0.023)
sd_lq	0.435*** (0.129)	0.603*** (0.168)	0.575** (0.240)	-0.182 (0.245)	-0.041 (0.076)	-0.017 (0.074)
avg_lq	0.041 (0.049)	0.041 (0.067)	0.133* (0.093)	-0.142 (0.127)	-0.064 (0.040)	0.044* (0.024)
areakm2	-0.012 (0.066)	-0.017 (0.086)	-0.072 (0.104)	-0.113** (0.045)	0.023 (0.044)	0.069** (0.032)
dmecca	-0.060*** (0.013)	-0.066*** (0.013)	-0.035 (0.028)	0.011 (0.032)	-0.010 (0.009)	0.010*** (0.007)
in_centry	0.054 (0.047)	0.127 (0.091)	-0.207 (0.187)	-0.188 (0.156)	0.628*** (0.062)	0.031 (0.038)
#_centry	0.054*** (0.017)	0.034* (0.019)	0.032 (0.020)	-0.017 (0.024)	-0.003 (0.011)	-0.005 (0.005)
elev	-0.047** (0.020)	-0.057** (0.026)	-0.090** (0.023)	0.029** (0.028)	0.159*** (0.017)	-0.048*** (0.006)
abs_lat	-0.004*** (0.001)	-0.006*** (0.002)	-0.008*** (0.003)	0.008*** (0.003)	-0.001 (0.001)	0.003*** (0.001)
sea_dist	-0.000 (0.000)	0.000 (0.000)	0.000* (0.000)	-0.000 (0.000)	-0.000*** (0.000)	0.000 (0.000)
%nowater	-0.133*** (0.034)	-0.168*** (0.054)	0.014 (0.058)	-0.003 (0.048)	0.065*** (0.019)	-0.016 (0.010)
ln#groups	-0.042*** (0.015)	-0.057*** (0.013)	-0.054*** (0.020)	0.049** (0.027)	-0.024* (0.013)	-0.024* (0.013)
Observations	1925	1466	687	687	687	687
R ²	0.76	0.75	0.64	0.78	0.76	0.73

*** p<0.01, ** p<0.05, * p<0.1

Standard errors in parentheses, corrected for spatial autocorrelation, Conley (1999),

All specifications include country and continental fixed effects and a dummy for the Colonizer's Identity,

Specification 1 includes all Virtual Countries worldwide, 2 focuses on Virtual Countries within the Old

World i.e., Europe, Asia, Africa, Specifications 3-7 focus on Virtual Countries in the Old World that

have not been part of a Muslim Empire

See Appendix B for variables definitions

Figure 1

Muslims and % of Low Quality Regions across Virtual Countries

Within the Old World, Conditional on Geographical Controls, Country and Continental FE

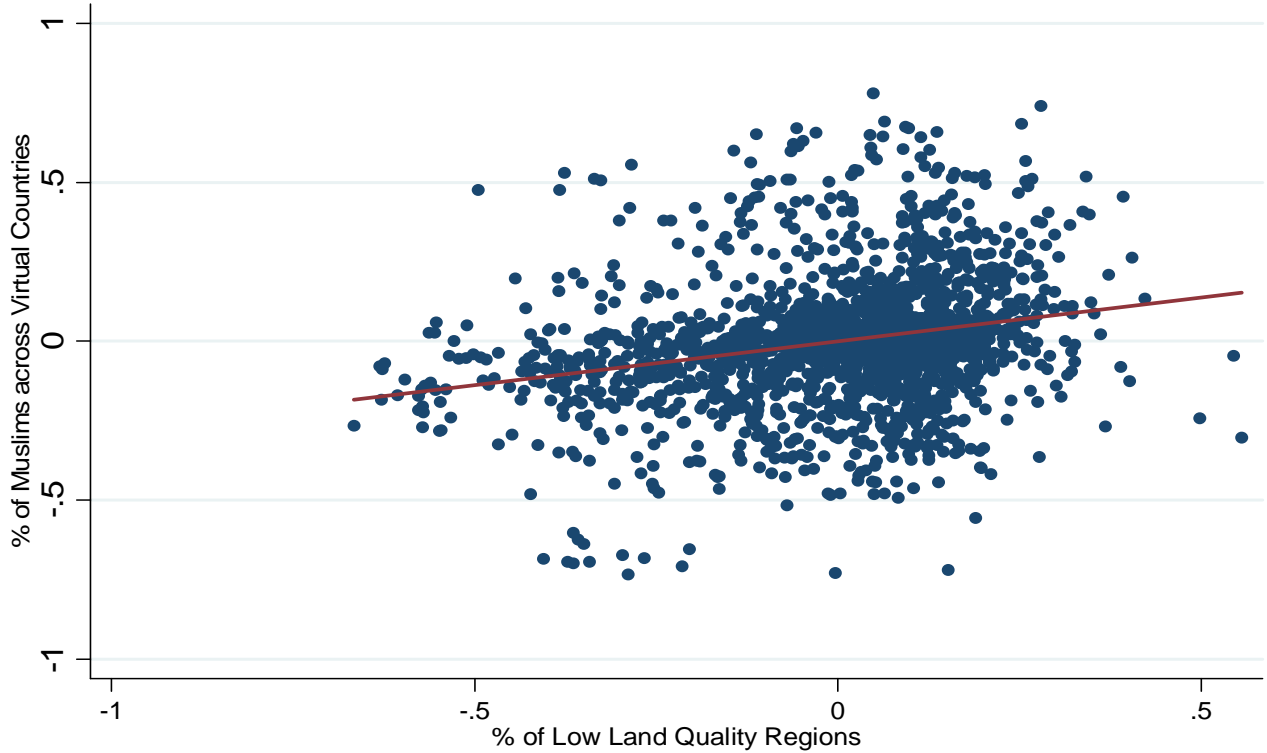


Table 9a: Summary Statistics for Alternative Thresholds of Poor Land Quality - Virtual Country Analysis

<i>_stats</i>	%Muslim	%low_lq	%lq15pc	%lq20pc	%lq5pc	sd_lq
<i>mean</i>	0.29	0.45	0.48	0.50	0.39	0.09
<i>sd</i>	0.41	0.46	0.46	0.46	0.45	0.09
<i>max</i>	1.00	1.00	1.00	1.00	1.00	0.47
<i>min</i>	0.00	0.00	0.00	0.00	0.00	0.00

See Appendix B for variables' definitions

Table 9b: Correlation Matrix for Alternative Thresholds of Poor Land Quality - Virtual Country Analysis

	%Muslim	%low_lq	%lq15pc	%lq20pc	%lq5pc	sd_lq
%Muslim	1.00					
%low_lq	0.21	1.00				
%lq15pc	0.21	0.99	1.00			
%lq20pc	0.21	0.97	0.99	1.00		
%lq5pc	0.24	0.96	0.93	0.90	1.00	
sd_lq	-0.04	-0.68	-0.66	-0.64	-0.68	1.00

See Appendix B for variables' definitions

Table 10: Robustness Checks for the Virtual Country Analysis
Alternative Land Quality Thresholds for Poor Regions

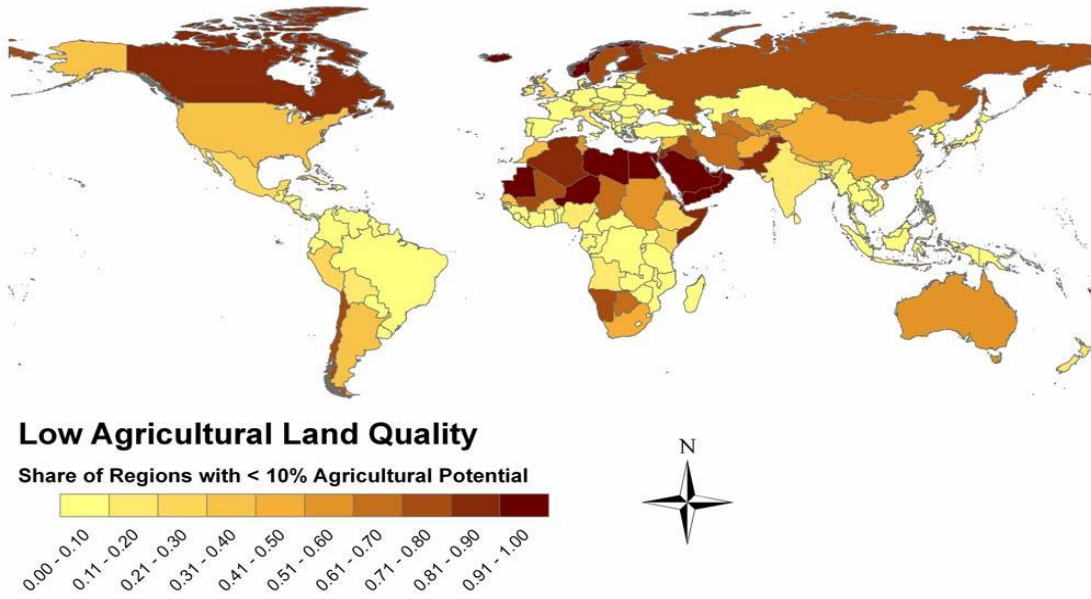
VARIABLES	(1)	(2)	(3)	(4)
	%Muslim05	%Muslim	%Muslim	%Muslim
%low_lq	0.338*** (0.076)			
%lq20pc		0.402*** (0.074)		
%lq5pc			0.260*** (0.061)	
%lq15pc				0.378*** (0.083)
sd_lq	0.603*** (0.168)	0.442*** (0.145)	0.585*** (0.164)	0.531*** (0.158)
Observations	1466	1466	1466	1466
R^2	0.75	0.75	0.75	0.75

*** p<0.01, ** p<0.05, * p<0.1

Standard errors corrected for spatial autocorrelation, Conley (1999)

All specifications include the controls of Table 8 and focus on Virtual Countries in the Old World. See Appendix B for variables' definitions

Map 4a: Fraction of Regions with Low Land Quality Across Countries



Map 4b: % of Muslim Population in 1900 Across Countries

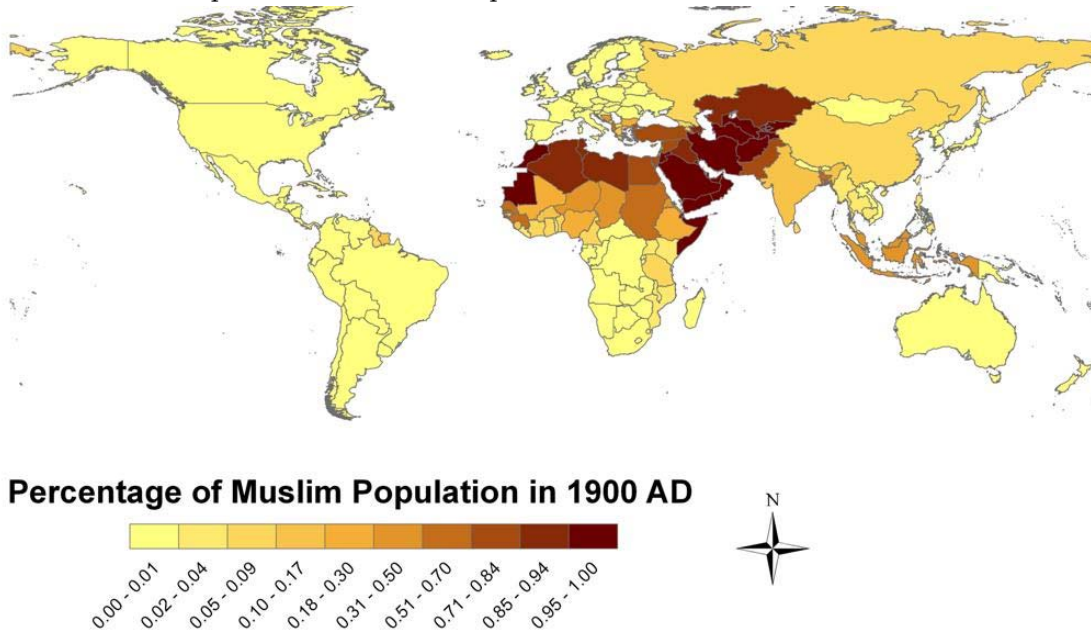


Table 11a: Summary Statistics for the Cross-Country Analysis

<i>_stats</i>	Muslim1900	%low_lq	avg_lq	areakm2	sd_lq	dmecca	elev	%nowater	sea_dist	staterel1900	shist600ad
<i>mean</i>	0.21	0.22	0.46	9.29	0.20	5.73	0.60	0.53	0.37	0.63	0.23
<i>sd</i>	0.35	0.32	0.24	22.09	0.09	3.57	0.53	0.24	0.47	0.49	0.31
<i>max</i>	1.00	1.00	0.96	169.45	0.42	15.07	2.91	0.99	2.39	1.00	1.00
<i>min</i>	0.00	0.00	0.00	0.11	0.00	1.03	0.02	0.01	0.02	0.00	0.00

See Appendix B for variables' definitions

Table 11b: The Correlation Matrix for the Cross Country Analysis

	Muslim1900	%low_lq	avg_lq	areakm2	sd_lq	dmecca	elev	%nowater	sea_dist	staterel1900	shist600ad
Muslim1900	1.00										
%low_lq	0.50	1.00									
avg_lq	-0.38	-0.82	1.00								
areakm2	-0.04	0.29	-0.28	1.00							
sd_lq	0.09	-0.04	0.08	0.19	1.00						
dmecca	-0.41	-0.20	0.20	0.18	-0.02	1.00					
elev	0.16	0.18	-0.12	0.04	0.38	-0.12	1.00				
%nowater	0.41	0.25	-0.29	-0.02	0.03	-0.27	0.22	1.00			
sea_dist	0.32	0.39	-0.41	0.44	0.14	-0.23	0.40	0.24	1.00		
staterel1900	0.17	0.17	-0.08	0.00	-0.03	-0.03	0.13	0.02	0.12	1.00	
shist600ad	0.35	0.18	0.02	-0.05	0.28	-0.29	0.16	0.11	-0.11	0.20	1.00

See Appendix B for variables' definitions

Table 12: Cross Country Analysis - Muslim World in 1900 AD

VAR.	(1)	(2)	(3)	(4)	(5)	(6)
	%Muslim	%Muslim	%Muslim	%Muslim	%Muslim	%Muslim
%low_lq	0.538*** (0.122)	0.482*** (0.122)	0.514*** (0.127)	0.483*** (0.136)	-0.007 (0.018)	0.505*** (0.152)
sd_lq	0.585** (0.240)	0.501** (0.238)	0.561** (0.219)	0.493** (0.229)	-0.022 (0.039)	0.562** (0.281)
avg_lq	0.001 (0.125)	-0.054 (0.129)	0.078 (0.111)	0.024 (0.128)	-0.039 (0.033)	0.008 (0.168)
areakm2	-0.003*** (0.001)	-0.003*** (0.001)	-0.004*** (0.001)	-0.004*** (0.001)	-0.000 (0.000)	-0.005*** (0.001)
dmecca		-0.027* (0.016)	-0.023 (0.016)	-0.021 (0.016)	-0.008 (0.007)	-0.014 (0.020)
elev			-0.099* (0.053)	-0.102* (0.053)	-0.002 (0.008)	-0.102* (0.055)
abs_lat			-0.004*** (0.002)	-0.004** (0.002)	0.000 (0.000)	-0.003 (0.003)
sea_dist			0.198** (0.084)	0.220*** (0.081)	-0.021 (0.019)	0.240*** (0.088)
%nowater			0.095 (0.154)			
staterel1900				-0.024 (0.037)	-0.014 (0.011)	-0.034 (0.046)
shist600ad				0.126 (0.096)	0.014 (0.013)	0.156 (0.122)
reg_we	-0.376*** (0.072)	-0.372*** (0.069)	-0.233*** (0.065)	-0.270*** (0.058)		-0.290*** (0.066)
americas	-0.212*** (0.052)	-0.011 (0.116)	-0.078 (0.114)	-0.052 (0.124)		
reg_ssa	-0.080 (0.063)	-0.104 (0.069)	-0.242*** (0.087)	-0.193** (0.091)		-0.178 (0.115)
reg_mena	0.288*** (0.103)	0.238** (0.109)	0.240* (0.124)	0.245** (0.120)		0.244* (0.125)
pacific	-0.260*** (0.054)	-0.047 (0.128)	-0.071 (0.131)	-0.049 (0.143)	-0.013 (0.012)	
Observations	136	136	136	136	26	110
R ²	0.54	0.56	0.62	0.62	0.44	0.60

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Specification (5) focuses within the New World i.e. Americas and the Pacific, (6) within the Old World
See Appendix B for variables' definitions

Figure 2

Muslim World in 1900 and % of Poor Land Quality Regions

Conditional on Area, Mean and Variance of Land Quality and Continental FE

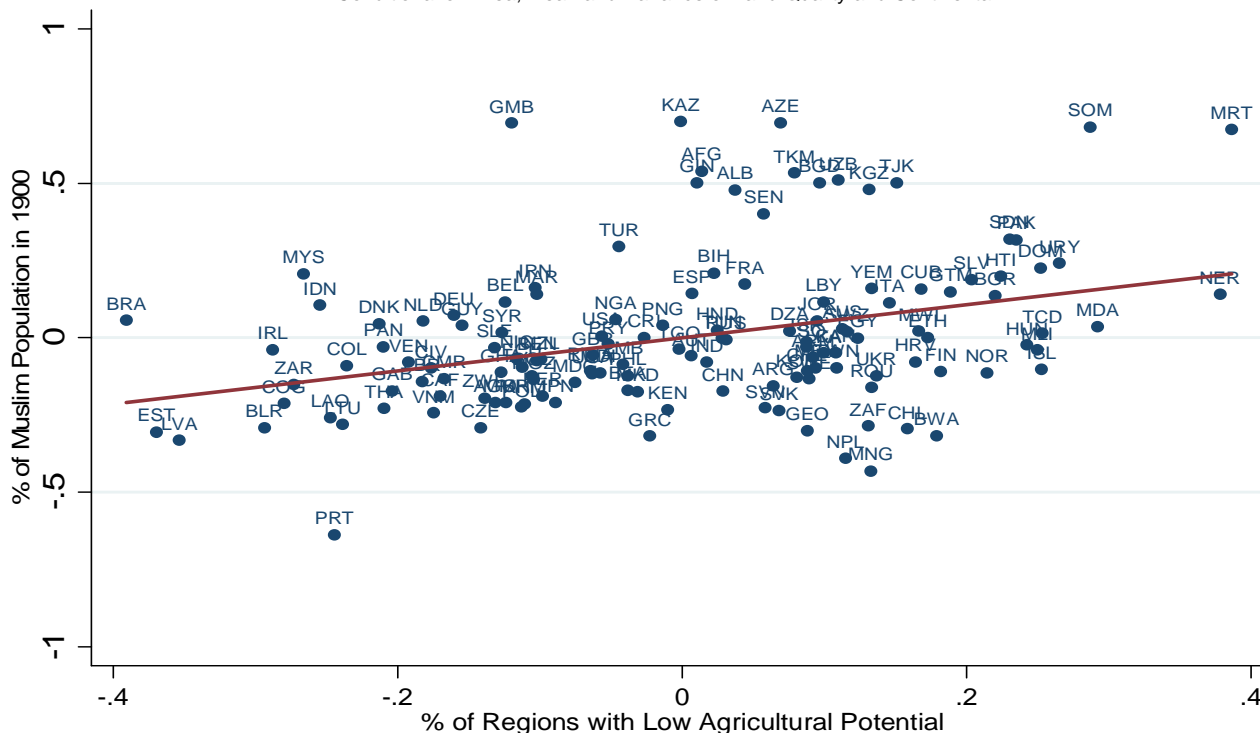


Table 13a: Summary Statistics for Alternative Thresholds of Poor Land Quality - Cross-Country Analysis

<i>_stats</i>	Muslim1900	%low_lq	%lq15pc	%lq20pc	%lq5pc	sd_lq
<i>mean</i>	0.21	0.22	0.24	0.26	0.19	0.20
<i>sd</i>	0.35	0.32	0.33	0.33	0.30	0.09
<i>max</i>	1.00	1.00	1.00	1.00	1.00	0.42
<i>min</i>	0.00	0.00	0.00	0.00	0.00	0.00

See Appendix B for variables' definitions

Table 13b: Correlation Matrix for Alternative Thresholds of Poor Land Quality - Cross-Country Analysis

	Muslim1900	%low_lq	%lq15pc	%lq20pc	%lq5pc	sd_lq
Muslim1900	1.00					
%low_lq	0.50	1.00				
%lq15pc	0.50	1.00	1.00			
%lq20pc	0.50	0.99	1.00	1.00		
%lq5pc	0.49	0.99	0.98	0.96	1.00	
sd_lq	0.09	-0.04	-0.01	0.00	-0.08	1.00

See Appendix B for variables' definitions

Table 14: Robustness Checks for the Cross-Country Analysis
Alternative Land Quality Thresholds for Poor Regions

VARIABLES	(1) Muslim1900	(2) Muslim1900	(3) Muslim1900	(4) Muslim1900
%low_lq	0.482*** (0.136)			
%low_lq20pc		0.522*** (0.140)		
%low_lq5pc			0.470*** (0.144)	
%low_lq15pc				0.496*** (0.135)
sd_lq	0.493** (0.230)	0.400* (0.224)	0.560** (0.242)	0.440* (0.226)
Observations	136	136	136	136
R^2	0.62	0.60	0.62	0.62

Robust standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

All specifications have the geographical and historical controls of column 4 in Table 12

See Appendix B for variables' definitions

Appendix B - Data Sources

Geographical Variables

abs_lat: Absolute latitudinal distance from the equator from the centroid of the respective unit of analysis, i.e. country, ethnic group or virtual country.

Source: Center for International Development, CID for the cross-country analysis.

areakm2: land area in 100000's of sq. km. of the respective unit of analysis.

Source: Center for International Development, CID for the cross-country analysis.⁵³

avg_lq: average land quality within the respective unit of analysis.

Source: Constructed using the index of land suitability for agriculture available at the Atlas of the Biosphere accessible at http://www.sage.wisc.edu/iamdata/grid_data_sel.php

dmecca: great-circle distance from Mecca of the centroid a country, ethnic group or virtual country in thousand kilometers.

Source: Calculated using the Haversine Formula.

elev: average elevation in kilometers within the unit of analysis, i.e. country or ethnic group or virtual country.

Source: Constructed using information on elevation above sea level at a grid level. The data is aggregated at the same level as the land quality data i.e. at 0.5 degrees latitude by 0.5 degrees longitude.

Source: The Atlas of Biosphere: <http://www.sage.wisc.edu:16080/atlas/>.

americas: dummy variable equals 1 for countries in the Americas.

reg_ssa: dummy variable equals 1 for countries in Sub-Saharan Africa.

Source: World Bank social indicators and fixed factors

reg_we: dummy variable equals 1 for countries in Western Europe.

Source: World Bank social indicators and fixed factors

reg_mena: dummy variable equals 1 for countries in the Middle East and North Africa.

Source: World Bank social indicators and fixed factors

pacific: dummy variable equals 1 for countries in the Pacific.

sd_lq: the standard deviation of land quality within the unit of analysis.

Source: See **avg_lq**

sea_dist: distance from the nearest coastline (1000's of km.) of the centroid of a country, an ethnic group or a virtual country.

Source: Center for International Development for the country analysis. For the ethnic groups and virtual country it is constructed using the coastlines of seas, oceans dataset. Pub-

⁵³All geographical data from CID are available at: <http://www.ksg.harvard.edu/CID>

lisher: Global Mapping International, Colorado Springs, Colorado, USA. Series name: Global Ministry Mapping System. Series issue: Version 3.0

%nowater: Share of regions (of 0.5 degrees latitude by 05 degrees longitude) within the respective unit of analysis that have no permanent water features.

Source: Constructed using the “Inland water area features” dataset and excluding the non-perennial/intermittent water bodies. This dataset is available at the Global Mapping International, Colorado Springs, Colorado, USA. Series name: Global Ministry Mapping System

%low_lq: share of regions with less than 10% probability of cultivation based climate and soil quality characteristics.

Source: See avg.

%lq5pc: share of regions with less than 5% probability of cultivation based climate and soil quality characteristics within the unit of analysis.

Source: See avg.

%lq15pc: share of regions with less than 15% probability of cultivation based climate and soil quality characteristics within the unit of analysis.

Source: See avg.

%lq20pc: share of regions with less than 20% probability of cultivation based climate and soil quality characteristics within the unit of analysis.

Source: See avg.

Historical Variables

in_entr: dummy equals 1 if a virtual country falls completely within a real country; constructed using ArcGIS.

%Muslim: Fraction of Muslim population in 2005 at the respective unit of analysis, i.e. ethnic group or virtual country in 2005AD.

Source: World Religion Database, available at: <http://www.worldreligiondatabase.org/>

ln#groups: Log number of ethnic groups found within a virtual country.

Source: 15th edition of the Ethnologue database of languages obtained from Global Mapping International's World Language Mapping System.

Muslim1900: Fraction of Muslim population in 1900AD.

Source: Religion Adherence Data - McCleary and Barro (2005) available at <http://ksghome.harvard.edu/~rmcclea/data.html>

#entr: number of real countries in which a virtual country belongs to; constructed using ArcGis.

shist600ad: the fraction of time between 1AD and 600AD that a supra-tribal polity was present within the present-day boundaries of a country. In the cross ethnic group analysis the **shist600ad** is a dummy variable that takes the value of 1 for countries with state history above the median.

Source: Putterman, L., 2007,

http://www.econ.brown.edu/fac/Louis_Putterman/antiquity%20index.htm.

staterel1900: is dummy variable taking the value of 1 if state religion is present in 1900, zero otherwise.

Source: See muslim1900.

staterel00: is dummy variable taking the value of 1 if state religion is present in 2000, zero otherwise.

Source: See muslim1900.

belgian_col: dummy equals 1 if a country was a Belgian colony after 1500 AD. Similarly constructed are **british_col**, **dutch_col**, **french_col**, **portu_col** and **spanish_col**

Source: "Determinants and Economic Consequences of Colonization: A Global Analysis"

Ertan, A., Putterman, L.,

Supplemented by entries from Encyclopedia Britannica where necessary.

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