# Trade and Geography in the Economic Origins and Spread of Islam: Theory and Evidence[*]

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## Abstract

This research examines the economic origins and spread of Islam and uncovers two empirical regularities. First, Muslim countries, virtual countries and ethnic groups, exhibit highly unequal regional agricultural endowments. Second, Muslim adherence is systematically larger along the pre-Islamic trade routes in the Old World. The theory argues that 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. It suggests 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 an economic system featuring direct income transfers and restrictions on physical capital accumulation. The latter rendered the investments on public goods, through religious endowments, increasingly attractive. As a result, capital accumulation remained low and wealth inequality bounded. Geography and trade 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.

*JEL classification Numbers:* O10, O13, O16, O17, O18, F10, Z12.

# 1  Introduction

Religion is widely viewed in the realm of social sciences as instrumental for the understanding of socioeconomic processes. Within economics, there has been a large and growing literature beginning with Barro and McCleary (2003), that links religious affiliation and religiosity to differences in economic performance across countries. Similarly, within sociology, anthropology, political science, psychology and history, the volume of work investigating the causes and effects of religion attests to its paramount importance.

This study examines theoretically and empirically the economic origins and spread of Islam. A novel and defining feature of this paper is that it provides a systematic exploration of the determinants of Muslim adherence within as well as across countries, shedding light on its geographic roots. In particular, the empirical investigation, conducted at various levels of spatial aggregation, establishes that inequality in regional agricultural potential and proximity to pre-Islamic trade routes are both fundamental determinants of contemporary Muslim adherence.

In the context of the proposed theory this particular type of geography in presence of trade opportunities conferred differential gains across regions fostering predatory behavior from the poorly endowed ones. To mitigate the trade disruption and secure access to trade networks the rich had to make concessions towards the poor. The resulting pact could manifest itself in the form of *static* income redistribution. However, as long as bequests increase with income, static income transfers would allow for income inequality to exacerbate over time. To preclude the latter restrictions on physical capital accumulation were implemented. These constraints distorted the relative returns to the factors of production inducing investments in public goods through religious endowments (*dynamic* income redistribution). As a result the Islamic economic principles allowed the Muslim lands to flourish in the preindustrial world limiting their potential for growth in the eve of large scale shipping trade and capital-intensive industrialization.[1]

The theory emphasizes the importance of unequal productive endowments and trade opportunities in the spread of Islam. To test its predictions empirically we construct new data on (i) the pre-Islamic trade routes in the Old World and (ii) the regional potential for agriculture. 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 produce a surplus and trade. Combining this data with information on Muslim adherence at a disaggregated level we perform a series of empirical tests.

First, to mitigate concerns related to the endogeneity of contemporary political boundaries, inherent to the literature on cross-country empirics, we arbitrarily divide the world into geographic entities, called virtual countries. Consistent with the theory, we find that Muslim adherence is systematically related to the underlying regional inequality in agricultural potential. Arguably, modern states have differentially affected religious affiliation via state-sponsored religion, for example. As such it is crucial to account for

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[1]Note that the proposed theory is an attempt to rationalize the set of economic principles embedded in the Islamic doctrine, remaining agnostic as to its theological underpinnings.

these state specific histories. Unlike a cross-country analysis, this is feasible in the context of virtual-country regressions, where we show that the results are robust to the inclusion of country fixed effects. These results remain robust (i) when we account for the proximity to trade routes and (ii) after controlling for contagion effects, that is, conversions provoked by proximity to Mecca and the borders of Muslim empires.

A second noteworthy feature of the empirical analysis is that it focuses on ethnicities by exploiting information on the traditional location of ethnic groups. Consistent with the hypothesis that Islamic economic principles provided an attractive social contract for populations residing along productively unequal regions, we find that Muslim adherence increases in the degree of geographic inequality closer to pre-Islamic trade routes. The results demonstrate that Islam spread successfully among groups historically located in agriculturally poor regions featuring few pockets of fertile land. It was along these places that the Islamic institutional arrangement would be appealing to the indigenous populations. Third, the importance of geography in shaping Muslim representation is validated at a cross-country level. The inhabitants of countries characterized by unequal land endowments are more likely to be Muslim.

Islam spread both via conquests and via the peaceful adoption of the doctrine. The proposed theory highlights the economic conditions conducive to the voluntary adoption of Islam. Hence, in the empirical analysis we focus on regions outside the Muslim empires. Doing so allows us to single out the role of geography and trade, and mitigate concerns related to the process of conversion within Muslim empires arising from coercion, Arab migration, and differential taxation.[2] Indeed, the acceptance of Islam in most of Inner Asia, South-East Asia, and Sub-Saharan Africa is well known to have occurred through contacts with merchants, Lapidus (2002) and Insoll (2003).

Finally, the independent role of proximity to trade routes in the spread of Islam, as a means of gaining access to the Muslim trading network, may be exemplified by the case of Indonesia, whose location along highly lucrative commercial routes precipitated the spread of Islam since the $11^{th}$ century despite a fairly equally distributed regional agricultural potential, Ricklefs (1991). Hence, proximity to pre-Islamic trade routes is an important variable in our empirical analysis. Incidentally, while the link between pre-industrial trade routes and Islam has been frequently theorized upon, this is the first study to our knowledge that produces a quantitative assessment of the role of pre-Islamic trade routes in the spread of Islam.

### Related Literature

Religion has been viewed both as a cause and an effect of economic development. On the one hand, the link between the structure of production and institutional formation has been proposed by Marx (1833 [1970]). According to Marx (1833 [1970]), religion, like any other social institution, is a product of

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[2] Jews and Christians in Muslim empires were subject to higher taxes than Muslims in exchange for economic and political rights and security, Lewis (2003).

the society's productive forces. Similarly, this study argues that the Islamic economic doctrine, shaped under the highly unequal geographical environment of the Arabian peninsula, was an outcome of the conflicting interest groups residing along these territories. On the other hand, Weber (1905 [1930]) motivated the effect of religion on economic performance by stressing the role of Protestant ethics in fostering economic progress. Such a feedback of religious affiliation to economic outcomes is also present in our study where we show that the very adoption of the Muslim economic principles had both long-run and short-run effects on the economic performance of the Muslim lands.

There is a recent literature in economics starting with Greif (1994), Platteau (2008, 2009), Becker and Woessmann (2009), Botticini and Eckstein (2005, 2007), Cervellati, Jansen, and Sunde (2008) and Rubin (2009) that has studied the role of the economic environment in affecting religious rules and vice versa. Moreover, the cross–country growth literature has seen an increased interest on the relationship between religion and politico-economic performance (see Barro and McCleary (2006a, 2006b) for an overview). Nevertheless, the evidence regarding the impact of Islam on economic and political indicators is at best controversial. Some studies identify a negative effect, see La Porta et al. (1997) and Barro and McCleary (2003), whereas others conclude that the effect is positive or insignificant, see Pryor (2007) and Martin, Doppelhofer, and Miller (2004). The current study contributes to this literature by showing that Muslim adherence is systematically higher in places characterized by unequal agricultural endowments close to pre-industrial trade routes, thus, (non) findings relating Islam to economic and political outcomes have to be carefully interpreted.

Within economics, religious affiliation has been linked to the formation of a common identity. For example, Iannaccone (1992) considers religion as a club good featuring positive congestion externalities and shows how people choose rationally to participate in a religion that involves voluntary limitations. In the context of Islam, Muslims had a preference of conducting trade with coreligionists because among other things it allowed access to Islamic judiciaries that facilitated the resolution of trade disputes, see Lapidus (2002). So, although it is true that the Islamic economic principles could be emulated by the local communities without explicitly converting, there were additional economic incentives to adopt the entire doctrine. This also may explain why proximity to trade routes has an independent effect on Muslim adherence.

The results of this research are also directly related to the literature on economic development and institutions. Studies by Engerman and Sokoloff (1997, 2002) and Acemoglu et al. (2001, 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 economic principles were devised as a means of governing the divergent interests of highly unequal regions in the beginning of $7^{th}$ 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 and trade opportunities dictating the diffusion and persistence of a set of economic rules. It is useful to note that we do not argue that Islamic principles are the only rules that may emerge under unequal geographic conditions. We do show nevertheless, that those rules prescribed in the Islamic economic doctrine provide a solution to the conflicting interests caused by an unequal geography.

The rest of the paper is organized as follows. Section 2 discussed in detail the elements of the Muslim economic doctrine and describes the role of trade and geography in the formation and expansion of Islam including historical evidence from both pre-Islamic Arabia and the Mali empire. Section 3 presents the theory. Section 4 discusses the data and presents the empirical analysis. This is conducted across (i) ethnic groups, (ii) virtual countries and (iii) real countries. Section 5 summarizes the key findings and concludes.

## 2 Geography and Trade in the History of Islam

The proposed theory rests upon two fundamental building blocks: (i) trade interests were a major driving force in the formation and expansion of Islam and (ii) inequality was a primal feature of the pre-Islamic Arabian economy which the economic principles of Islam had to directly address. We argue that such conditions brought forward a set of economic rules focusing on (i) income redistribution and poverty alleviation, the *zakat*, (ii) explicit costs imposed on capital accumulation, the anti-*riba* laws, and (iii) investments in public goods provision through donations to religious endowments, the *waqfs*.

### 2.1 The Origins of Islam

Arabia has a distinct geography with few places in Yemen, Bahrain, Central Arabia and several scattered oases in the interior producing agricultural goods, such as frankincense, myrrh, vine, dyes and dates on the eve of Islam. The rest of the peninsula features deserts and semi-arid regions where nomadic life-style was the norm, Ibrahim (1990). Across these infertile swaths of land, tribes were directly involved in the collection of booty by conducting raids, known as *ghazw,* on commercial caravans trading local produce as well as spices, gold, ivory, pearls, precious stones, and textiles—all of which arrived at the local ports from Africa, India, and the Far East, Berkey (2003).

In the pre-Islamic era, trade was maintained in the Peninsula as long as peripheral kingdoms along the edges of Arabia, namely Himyarites, Ghassanids and Lakhmids, guarded the routes and policed Bedouin tribes. These kingdoms all disintegrated in the course of the $6^{th}$ century. As a result, political and commercial control over the Bedouin communities could no longer be exerted, and the Arabian economy was in decline, Lapidus (2002).

In parallel, the Persian and Byzantine empires had been fighting a series of long and exhausting wars since the start of the $6^{th}$ century. By the early $7^{th}$ century, the conflicts had ruined or disrupted

major international trade routes between the two empires, Lewis (1993). Piracy in the Red Sea was also on the rise due to the declining sea power of the Byzantines, Winder (2008). These events caused a diversion of trade through the peninsula giving profound commercial value to overland trade routes in Arabia. The resulting merchant diversion created new potential economic benefits for the relatively fertile regions. First, by selling to the merchants they could take advantage of markets outside Arabia, and second, the increased caravan traffic was equivalent to higher demand for local produce.[3]

In order to materialize these benefits, the trade hubs along the routes had to be safely reached. Yet due to the extremely unequal Arabian geography, these hubs were surrounded by unsafe deserts. As a result caravans were constantly exposed to raids by the Bedouins, who made up a considerable fraction of the population in the Arabian peninsula at that time, Berkey (2003). Such increased 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, Ibrahim (1990). These elements produced a highly conflicting environment featuring the merchants and oasis cultivators on one side and the Bedouins on the other. 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 disrupt its network of alliances and trade routes".[4]

It was in this cross-section of historical events that Muhammad was born. The importance of trade in the formation of Islamic principles can hardly be underestimated. Muhammad himself was a Meccan merchant, and the majority of those who contributed to the crystallization of the Muslim law over time had a merchant or craftsman background, Cohen (1970). To gain a hearing across all Arabian tribes a doctrine with a political base was necessary. Consequently, this study argues that the Islamic economic principles were forged to align these clashing interests nurtured by an underlying unequal geography.

## 2.2 The Economic Doctrine of Islam

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 one of the Five Pillars of Islam. The Qur'an requires a believer of sufficient economic means to give a fraction of

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[3]Crone (2007) discusses the possibility that Meccans benefited directly from the Persian and Byzantine wars supplying leather and hides to the Roman army.

[4]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.

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 decades of Islam, *zakat* was collected and distributed by the government appointed officials, in a centralized manner and it was effective in alleviating poverty, see Habib (2004) and the references therein. Over time however, its centralized collection was less frequently enforced and adherence to it was left to the local authorities, see Kuran (2008b).[5]

An additional dimension along which Islamic economic doctrine features a host of detailed rules is on the limits imposed on the accumulation of capital and wealth in general. The role of inheritance laws, anti-usury laws and the prohibition on the rise of the corporation are three characteristic examples. Islamic law by recognizing only natural persons effectively blocked the emergence of more complex organizational forms restricting the mobilization and pooling of resources. Regarding the inheritance laws 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, Kuran (2008a). 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. Moreover, 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.

Islamic law did not only impose limits on the evolution of equity investment contracts. Perhaps, the most widely known Muslim economic principle is the prohibition against *riba*, which most Muslim scholars have interpreted as "interest" (*riba*).[6] *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 the 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 (2004) 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.

One could use either of the principles described above to formalize the limits on wealth accumulation under Islam. In the context of the proposed theory we focus on the role of interest bearing loans as well as on the formation of more efficient organizational forms. Such restrictions distorted the relative returns to the factors of production against capital accumulation and in favor of public good investments enhancing labor productivity. In fact, the Qur'an declares that the opposite of *riba* is sadaqah which is

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[5] Kuran (2001) notes that the third Caliph Uthman turned the obligation to pay *zakat* essentially into a tax on agricultural output.

[6] There 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 this restriction, systematically engaged in money lending.

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.[7]

Unlike *zakat* that catered to the immediate needs of the poor, *waqfs* were voluntary and enhanced the population's productive capacity through the provision of public goods such as education, health care, and public utilities.[8] Other examples of *waqfs* include mosques, free accommodations for the poor, building and maintenance of water conduits and other public services that would benefit the community. The earliest *waqfs* appear in early in Islam and become increasingly important over time, Habib (2004). By the 18th and 19th century land *waqfs* have enormous economic standing. In Turkey, Algeria and Tunisia a significant fraction of the countries' arable lands and a vast array of urban assets are under *waqf*.[9]

We do not argue that the economic principles discussed above are unique to the Islamic religion. Indeed, similar principles on redistribution, limits on capital accumulation and donations to religious endowments may be found in the other Abrahamic religions at certain points in history, but in the course of time they became less focal. We do argue, though, that these principles emerged and persisted in Islam because of a geography characterized by highly unequal productive endowments which shaped the economic aspects of the Islamic religious doctrine. In fact, we show that the empirical relationship between geographical inequality and religious affiliation is unique to the Muslim adherence.

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 economic 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, 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, Lewison (1999), Rubin (2010). Also, perhaps more importantly, in Christianity inheritance laws were preserving economic inequality allowing in several instances such laws as that of primogeniture, see Bertocchi (2006), and there were no restrictions

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[7]There 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. Our theory focuses on the former.

[8]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."

[9]According 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.

on the formation of the corporation effectively facilitating the mobilization of resources and the accumulation of physical capital. Finally, the fact that Arab merchants dominated African and Eurasian trade routes from the $7^{th}$ till the $15^{th}$ century (see Labib (1969)) implies that the indigenous populations in Asia and Africa were primarily exposed to the Muslim doctrine. So, even if one were to take the view that Christianity and Islam are doctrinally close substitutes, historically the effective choice that tribal areas outside Muslim empires faced was either convert to Islam or keep their tribal religions. As it is shown in the empirical section local, tribal religions persisted in territories with equal productive endowments whereas it was Islam that was readily adopted in places close to trade routes featuring unequal land endowments. The following section discusses the conversion to Islam in the Mali empire and in the Malay Archipelagos highlighting the role of trade routes, conflict and geography.

## 2.3   The Spread of Islam

### 2.3.1   The Case of the Mali empire

The voluntary adoption of Islam in the birth and development of the Mali empire after the collapse of the Ghana empire kingdom is another historical example consistent with our hypothesis. The Mali empire flourished in the western part of the Sahel, the African biogeographic zone where Sahara desert and savannas met. This region includes part of today's territories of Ghana, Mali, Mauritania and Senegal, a highly unequal zone in terms of agricultural potential given the very small portion of arable territory.

At the end of first millennium AD, natural resources such as gold and salt helped the Ghana empire achieve a primal position in the area by satisfying the increasing demand coming from the northern African empires, in particular the Almoravids, Chu and Skinner (1965). Although the Ghana empire experienced its first contact with Islam through trade, it did not switch from local tribal religions to Islam. The Ghana Empire disintegrated in the beginning of the $11^{th}$ century due to repeated attacks by the nomadic tribes located in the northern part of Ghana attempting to gain control of the lucrative trade routes linking North Africa with Ghana, Goucher, LeGuin, and Walton (1998).

The socioeconomic conditions in the beginning of the Mali empire were similar to those prevailing in the $7^{th}$ century Arabian peninsula. It was under tribal feuding and trade opportunities that Islam started gaining a hearing across the diverse local populations residing along unequally endowed regions. Specifically, it was trade contact with the Almoravids and other Muslim tribes that introduced Islam to the indigenous. After more than a century of conflict around 1235 $AD$ the Muslim king Sundiata founded the Mali Empire. Islam was mostly an elite religion at that point of time and cohabited with other previously established animist religions. Islamic adherence increased in the subsequent decades and in 1312 $AD$, at the apex of Mali Empire, Mansa Musa became the first truly devout Muslim Mali emperor. Mansa Musa gathered fame for his efforts to make Islam the religion of the nobility, the establishment of several universities and mosques, and the further development of trade, Stride and

Ifeca (1971). Contemporaneous chronicles associate the increasing spread of Islam in the Mali Empire with the successful unification of the indigenous tribes. Moreover, these chronicles refer to the population of the Mali Empire as "seldom unjust, with greater abhorrence of injustice than any other people", and also document the security that inhabitants and travelers felt, Battuta (1929).

### 2.3.2 Tha Case of the Malay Archipelagos

Historical accounts regarding the spread of Islam in the Malay and Indonesian Archipelagos paint a picture similar to the case of the Mali empire, see Hirth and Rockhill (1911). The strategic location of the Malay Archipelago, which sits in the middle of the China-India trade route, had helped in the development of trade in the region. The decline of the powerful Srivijaya kingdom in the $13^{th}$ century crippled the trade routes of the time. It was during this period of heightened local feuding and foregone trade opportunities that Islam made its way to Sumatra, spreading through contacts with Arab and Indian traders. By the late $13^{th}$ century, the kingdom of Pasai in northern Sumatra converted to Islam whereas the history of Islam in Malacca began almost a century later when a prince of Srivijaya origin, Parameswara, converted to the religion by an Arab scholar from Mecca. Adoption of Islam was followed by a reinvigoration of the trade routes.

## 3 The Model

### 3.1 The Basics

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 doctrine, we now turn to the formal exposition of the model. The theory illustrates the conditions under which an unequal geography exposed to trade opportunities may lead to the adoption of the Islamic economic principles. The crux of the argument is the following: The appearance of trade routes creates divergent economic opportunities across territories characterized by unequal agricultural endowments. On the one hand, fertile, thus, surplus producing regions can greatly benefit from trade by selling their output at higher prices, whereas regions with poor land endowments cannot. However, to the extent that the latter are numerous enough to significantly threaten the trade activities of the former, a set of rules similar in essence to the economic principles of Islam may emerge. Hence, it is the juxtaposition of few fertile pockets of land with an overwhelming majority of agriculturally poor regions that causes the predatory behavior from the poorly endowed ones when trade opportunities arise. As in Anderson and Bandiera (2006) the interaction of predators, whose density in our model is shaped by the mass of infertile regions, and prey is crucial. Any encounter between the merchants and the Bedouins results in a loss and the greater the density of the latter, the more vulnerable are traders' activities. In the context of the theory this relative capacity to avoid predation, determined by the underlying geographical inequality, is the ultimate determinant of the

concessions, i.e. the extent of income redistribution, that fertile regions are willing to accept.[10]

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 technological 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 investments 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 respectively. There is one to one mapping between regions and individuals, so regional and per capita quantities coincide.[11] 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 $\lambda$ and $(1 - \lambda)$, respectively. Each individual has one child and migration across regions is not allowed, so regional population is stationary.[12] We consider all the individuals living in the low (high) quality areas as the representative poor (rich) agent of mass $\lambda$ and $(1 - \lambda)$ respectively. With the vector $(v_0, \lambda)$ we may characterize the economy-wide land quality distribution whose geographical inequality is increasing in both the arguments.

The agents may decide to sell their regional output at a foreign market if profitable. The price on the foreign market is $p > 1$, where 1 is the normalized domestic price. Trade involves a fixed goods' cost $\mu < 1/2$, needed to set up a caravan going to the foreign market. If an agent does not find it profitable to trade, he may challenge those who engage in trade by incurring a cost equal to $\theta < 1/2$, where $\theta$ 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 relative size of each group.

## 3.2 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 $y_{r,t}$ :

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

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[10]The theory does not model the merchant class independently. Allowing for a merchant class would not alter the predictions qualitatively. The goal of the merchants is to ensure a smooth passage of goods. Similarly, the oasis cultivators want to have their goods sold intact via the merchants to the outside markets. Thus, both parties have a common incentive to keep trade routes open and avoid caravan raids. Since the interests of merchants and oasis cultivators are perfectly aligned we model them as one party.

[11]Allowing 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, see Ashraf and Galor (2009). 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.

[12]The predictions of the theory would remain intact if we were to allow for labor mobility and property rights 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.

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:

$$w_r = (1 - \alpha)T_r$$
$$R_r = \alpha T_r \tag{1}$$

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.

## 3.3 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 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 bequests. Each agent's gross income is therefore

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

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, $I_{r,t+1}^G$.[13] 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 child. Consider a utility function $U(c_t; I_{t+1}^G)$ defined as

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

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 savings behavior i.e., bequests and savings are an increasing function of wealth.[14]

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[13] Alternatively, 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.

[14] Allowing 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

## 3.4 Optimal Consumption and Transfers

In this section we look at the optimization problem of rich and poor agents given their net income, $I_{r,t}^N$. See section 3.5 on how gross income $I_{r,t}^G$ evolves into net income $I_{r,t}^N$ through the process of trade and conflict. 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 $\mu$.

### 3.4.1 Physical Capital versus Public Good 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:

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

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 if poor do not invest in *waqfs*, $e_{P,t} = 0$, then $\lambda$ 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:

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

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

Now that we have defined the main building blocks and individuals' optimization structure, it is useful to define the starting point of the economy:

**Definition 1** *The initial condition of the model (at time $t = 0$) is one in which $h_0 = 1$ and $s_{P,-1} = s_{R,-1} = 0$, so that $I_{P,0}^G = \frac{1-\alpha}{v_0}$ and $I_{R,0}^G = 1 - \alpha$.*

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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 qualitative 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.

In order for trade opportunities to act as a trigger for capital accumulation, we assume that in absence of trade, $p = 1$, no individuals leave bequests:

$$1 - \alpha < \tilde{c}. \tag{C2}$$

It follows that without trade and under (C2) regional incomes remain constant. Moreover, throughout the analysis we assume that agriculturally poor regions are unable to engage in trade, i.e.

$$I_{P,t}^G < \mu, \forall t \tag{C3}$$

and this is always true for large enough values of $v_0$. Condition (C3) implies that if $v_0 \to 1$ the poor regions are indistinguishable from the rich regions because their productivities coincide and they would behave in the same way in terms of production, trade, and bequests. Moreover, looking at (1), (2) and (4), $v_0 \to \infty$ gives $I_{P,t}^G \to 0$. Hence, we consider small enough values of poor land productivity $T_P$ such that the emergence of trade opportunities creates conflicting interests between regions.

In what follows, we characterize the optimal behavior of agents in the rich regions given the following three conditions: (C1), (C2) and (C3). Note that in absence of income transfers, poor regions cannot reach satiation point $\tilde{c}$, thus do not leave bequests.

### 3.4.2 Anti-*Riba* Regulation and Investment in Public *waqf*

Kuran (2008a) 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.[15] Despite its important consequences, penalizing capital accumulation to induce investments in public goods has not, to the best of our knowledge, been incorporated in a general equilibrium growth model. We model such restrictions as follows. Define the net return on capital investments as $R_r^N = \delta R_r$, where $\delta \in [0, 1]$ is an inverse measure of the distortion in the marginal product of physical capital induced by the limitations on contracts involving capital investments. The comparison between the two forms of investment boils down to evaluating the returns from physical capital bequests versus public good investments, i.e. $\delta R_R \lesseqgtr w_R \gamma (1 - \lambda)$.

Returns to factors of production are independent of the quantity of factors employed. So, individuals from fertile regions prefer public good investments over capital savings as long as:[16]

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

---

[15] The 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, must monitor each investment he is financing. Such costs decrease the expected 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.

[16] One 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.

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 there are no distortions on capital accumulation, rich only bequeath physical capital when bequests are positive:

$$s_{R,t}^*(I_{R,t}^N) = \begin{cases} 0 & \text{if} \quad I_{R,t}^N \leq \tilde{c} \\ I_{R,t}^N - \tilde{c} & \text{if} \quad I_{R,t}^N > \tilde{c} \end{cases}. \tag{6}$$

When restrictions are significant, i.e. *riba* is not allowed, $\delta \leq \delta_R$, the rich invest in public goods. In this case optimal labor enhancing investment becomes:

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

Note that because of (4) the poor benefit from the *waqf* investment made by the rich.[17]

## 3.5 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 $t = 0$ as defined above.

### 3.5.1 Trade and the Threat of a Raid

When trade becomes a viable option only fertile regions may participate. Poor regions because of (C3) cannot overcome the fixed traded cost, $\mu$. Nevertheless, they may raid the caravans of the trading regions and obtain part of the goods if it is profitable. The outcome of the confrontation depends on the fighting strength of each side, determined by a retention function $f_r(\lambda) \in [0,1]$ whose argument is the fraction of poorly endowed regions $\lambda$. Given the one to one mapping between regions and individuals, the fighting strength of each side is purely determined by the relative population size of the two sides.[18] The function $f_r(\lambda)$ is continuous and differentiable. Without loss of generality we focus on the retention rate of the rich regions, i.e. $f_R(\lambda) = 1 - f_P(\lambda)$ which is bounded between zero and one. A key property of $f_R(\lambda)$ is:

$$-\frac{\partial f_R(\lambda)}{\partial \lambda} > \frac{\gamma}{1-\gamma} \tag{8}$$

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

---

[17]Given our utility function, there are no free riding incentives. Given $\delta < \delta_R$ once $c = \tilde{c}$ is attained, the only way to increase utility is to leave bequests.

[18]Allowing for endogenous fertility one could augment the retention function to incorporate the effect of relative population densities. In a Malthusian world in presence of land inequality, fertile regions would be more densely populated than poorly endowed ones, weakening the potency of predation by the latter. In this case, one should make the additional assumption that the higher is the density of poorly endowed regions, $\lambda$, the larger is the predation threat at any level of relative population density. Given that overland trade is space intensive this seems to be a reasonable assumption.

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), (6), and (7) 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 $I_{R,t}^G$:

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

which in period 0 can be rewritten as

$$f_R(\lambda) - \frac{1-\alpha}{p(1-\alpha-\mu)} > 0. \tag{9}$$

The inequality shows that trade is more likely to occur as the ability of the rich to retain goods during a raid increases (larger $f_R(\lambda)$), and gains from trade are large (a higher gross income $1-\alpha$, higher prices $p$, or lower trade costs $\mu$). 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. $f_R(\lambda \to 1) = \frac{1-\alpha}{p(1-\alpha-\mu)}$, $f_R(\lambda \to 0) = 1$. Thus, defining a lower bound of $p$ as

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

it is straightforward to show that for any $p > \underline{p}$ condition (9) above holds in period 0 $\forall \lambda \in [0,1)$.

Poor regions may plunder the goods being traded. In line with our historical section, we assume a raid may occur when caravans are on their way to the trade routes.[19] 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 $\theta$ of the goods they seize at the end of the conflict. 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.

$$I_{P,t}^G < I_{P,t}^G + \frac{1-\lambda}{\lambda}(I_{R,t}^G - \mu)[f_P(\lambda) - \theta], \tag{10}$$

which can be rewritten as

$$f_P(\lambda) - \theta > 0. \tag{11}$$

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 $\theta$.

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

**P roof.** Note that $f_P(\lambda)$ is continuous, monotonically increasing in $\lambda$ and $f_P(0) = 0$ and $f_P(1) = 1 - \frac{1-\alpha}{p(1-\alpha-\mu)}$. Since $p > \underline{p}$ and (C2) it follows from the *Intermediate Value Theorem* that there exists a unique level of poor regions' size $\underline{\lambda}$ such that $f_P(\underline{\lambda}) = \theta \equiv \underline{f_P}$. Hence there exists a $\lambda \equiv \underline{\lambda}$ such that if $\lambda > \underline{\lambda}$ then $f_P(\lambda) > \underline{f_P}$ and the poor raid, whereas if $\lambda < \underline{\lambda}$ then $f_P(\lambda) < \underline{f_P}$ and there is no conflict. ∎

---

[19] Note that as the poor cannot overcome the costs of setting up a caravan, we assume away the possibility of trading goods collected during a raid.

### 3.5.2  The *zakat* Redistribution System

We now introduce the possibility of static, that is same period, income redistribution, *zakat*, and investigate the necessary conditions under which a *zakat* contract is accepted by both sides.[20] The *zakat* contract takes the form of a fraction $z$ of rich's income that is transferred to the poor. 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

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

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, $\lambda$. This gives a minimum acceptable *zakat* rate, $\underline{z}$, of

$$\underline{z} \equiv \underline{z}(\lambda) = \max\{0, f_P(\lambda) - \theta\}, \tag{12}$$

which is weakly increasing in $f_P(\lambda)$, thus weakly increasing in $\lambda$ and weakly decreasing in $\theta$. Note that $\underline{z}$ only becomes positive at $\underline{f_P}$, which looking at (11) occurs at the exact level of poor regions' size $\underline{\lambda}$, 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:

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

which gives

$$\bar{z} \equiv \bar{z}(\lambda) = f_P(\lambda) < 1. \tag{13}$$

and is increasing in $\lambda$. Note that conflict occurs only when $f_P(\lambda) > \underline{f_P}$. Below this threshold there is no conflict so the maximum *zakat* rate of the rich is 0.

It is easy to see from (12) and (13) that $\underline{z} < \bar{z}$ always holds. Consistent with the initial days of Islam, a *zakat* rate of $\underline{z}$ is enforced when agreed upon by both sides as long as $\underline{z}$ is non-negative i.e. $\lambda > \underline{\lambda}$.

**Lemma 2** *Using (12) and (13), a zero zakat rate obtains for $\lambda \leq \underline{\lambda}$, while for $\lambda > \underline{\lambda}$ there exists a positive zakat rate of $\underline{z}$ increasing in $\lambda$, which is beneficial for both sides.*

**P roof.** Follows by directly comparing (12) to (13) and the properties of $f_P(\lambda)$.  ∎

---

[20] We 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.

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

$$
I_{R,t}^N = \begin{cases} p\left(I_{R,t}^G - \mu\right) & \text{no conflict} \\ f_R(\lambda)p\left(I_{R,t}^G - \mu\right) & \text{conflict} \\ (1-\underline{z})p\left(I_{R,t}^G - \mu\right) & zakat \end{cases} \tag{14}
$$

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, $\frac{1-\lambda}{\lambda}\underline{z}(\lambda)\left(I_{R,t}^G - \mu\right)$, does not exceed the minimum amount required to convince them to forgo raiding, $\underline{z}(\lambda)\left(I_{R,t}^G - \mu\right)$, i.e.,[21]

$$
\underline{z}^m(\lambda) = \min\{\underline{z}(\lambda); \left(\frac{1-\lambda}{\lambda}\right)\underline{z}(\lambda)\}. \tag{15}
$$

The net income of the poor is therefore

$$
I_{P,t}^N = I_{P,t}^G + \underline{z}^m(\lambda)\left(I_{R,t}^G - \mu\right). \tag{16}
$$

## 3.6 Geography and the Emergence of Islamic Economic Principles

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 a static income redistribution system, i.e. *zakat*, along with regulations limiting capital accumulation inducing public good investments, i.e. *waqfs*, by the rich. Note that investments in *waqfs* by the rich is a *dynamic* form of redistribution, since the benefits to the next generation in terms of higher labor productivity are also enjoyed by the poor. We concentrate on the initial condition at $t = 0$ while in Appendix C we report further results based on the dynamic analysis.

An Islamic pact is offered and must be accepted by both sides to go through. Starting with the poor, while $\underline{z}$ makes them indifferent between conflict and redistribution, they are strictly better off with a full Islamic pact that includes a *waqf*-inducing anti-*riba* regime for sufficiently large values of $v_0$.

**Lemma 3** *For sufficiently large differences in land quality $v_0$ that prevent the poor from leaving bequests, their utility under Islam is always greater than that under conflict or redistribution, i.e. $U_{P,0}^\xi > U_{P,0}^c$.*

**P roof.** The net income of the poor under conflict or redistribution is $I_P^{N(c)} = \frac{1-\alpha}{v_0} + \underline{z}^m(\lambda)(1-\alpha-\mu)$, where the first term on the LHS goes to zero when $v_0 \to \infty$. Subsequently, for large enough $v_0$, the poor are unable to leave capital bequest as long as $(f_P(\lambda) - \theta)(1-\alpha-\mu) < \tilde{c}$ which always holds by condition

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[21]Although 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. $(1 - \lambda) \geq 1/2$.

(C2). As a result, since the only extra source of utility to the poor is the benefits spilled over to their offspring from public investment by the rich ($h_{t+1} > 1$), we obtain $U_{P,0}^{\xi} > U_{P,0}^{c}$. ∎

The poor use the threat of conflict to establish Islam with their bargaining power increasing in $\lambda$. To see whether or not Islam goes through one may compare the utility of the rich with and without Islam.

The rich regions 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 $\lambda > \underline{\lambda}$. Recall that the rich always prefer to pay the *zakat* rate $\underline{z}$ to avoid conflict as long as raiding is a credible threat. At time $t = 0$, 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, solves

$$f_R(\lambda) - \frac{\tilde{c}}{p(1 - \alpha - \mu)} > 0. \tag{17}$$

With equality, (17) gives $\lambda \equiv \tilde{\lambda}_0^c$ so that capital bequests are positive if $\lambda < \tilde{\lambda}_0^c$ and zero otherwise. In addition, looking at (9) and (17) along with (C2) and (C4) assures that $\underline{\lambda} < \tilde{\lambda}_0^c < 1$.[22] Bequests are more likely to be positive as $f_R(\lambda)$ increases, a higher initial gross income $1 - \alpha$, higher prices $p$, and lower trade costs $\mu$.

**Lemma 4** *Under conflict there exists a unique threshold of poor regions' size $\tilde{\lambda}_0^c \in (\underline{\lambda}, 1)$ giving $f_R(\tilde{\lambda}_0^c) = \frac{\tilde{c}}{p(1-\alpha-\mu)}$ so that capital bequests are only positive for $\lambda < \tilde{\lambda}_0^c$.*

**P roof.** Since $f_R(\lambda)$ is continuous with $f_R(\underline{\lambda}) = 1 - \theta$ and $f_R(\lambda \to 1) = \frac{1-\alpha}{p(1-\alpha-\mu)}$, given (C2), (C4), (6), (9), (14) and (17), it follows from the *Intermediate Value Theorem* that there exists a share of poor regions $\tilde{\lambda}_0^c \in (\underline{\lambda}, 1)$ such that $f_R(\tilde{\lambda}_0^c) \equiv \frac{\tilde{c}}{p(1-\alpha-\mu)} = \tilde{f}_{R,0}^c$. Also, since $f_R(\lambda)$ is monotonically decreasing in $\lambda$, this $\tilde{\lambda}_0^c$ is unique. So, if $\lambda < \tilde{\lambda}_0^c$ then $f_R(\lambda) > \tilde{f}_{R,0}^c$ and capital savings by the rich are positive, whereas if $\lambda > \tilde{\lambda}_0^c$ then $f_R(\lambda) < \tilde{f}_{R,0}^c$ 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 $\tilde{\lambda}_0^{\xi}$ below which bequests under Islam are positive:

$$f_R(\lambda) - \frac{\tilde{c}}{p(1 - \alpha - \mu)} + \theta > 0 \tag{18}$$

Substituting for $\underline{p}$ from (C4), one can show that (18) 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 $\theta$. To derive under which conditions Islam is accepted as an institution

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[22] Relaxing the assumption (C4) we could also have $\underline{\lambda} > \tilde{\lambda}_0^c$, which implies an economy without institutions for small $\lambda$, and a direct switch to Islam at the point when conflict starts, i.e. $\underline{\lambda}$.

we compare the utility of the rich under conflict and capital bequests to that under Islam and labor productivity enhancing investments that is, for any $I_{R,t}^G$,

$$G(\lambda, I_{R,t}^G) = U_R^c(\lambda, I_{R,t}^G) - U_R^\xi(\lambda, I_{R,t}^G) = \tag{19}$$
$$\alpha[p(I_{R,t}^G - \mu)f_R(\lambda) - \tilde{c}] - \gamma(1-\alpha)(1-\lambda)[p(I_{R,t}^G - \mu)(f_R(\lambda) + \theta) - \tilde{c}]$$

Looking at (19) and focusing on $t = 0$, it is straightforward to show that Islam is accepted for all $\lambda > \tilde{\lambda}_0^c$ where the alternative is no bequests. In this range, the only option for the rich to leave bequests to their offspring is to accept Islam and invest in public *waqfs*. Therefore, the rest of this section focuses on the values $\lambda < \tilde{\lambda}_0^c$ to find the minimum fraction of poor regions above which Islam is accepted.

Islam brings static gains by preventing conflict. The difference between what a rich is willing to pay to avoid conflict and what he actually pays, i.e. the difference between $\underline{z}$ and $\bar{z}$ in (12) and (13), is the economic value added by Islam and amounts to $\theta$. 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. As the dynamic loss is decreasing in $\lambda$, Islam is a more attractive option for large values of $\lambda$. More formally, given Lemmas 3 and 4, one may show that:

**Proposition 1** *There exists a unique threshold $\lambda_0^\xi \in (\underline{\lambda}, \tilde{\lambda}_0^c)$, implicitly defined as $f_R(\lambda_0^\xi) = \frac{\tilde{c}}{p(1-\alpha-\mu)} + \theta\frac{\gamma(1-\alpha)(1-\lambda_0^\xi)}{\alpha-\gamma(1-\alpha)(1-\lambda_0^\xi)}$, such that a full Islamic contract, i.e. zakat plus an anti-riba law, is agreed upon by the rich at $t = 0$ if $\lambda \geqslant \lambda_0^\xi$, and rejected if $\lambda < \lambda_0^\xi$.*

**P roof.** Consider equation (19) at time $t = 0$:

(1) Given the property of the retention function (8), $G(\lambda)$ is continuous and monotonically decreasing in $\lambda$:

$$\frac{\partial G(\lambda)}{\partial \lambda} = \frac{\partial f_R(\lambda)}{\partial \lambda}[\alpha - \gamma(1-\alpha)(1-\lambda)]p(1-\alpha-\mu) + (1-\alpha)\gamma\{[f(\lambda) + \theta]p(1-\alpha-\mu) - \tilde{c}\}.$$

The first term on the RHS is negative because of $\frac{\partial f_R(\lambda)}{\partial \lambda} < 0$ and (C1), while the second term is positive. Given (8), $G(\lambda)$ decreases with $\lambda$, 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) $G(\underline{\lambda}) > 0$ due to no conflict at $\lambda = \underline{\lambda}(v_0)$ and (C1)

(3) $G(\tilde{\lambda}_0^c) < 0$ due to zero bequests under conflict and positive under Islam

it follows from the *Intermediate Value Theorem* that there exists a unique level of poor regions' size $\lambda \equiv \lambda_0^\xi$ such that $f_R(\lambda_0^\xi) = \frac{\tilde{c}}{p(1-\alpha-\mu)} + \theta\frac{\gamma(1-\alpha)[1-\lambda_0^\xi]}{\alpha-\gamma(1-\alpha)[1-\lambda_0^\xi]} \equiv f_{R,0}^\xi$ and $U_{R,0}^\xi(\tilde{\lambda}^\xi) = U_{R,0}^c(\tilde{\lambda}^c)$. Hence, there exists a $\lambda \equiv \lambda_0^\xi$ such that if $\lambda > \lambda_0^\xi$ then $G(\lambda) < 0$ and Islam goes through, whereas if $\lambda < \lambda_0^\xi$ then $G(\lambda) > 0$ and a full Islamic contract is not agreed upon. ∎

In summary, when poor regions take up a small fraction of an economy, i.e. for $\lambda < \underline{\lambda}$, there is no threat of a raid and no institutions are founded. When poor regions account for an intermediate fraction of the economy, i.e. $\underline{\lambda} < \lambda < \lambda_0^{\xi}$, a 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 $\lambda_0^{\xi} < \lambda < \tilde{\lambda}_0^c$ because gains from the prevention of conflict dominate losses from the lower *waqf* returns, and (b) $\lambda > \tilde{\lambda}_0^c$ because the rich will otherwise not be able to leave any bequests under conflict. As a consequence, once trade becomes feasible in period $t = 0$, Islam is founded for $\lambda > \lambda_0^{\xi}$, the rich pay *zakat*, and leave bequests in the form of public *waqfs*.

In Appendix $C$ we establish the conditions under which that Islamic economic principles, once adopted, also persist in the long run and we analyze the steady state levels of income and inequality under different initial conditions.

## 3.7 Main Theoretical Results and Testable Implications

In this section we have sketched a simple model that shows how the geographical features of a given economy shape the endogenous emergence of Islamic redistributive institutions. To summarize, first, the precondition of having access to foreign markets at an attractive price, i.e. $p > \underline{p}$, must be met. Second, a large inequality $v_0$ is a necessary condition for any kind of redistribution since it guarantees that the poor regions are not be able to trade their local production. Third, the (relative) size of poor population is crucial in determining the institutional setup. If poor regions' constitute a small fraction of an economy, i.e., $\lambda < \underline{\lambda}$, no institutions arise, while for intermediate values $(\underline{\lambda} < \lambda < \lambda_0^{\xi})$ static redistribution is the preferred institution. Once poor regions' size increases further $(\lambda > \lambda_0^{\xi})$ the threat for the rich to be raided increases further so that the Islamic contract is agreed upon.

Both intuitively and under a broad class of inequality measures a distribution characterized by parameters $\lambda$ and $v_0$ is more unequal the larger are $\lambda$ and $v_0$.[23] Therefore, in the empirical section we use different indexes of inequality as our main explanatory variable of Muslim representation. Also, to capture regional access to trade we also use a variety of indicators measuring the proximity to pre-industrial trade routes.

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[23] It is straightforward to demonstrate that for a discrete distribution characterized by $\lambda$ and $v_0$ a larger $\lambda$ and/or $v_0$ produce a more unequal distribution under the First Order Stochastic Dominance criterion. The Gini Index of this distribution, $Gini(\lambda; v_0)$, is increasing in $v_0$, and in $\lambda$ except for combinations of large $\lambda$ and low $v_0$, i.e. equality. The fact that in the limit as $\lambda$ approaches 1 the Gini Index decreases is due to the fact the distribution becomes degenerate, i.e., $\lambda = 0$ or $\lambda = 1$ are both characterized by $Gini(\lambda; v_0) = 0, \forall v_0$.

# 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.

The global data on current land quality for agriculture were assembled by Ramankutty, Foley, Norman, and McSweeney (2002) to investigate the effect of the future climate change on contemporary agricultural suitability. This dataset provides information on land quality characteristics at a resolution of 0.5 degrees latitude by 0.5 degrees longitude. In total there are 64, 004 observations. Each observation takes a value between 0 and 1 and represents the probability that a particular grid cell may be cultivated. Appendix $B$ discusses in detail the exact formulas used in the construction of the land quality index and the data sources. These raw global data, presented in Figure 1, provide the basis for constructing the distribution of land quality at the desired level of aggregation, i.e., across countries, ethnic groups and virtual countries.

Using contemporary geographic data to proxy for historical inequality in agricultural endowments presents its own potential pitfalls, which merit further discussion. For example, a potential concern is how representative is land quality of the period when Islam started spreading. This is because precipitation, temperature and soil properties, which are the basis of this index, may have changed regionally over the last 1, 500 years. Hence, this measure of land quality is a noisy index of what might have been the true distribution of agricultural quality in the past. On the one hand, this measurement error may be white noise, making it harder to detect a relationship between inequality in agricultural suitability and Muslim adherence. On the other hand, though, this measurement error could be systematic; the same forces that engineer religious affiliation (modern statehood) may also be associated with human interventions that affect the landscape, generating a spurious relationship. This possibility underscores the need for the analysis to be conducted at a level of aggregation where country fixed effects can be explicitly incorporated. This is done in the virtual country and ethnic group specifications whereby the introduction of country fixed effects accounts for any country-level unobserved forces that may have

affected both land's suitability for agriculture and religious affiliation.

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 reported at Barrett, Kurian, and Johnson (2001). 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.[24] These estimates are derived from the World Christian Database and are subsequently adjusted based on three sources of data on religious affiliation: census data, demographic and health surveys and population survey data.[25]

The theory links the adoption of Islam to the underlying geography. Thus, when testing the theory across ethnic groups one needs to identify the land endowments of the traditional homeland of an ethnic group. Information on the location of ethnic groups' homelands is available from the World Language Mapping System (WLMS) database. This dataset maps the locations of the language groups covered in the 15th edition of the Ethnologue (2005) database. 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 WLMS (2006) 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 matching between the WLMS (2006) and the WRD is done using the unique Ethnologue identifier for each ethnic group within a country.[26] In the virtual country analysis the fraction of Muslims is estimated using information on both the location of ethnic groups from the WLMS (2006) and their respective population and Muslim adherence in 2005 from the WRD.

In absence of historical estimates of Muslim representation at an ethnic group or virtual country level, we are constrained in using contemporary data. Reassuringly, country level estimates of Muslim representation derived using the WRD estimates of Muslim adherence across ethnic groups within a country, exhibit a correlation of 0.93 with the cross-country estimates of Muslim adherence in 1900 AD.[27]

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[24]WRD classifies as Muslims the followers of Islam, in its 2 main branches (with schools of law, rites or sects): Sunnis or Sunnites (Hanafite, Hanbalite, Malikite, 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.

[25]Hsu, Gibbon, Hackett, and Reynolds (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.

[26]For some language groups in WLMS (2006) the WRD offers information at the subgroup level. In this case the religious affiliation is the average of the subgroups' affiliation.

[27]Converting out of Islam by committing apostasy or ridda is subject to punishment in several Islamic countries. Also, the Qur'an explicitly forbids the forced conversion of other monotheists.

## 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 shares 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, conditional on country specific characteristics, 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.[28]

To capture the conflicting economic interests caused by an unequal geography we use the global data on the suitability of land for agriculture to estimate the Gini inequality in the climatic potential for farming across regions.[29] The prediction is that ethnicities featuring few pockets of fertile land and a majority of relatively infertile areas, i.e. a higher $\lambda$ in the context of the theory, would find Islam an attractive solution to mitigating and overcoming the high geographical inequality. An additional geographical feature that is likely to increase transaction costs for trading activities is the presence of a variable topography. Conditional on agricultural endowments a more rugged terrain may increase the probability of raiding the trade caravans because raiders can easily retreat and hide taking advantage of such geography. As a result a set of economic rules akin to the Muslim principles that align the interests of opposing groups, one that benefits from disrupting trade flows and the other whose economic livelihood depends on the secure passage of goods, is more likely to prevail.

Figure 2a 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. Figure 2b 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

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[28]Ideally, we would like to be able to trace the homelands of ethnic groups sufficiently back in history. Unfortunately, such data are not available. Nevertheless, it is informative to note that at least in the case of Africa the contemporary spatial distribution of ethnicities across the continent has remained largely similar to the pre-colonial times. Nunn and Wantchekon (2009) using individual data from the Afrobarometer in 2005 across countries show a very strong correlation (around 0.62) between the current location of the respondents and the pre-colonial homeland of their ethnicity as identified by Murdock (1959).

[29]In the online Appendix we show that the results are qualitatively and quantitatively similar using alternative indexes of inequality, including the Theil index or the mean logarithmic deviation (MLD).

endowments, with an estimated Gini index of land suitability $Gini_{Amhara} = 0.13$. On the other hand, 72% of Somali's homeland is dominated by agriculturally poor regions dotted with few fertile pockets, $Gini_{Somali} = 0.62$. According to the theory, the highly unequal distribution of agricultural quality within the Somali group would make the Islamic principles more likely to be accepted, 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.

Table 1a presents the summary statistics of the variables employed in the cross-ethnic group analysis.[30] An average ethnic group has 19% of its population adhering to Islam in 2005, spans $31,000$ square kilometers and the Gini index of land inequality across its land endowments is 0.16. There are also several distance measures that have been constructed to account for the spatial diffusion of Islam. An average ethnic group is $6,250$ kilometers from Mecca, $7,030$ kilometers from Rome, and $2,460$ kilometers from trade routes in the 600 AD, that is, in the eve of the Muslim expansion. Table 1b shows the raw correlations among the variables of interest. Muslim representation at an ethnic group is positively related to the degree of inequality in the regional suitability for farming, negatively related to its distance from Mecca and its distance from the trade routes in 600 AD and finally positively related to the variation in elevation. For the cross-ethnic group analysis the following specification is adopted:

$$\text{Muslim}\%_i = a_0 + a_1 land\_inequality_i + a_2 X_i + \eta_i \tag{20}$$

The key theoretical prediction is that ethnicities characterized by more unequal regional agricultural potential are more likely to have adopted Islamic principles. The main prediction is corroborated across alternative specifications of Table 2.[31] In the first column of Table 2 *land inequality$_i$* enters positive and is statistically significant. Moving from an ethnic group with equally distributed regional farming suitability to an ethnic group with extremely unequal distribution increases Muslim representation by 33%. It is important to note that in all specifications we explicitly control for the country 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 element related to the state histories of existing countries and, thus, produce reliable estimates of the effect of geographic inequality on Muslim adherence.

In Column 2 we add a series of controls to account for alternative hypotheses that have been proposed in the literature. The negative coefficient on the distance from Mecca is consistent with the diffusion hypothesis. As Islam originated in the Arabian peninsula and spread from there, regions closer to Mecca were more likely to receive the expanding Muslim populations. Also, the distance from trade routes in 600 AD has a strong negative effect (Figure 3a presents portrays the major trade routes for the

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[30]We focus on ethnic groups with an area of at least 1000 square kilometers. Using all ethnic groups irrespective of the size does not change the result.

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

whole period between 600 AD and 1800 AD). Ethnic groups within countries located further from the pre-Islamic trade routes have systematically lower Muslim adherence. This is in line with the argument that historians of Islam have proposed. Following the demise of the Persian empire in the $7^{th}$ century Muslims came to dominate the preexisting trade routes. Hence, local populations had an incentive to convert to Islam in order to take advantage of the expansive Muslim trade network. This negative coefficient on distance from trade routes in 600 AD may be then interpreted as evidence of a transaction effect. Accounting for these important features the coefficient on land inequality reduces by a third but remains precisely estimated. Conditional on the distance from preexisting trade routes and the distance from Mecca, ethnic groups with more unequal agricultural potential are more likely to be Muslim.

In Column 2 we also control for a series of geographical characteristics to mitigate any concerns related to omitted variable's bias. Ethnicities located in lowland areas are more likely to have higher Muslim adherence. This is an intuitive finding, given that Muslims controlled the pre-industrial trade routes between Asia and Europe and the latter were more likely to be found along low elevation territories. Perhaps, a more important finding from a theoretical point of view, is the positive and significant effect that variation in elevation exerts on Muslim representation. Conditional on geographic characteristics and distance from trade routes and Mecca, ethnic groups located in regions with variable terrain are more likely to adhere to Islam. To the extent that a variable topography makes it easy to disrupt any trade flow over such territories then the groups in these geographically conflict prone regions would have an incentive to adopt the conflict reducing principles of Islam. Additional geographical controls like: average land quality, the area of an ethnic group, the distance from Rome, the distance from the equator, $abs\_lat$, and distance from the coast do not systematically correlate with Muslim adherence. Finally, we also control for population density in 1990 within an ethnic group. Note that the derived estimate cannot be causally interpreted since fertility decisions are likely to be affected by religious beliefs. Nevertheless, we introduce this control to ensure that our results are not driven by systematic differences in population density between Muslim and non-Muslim groups.

The last two columns of Table 2 divide the sample of ethnic groups between those that belong to the New World and those to the Old World. The proposed 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 rather than the indigenous populations that were severely disrupted, see Acemoglu, Johnson, and Robinson (2002). As a result, within the New World geography should not have an effect on the adoption and spread of the Islamic religion. Indeed, this is what is shown in column 3 of Table 2, whereas column 4 shows the strong effect of an unequal geography and a variable topography in bringing forward and sustaining larger Muslim populations within the Old World.

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### 4.2.1 Muslim Empires and Other Religions

The proposed theory 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. Likewise, instances of forced conversion, religious persecution during the Muslim expansion, or Arab migration movements towards territories similar to their homelands, might have shaped the observed religious affiliation.[32] 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 uniformly distributed land endowments. To mitigate such plausible concerns in Table 4 we focus on 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.

We investigate how geography shapes religious affiliation in the Old World across ethnic groups whose homelands have not been at any point in history under the direct rule of Muslim empires. Following Black (2005) we identify the regions that have been dominated by the Umayyads, Abassids, Karakhanids, Ghurids, Ghaznavids, Mughals, Ottomans, Mamluks, Seljuks, Timurids, Fatimids, Almoravids and the Almohads and exclude them from the analysis, see Figure 3b. Such restriction produces a sample of 2,015 ethnic groups. Tables 3a and 3b present the summary and the correlation between geographical features and adherence rates to various religious denominations for this subset of groups. Reassuringly, column 1 of table 4 shows that ethnic groups with large Muslim adherence in the Old World and out of the direct control of a Muslim empire consistently exhibit higher levels of inequality in agricultural endowments and have more variable topography. Also, distance from the borders of the Muslim empires of the centroid of each ethnic group enters with the expected negative sign, however it is not precisely estimated. In contrast, the coefficient on the distance from trade routes is both economically and statistically significant. In the online appendix we show that the results are robust to alternative measures of Muslim representation, indexes of land inequality and distances from trade routes.

In columns 2 to 4 of Table 4 we use as a dependent variable the percentage of people within an

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[32]A region can become Muslim either because the indigenous population converts to Islam or because there is a significant inflow of Muslims. To formally quantify the importance of each channel would require historical data on migration flows which are virtually non-existent. To the extent that Muslims migrated to regions with unequal endowments because their human capital was appropriate for such territories, this scenario could produce the observed positive correlation between unequal endowments and Muslim representation. However, this association does not obtain within the Muslim empires where movements of Muslims were arguably much easier compared to migrating out of Muslim empires. As such the evidence produced in Table 4 is more in line with indigenous communities differentially adopting the Islamic principles, consistent with Lapidus (2002).

ethnic group adhering to 3 other major religions i.e. Christianity, Hinduism and Buddhism respectively, whereas the fraction of people adhering to local animistic, or shamanistic religions, that is ethnoreligionists, is used in column 5. Neither Christians nor Hindus are systematically found along unequal land endowments whereas Buddhists like Muslims are more likely to be found along agriculturally unequal territories. It is interesting to note that the only religious group that follows the opposite geographic pattern compared to Muslims are the local tribal denominations.[33] Our interpretation is that when Islam started spreading, the ethnic groups that maintained their local tribal religions had exactly the type of geographic endowments (relatively uniform distribution of agricultural potential) that were not conducive to the adoption of the Islamic principles, whereas those residing along more unequally endowed regions endogenously adopted the Islamic economic principles.

These findings uncover the so far neglected crucial role of geographical inequality in shaping the differential adherence to the Muslim 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 focused 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 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 of people 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 virtual countries are constructed in the following way: we generate a global grid of 2.5 by 2.5 decimal degrees that extends from $-180$ to 180 degrees longitude and from 85 degrees latitude to $-65$ degrees latitude. This global grid is intersected with the territories that are covered linguistically by the WLMS (2006) database. Since no linguistic groups are mapped for oceans, large lakes and seas, the virtual countries falling entirely in such places vanish. Each and every part of a virtual country that remains after the spatial intersection has complete linguistic coverage, and it is across these territories that geographic and population statistics are constructed. Figure 4 illustrates the resulting virtual countries with linguistic and religious affiliation. Out of the $64,004$ cells in the land quality dataset $18,941$ contain no information on languages and are dropped from the analysis. This is mostly due to the incomplete mapping of regions in the Americas and Australia.

Figure 5 shows one example of a virtual country. 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,

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[33]Results are the same if we include all ethnic groups across the world in the regressions of non-Muslim denominations.

the southern part to Jordan and a small part in the East to Iraq. 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.[34] The artificial country in Figure 5 has a Muslim representation of 99%, 76% of its regions are poorly endowed for agricultural activities and has an estimated Gini index of land suitability of 0.76.

In the regression analysis virtual countries of at least $10,000$ square kilometers are included yielding an average virtual country of $44,000$ square kilometers. The resulting sample size is 1902 observations with a median of 25 regions. A virtual country falls on average into 7 ethnic groups. Descriptive statistics and the raw correlation between the variables used in the regressions are presented in Tables $5a$ and $5b$. An average virtual country has 22% Muslims.

We now estimate (20) using cross-virtual country data. Column 1 of table 6 shows that conditional on average land quality a more unequal distribution of agricultural potential across virtual countries contributes significantly to the formation of Muslim communities.[35] By taking advantage of the arbitrarily drawn borders of these geographical entities, we control for country fixed effects in all specifications.[36] In column 2 we account for a series of controls. Once we do so, the negative effect of average land quality becomes marginally significant suggesting that Muslim communities are located along poorly endowed regions. On the other hand, virtual countries featuring a more variable terrain, which presumably has been historically exposing trade activities in these areas to higher risks of expropriation, also sustain larger Muslim adherence.

The area of a virtual country is not statistically significant whereas the within country indicator is negative. 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. The distance from Mecca of each artificial country negatively affects Muslim intensity. Likewise, virtual countries located at higher altitudes and having more ethnic groups sustain

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[34]For example, the Muslim adherence in 2005 for the virtual country depicted in Figure 5 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.

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

[36]The virtual countries that fall into more than one country are assigned as a country dummy the country where their centroid belongs to.

smaller Muslim populations. In specifications 3 and 4 of Table 6 we focus on different subsets of the sample. In particular, in column 3 the sample consists of virtual countries of the Old World. Similar to the ethnic group findings, an unequal geography significantly increases Muslim intensity across virtual countries in Africa, Asia and Europe (in the online appendix we replicate the analysis using alternative measures of Muslim representation, indexes of land inequality and distances from trade routes).

In order to alleviate concerns related to conversion into Islam across places within a Muslim empire in column 4 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 assess 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 systematically increases Muslim adherence at a virtual country level. Also, now the distance from the borders of a Muslim empire becomes a significant determinant of religious affiliation. Virtual countries closer to the Muslim borders have higher Muslim representation.

In the last 4 columns of table 6 we use as dependent variable the adherence in other religious denominations. Despite the large negative correlation between Muslim and Christian adherence across virtual countries ($-0.67$), column 5 shows that land inequality does not systematically shape Christian shares across virtual countries. Similar non-findings regarding the effect of unequal geography obtain for the share of Buddhists and Hindus. In the last column of Table 6 the dependent variable is the share of the population that is ethnoreligionist. Echoing the findings of the cross-ethnic group specifications ethnoreligionists are concentrated along virtual countries that are characterized by a relatively equal distribution of agricultural potential following the opposite pattern uncovered for the Muslim adherents. This reinforces the theoretical argument that Islamic principles were more likely to be adopted by indigenous populations in places whose underlying geography was creating conflicting interests that Islamic principles were engineered to bring together.[37]

## 4.4 Cross-Country Analysis

In this 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. Figure 6$a$ in Appendix $A$ shows that existing countries vary widely in the distribution of agricultural suitability. The descriptive statistics and the raw correlations between the variables of interest are presented in the online appendix. A typical country has a Gini index of land inequality of 0.35 whereas in 1900 AD an average country had about 22% of Muslims, see Figure 6$b$. These two variables have a correlation of 0.48.

To estimate the effect of agricultural inequality on Muslim adherence the following specification is

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[37]We also attempted to detect whether there is a diminishing effect of land inequality on Muslim adherence for virtual countries further from the trade routes. Although the interaction entered negatively as expected it was statistically insignificant. This is presumably because the maps of historic trade routes are drawn with a certain degree of accuracy and indicate only the major continental routes of the era.

adopted:

$$\text{Muslim1900}_i = \gamma_0 + \gamma_1 land\_inequality_i + \gamma_2 X_i + \nu_i \tag{21}$$

where $\text{Muslim1900}_i$ is the fraction of the population adhering to Islam in 1900 AD.

The results of the main specification (21) are presented in column 1 of Table 7.[38] A one standard deviation increase in the Gini inequality of agricultural suitability increases the fraction of the Muslim population in 1900 by 13% and differences in regional inequality account for 23% of the variation in Muslim representation. The average land quality is insignificant. In column 2 of Table 7 we introduce a host of geographic controls. Larger countries have lower Muslim representation but the estimate is insignificant. Countries further from Mecca and further from Rome are also less likely to be Muslim. The distance from pre-Islamic trade routes is imprecisely estimated whereas countries further from the equator are less probable to be Muslim. In the same specification a set of continental dummies is included. As expected countries in Western Europe have fewer Muslims, whereas those in the Middle East, Northern Africa and Asia have a larger Muslim populace.

The additional geographical controls like mean elevation and variation in elevation within a country and the mean distance to the nearest coastline or sea-navigable river are not systematically related to Muslim adherence. These geographical controls do not change the economic and statistical significance of inequality in agricultural potential, highlighting the robustness of our findings.

Column 3 and 4 of Table 7 split the sample of countries between the Old and the New World respectively. Consistent with the pattern identified in the cross-ethnicity and cross-virtual country regressions, 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. Finally, column 5 focuses across countries in the Old World that have not been under a Muslim empire in order to identify the role of geographical endowments across societies that have not been subjects of a Muslim imperial power. The sample of countries in this case reduces to 76 observations, however the estimate on the land inequality remains both economically and statistically significant.

This section corroborates the pattern uncovered in the cross-ethnic and cross-virtual country analysis demonstrating the fundamental role of geographical inequality in determining adherence to Islam across modern day countries.

## 5 Conclusion

This research sheds new light on the economic origins of Islam. The empirical analysis uncovers that the Muslim lands are characterized by high inequality in the suitability for agriculture across regions and

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[38] We focus on countries with at least 20 regional observations to ensure that our findings are not driven by countries with limited regional coverage. Using as dependent variable the Muslim representation as of 2000 the coefficients of interest are larger and more precisely estimated. Presumably this is because earlier estimates of religious affiliation are bound to be more noisy.

shows that Muslim adherence is systematically larger along the pre-Islamic trade routes in the Old World. The theory provided links this particular type of geography to the formation of the Islamic principles and investigates its impact on the economic performance of the Muslim world 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 high inequality in agricultural potential 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 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 closer to pre-Islamic trade routes 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 and trade opportunities 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 an economic system dictating both static and dynamic income redistribution. The latter was implemented by increasing the costs of physical capital accumulation rendering the investments in public goods, through religious endowments, increasingly attractive. The Islamic economic principles allowed the Muslim lands to flourish in the preindustrial world limiting the potential for growth in the eve of large scale shipping trade and industrialization.

# 6 Appendix A

Figure 1: Regional Suitability for Agriculture Across the Globe
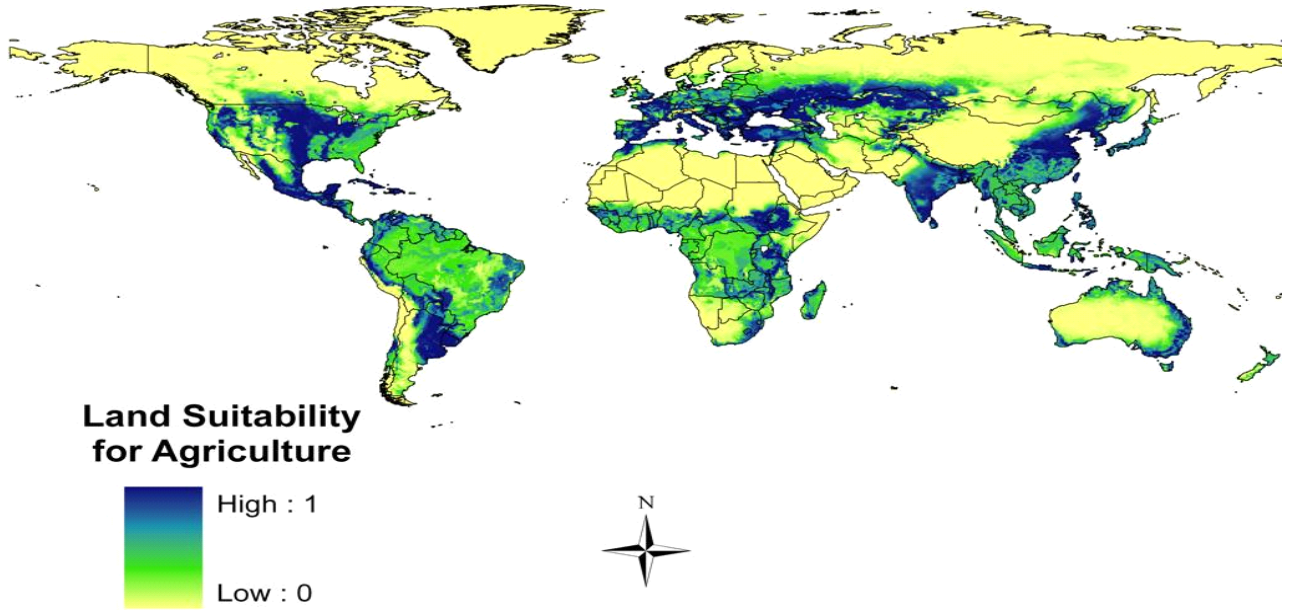
Figure 2*a*: Location and Muslim Representation across Groups in Ethiopia
The Case of the Amharic and Somali Ethnicities



**2 Ethnic Groups in Ethiopia**

▨ Homeland of the Amharic Group  -   1% Muslim in 2005

▨ Homeland of the Somali  Group  - 100% Muslim in 2005
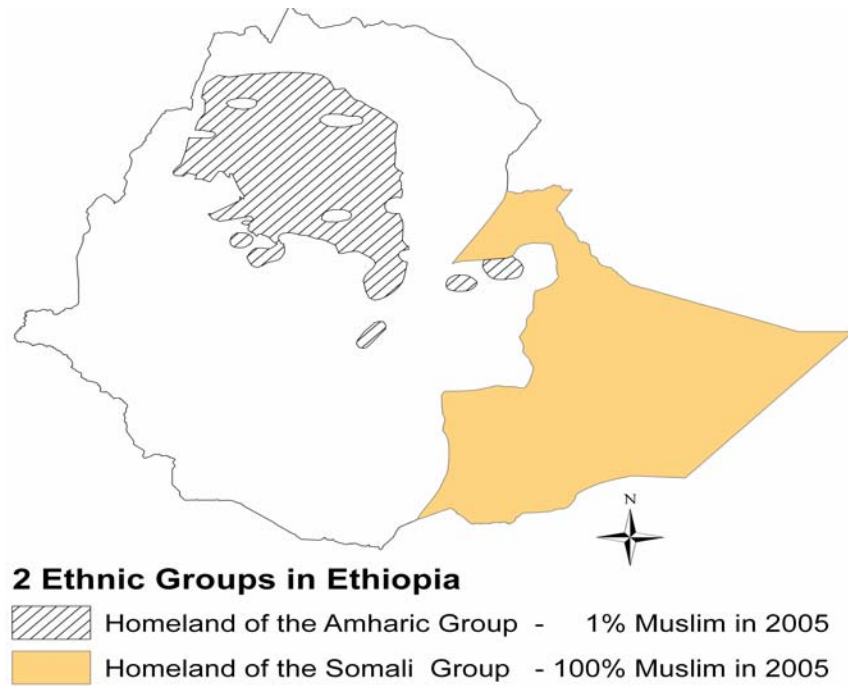
Figure 2*b*: Regional Land Quality across Groups in Ethiopia
The Case of the Amharic and Somali Ethnicities



**Regional Land Quality for Agriculture**

▨ < 10% Agricultural Potential

▨ > 10% Agricultural Potential
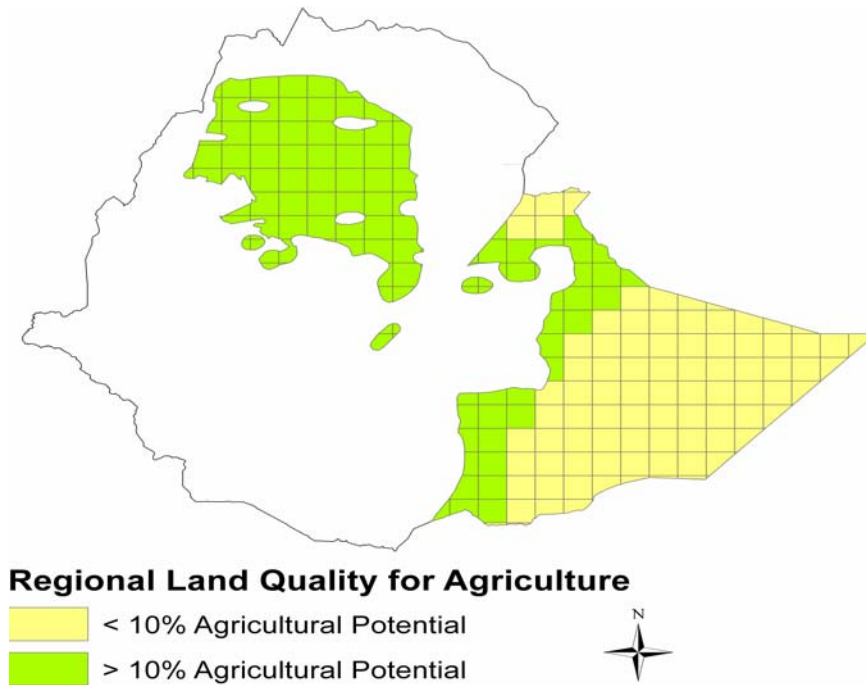
**Table 1a  -  Summary Statistics for the Cross Ethnic Group Analysis - Muslim World in 2005 AD**

| _stats | Muslim % in 2005 | Land Inequality (Gini) | Average Land Quality | Area | Distance from Mecca | Distance from Trade Routes in 600 AD | Distance from Rome | Mean Elevation | Variation in Elevation | Ln(Population Density in 1990) |
|---|---|---|---|---|---|---|---|---|---|---|
| mean | 0.19 | 0.16 | 0.44 | 0.31 | 6.25 | 2.46 | 7.03 | 0.72 | 0.21 | 2.74 |
| sd | 0.35 | 0.15 | 0.23 | 2.29 | 3.58 | 2.56 | 3.37 | 0.81 | 0.22 | 1.92 |
| max | 1.00 | 0.97 | 1.00 | 80.24 | 16.51 | 10.92 | 18.49 | 5.42 | 1.80 | 7.34 |
| min | 0.00 | 0.00 | 0.00 | 0.01 | 0.44 | 0.00 | 0.12 | -0.59 | 0.00 | -4.78 |

See Appendix B for variables' definitions

**Table 1b  -  Correlation Matrix for the Cross Ethnic Group Analysis - Muslim World in 2005 AD**

| | Muslim % in 2005 | Land Inequality (Gini) | Average Land Quality | Ln(Area) | Ln(Distance from Mecca) | Ln(Distance from Trade Routes in 600 AD) | Ln(Distance from Rome) | Mean Elevation | Variation in Elevation | Ln(Population Density in 1990) |
|---|---|---|---|---|---|---|---|---|---|---|
| Muslim % in 2005 | 1.00 | | | | | | | | | |
| Land Inequality (Gini) | 0.24 | 1.00 | | | | | | | | |
| Average Land Quality | -0.18 | -0.48 | 1.00 | | | | | | | |
| Ln(Area) | 0.03 | 0.19 | -0.06 | 1.00 | | | | | | |
| Ln(Distance from Mecca) | -0.33 | -0.14 | 0.03 | -0.01 | 1.00 | | | | | |
| Ln(Distance from Trade Routes in 600 AD) | -0.27 | -0.09 | 0.00 | -0.01 | 0.82 | 1.00 | | | | |
| Ln(Distance from Rome) | -0.30 | -0.21 | 0.05 | -0.04 | 0.88 | 0.55 | 1.00 | | | |
| Mean Elevation | -0.05 | 0.36 | -0.03 | 0.00 | -0.20 | -0.17 | -0.18 | 1.00 | | |
| Variation in Elevation | 0.06 | 0.26 | 0.11 | 0.08 | -0.04 | -0.10 | -0.03 | 0.54 | 1.00 | |
| Ln(Population Density in 1990) | 0.13 | -0.09 | 0.41 | -0.01 | -0.35 | -0.43 | -0.28 | 0.09 | 0.23 | 1.00 |

See Appendix B for variables' definitions

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

|  | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| VARIABLES | Muslim%2005 | Muslim%2005 | Muslim%2005 | Muslim%2005 |
| Land Inequality (Gini) | 0.328*** | 0.207*** | 0.001 | 0.233*** |
|  | (0.070) | (0.068) | (0.001) | (0.087) |
| Average Land Quality | -0.014 | -0.123* | 0.001 | -0.159* |
|  | (0.124) | (0.072) | (0.001) | (0.095) |
| Variation in Elevation |  | 0.129*** | -0.001 | 0.160** |
|  |  | (0.049) | (0.001) | (0.062) |
| Mean Elevation |  | -0.050*** | 0.001 | -0.059** |
|  |  | (0.018) | (0.001) | (0.026) |
| Ln(Distance from Mecca) |  | -0.435*** | 0.008 | -0.474*** |
|  |  | (0.164) | (0.009) | (0.181) |
| Ln(Distance from Trade Routes in 600AD) |  | -0.057** | -0.002 | -0.056*** |
|  |  | (0.023) | (0.004) | (0.019) |
| Ln(Area) |  | 0.002 | 0.001 | 0.002 |
|  |  | (0.006) | (0.001) | (0.008) |
| Ln(Distance from Rome) |  | -0.150 | -0.005 | -0.136 |
|  |  | (0.173) | (0.004) | (0.192) |
| Ln(Sea Distance) |  | 0.007 | 0.001 | -0.032 |
|  |  | (0.089) | (0.001) | (0.106) |
| Absolute Latitude |  | 0.004 | 0.001 | 0.008 |
|  |  | (0.004) | (0.001) | (0.006) |
| Ln(Population Density in 1990) |  | 0.014 | 0.001 | 0.018 |
|  |  | (0.018) | (0.001) | (0.027) |
| Country FE | Yes | Yes | Yes | Yes |
| Observations | 2911 | 2911 | 572 | 2339 |
| R² | 0.52 | 0.59 | 0.12 | 0.57 |

Standard errors in parentheses are clustered at the country level, *** p<0.01, ** p<0.05, * p<0.1

Specification (3) focuses within the New World i.e. the Americas and the Pacific (4) focuses within the

Old World i.e., Asia, Africa and Europe

See Appendix B for variables' definitions

Figure 3a: Pre-industrial Trade Routes in the Old World
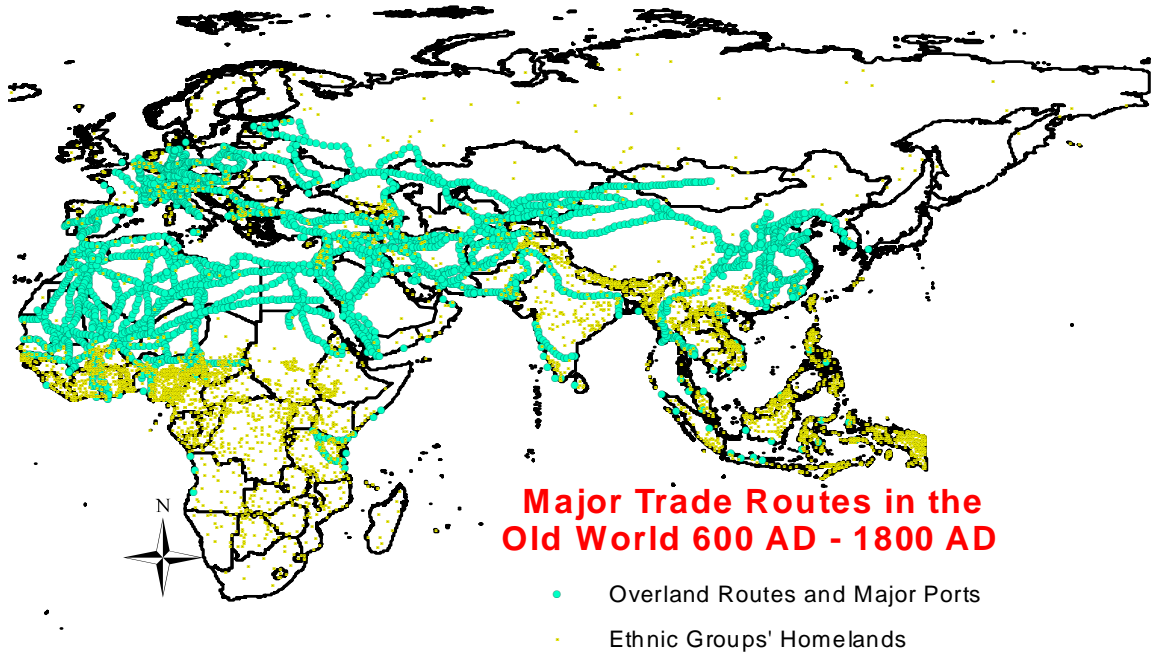


Major Trade Routes in the
Old World 600 AD - 1800 AD

• Overland Routes and Major Ports

• Ethnic Groups' Homelands

Figure 3b: Regions Dominated by Muslim Empires in the Old World



Muslim Empires in
the Old World

Muslim Empires

### Table 3a - Summary Statistics for the Cross Ethnic Group Analysis - All Religions in 2005 AD

| _stats | Muslim %05 | Christian %05 | Hindu %05 | Buddhist %05 | EthnoRel %05 | Land Inequality (Gini) | Average Land Quality | Distance from Mecca | Distance from Trade Routes in 600 AD | Distance from Muslim Empires |
|---|---|---|---|---|---|---|---|---|---|---|
| mean | 0.18 | 0.42 | 0.01 | 0.04 | 0.32 | 0.16 | 0.43 | 5.08 | 1.54 | 2.04 |
| sd | 0.33 | 0.37 | 0.08 | 0.18 | 0.33 | 0.14 | 0.21 | 2.38 | 1.11 | 1.42 |
| max | 1.00 | 1.00 | 0.99 | 1.00 | 1.00 | 0.97 | 0.98 | 11.48 | 4.78 | 6.47 |
| min | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.51 | 0.01 | 0.00 |

See Appendix B for variables' definitions

### Table 3b - Correlation Matrix for the Cross Ethnic Group Analysis - All Religions in 2005 AD

| | Muslim %05 | Christian %05 | Hindu %05 | Buddhist %05 | EthnoRel %05 | Land Inequality (Gini) | Average Land Quality | Ln(Distance from Mecca) | Ln(Distance from Trade Routes in 600 AD) | Ln(Distance from Muslim Empires) |
|---|---|---|---|---|---|---|---|---|---|---|
| Muslim%05 | 1.00 | | | | | | | | | |
| Christian%05 | -0.49 | 1.00 | | | | | | | | |
| Hindu%05 | -0.04 | -0.11 | 1.00 | | | | | | | |
| Buddhist%05 | -0.13 | -0.25 | -0.01 | 1.00 | | | | | | |
| EthnoRel%05 | -0.35 | -0.45 | -0.07 | -0.15 | 1.00 | | | | | |
| Land Inequality (Gini) | 0.15 | -0.13 | 0.01 | 0.24 | -0.19 | 1.00 | | | | |
| Average Land Quality | -0.11 | 0.02 | 0.08 | -0.09 | 0.11 | -0.47 | 1.00 | | | |
| Ln(Distance from Mecca) | -0.12 | -0.15 | 0.03 | 0.12 | 0.19 | -0.09 | -0.08 | 1.00 | | |
| Ln(Distance from Trade Routes in 600 AD) | 0.03 | 0.12 | -0.10 | -0.25 | 0.04 | -0.08 | -0.25 | 0.52 | 1.00 | |
| Ln(Distance from Muslim Empires) | -0.16 | 0.25 | -0.30 | -0.21 | 0.09 | -0.20 | -0.07 | 0.62 | 0.61 | 1.00 |

See Appendix B for variables' definitions

**Table 4: Cross Ethnic Group Analysis - Other Religions in 2005**

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| | | | | | Ethno- |
| VARIABLES | Muslim% | Christian% | Hindu% | Buddhist% | Religious% |
| Land Inequality (Gini) | 0.270*** | -0.174 | -0.015 | 0.247*** | -0.313** |
| | (0.078) | (0.106) | (0.022) | (0.076) | (0.120) |
| Average Land Quality | -0.229*** | 0.052 | 0.010 | 0.004 | 0.135** |
| | (0.083) | (0.073) | (0.018) | (0.028) | (0.067) |
| Variation in Elevation | 0.123* | 0.005 | 0.050* | -0.188*** | 0.012 |
| | (0.069) | (0.065) | (0.026) | (0.045) | (0.116) |
| Mean Elevation | -0.086*** | 0.070** | -0.028** | 0.118*** | -0.049 |
| | (0.029) | (0.032) | (0.014) | (0.029) | (0.032) |
| Ln(Distance from Mecca) | -0.221 | 0.289 | 0.024 | -0.096 | 0.002 |
| | (0.229) | (0.199) | (0.024) | (0.061) | (0.148) |
| Ln(Distance from Trade 600 AD) | -0.085*** | 0.071* | 0.008* | 0.024** | -0.018 |
| | (0.029) | (0.039) | (0.005) | (0.011) | (0.021) |
| Ln(Distance from Muslim Empires) | -0.083 | 0.036 | -0.041** | 0.030 | 0.021 |
| | (0.055) | (0.045) | (0.020) | (0.023) | -0.026 |
| Ln(Area) | 0.005 | 0.010 | 0.002 | 0.005 | -0.033*** |
| | (0.006) | (0.009) | (0.002) | (0.005) | (0.009) |
| Ln(Distance from Rome) | -0.074 | -0.125 | 0.070** | -0.028 | 0.237 |
| | (0.253) | (0.307) | (0.034) | (0.034) | (0.167) |
| Ln(Sea Distance) | 0.030 | -0.179 | 0.037* | -0.047 | 0.201*** |
| | (0.110) | (0.135) | (0.019) | (0.034) | (0.076) |
| Absolute Latitude | 0.012** | -0.006 | 0.001 | -0.002 | -0.004 |
| | (0.006) | (0.005) | (0.001) | (0.002) | (0.005) |
| Ln(Population Density in 1990) | 0.026 | 0.024 | 0.005** | -0.004 | -0.061*** |
| | (0.027) | (0.024) | (0.002) | (0.006) | (0.013) |
| Country FE | Yes | Yes | Yes | Yes | Yes |
| Observations | 2015 | 2015 | 2015 | 2015 | 2015 |
| R² | 0.47 | 0.56 | 0.32 | 0.51 | 0.36 |

Standard errors in parentheses are clustered at the country level, *** p<0.01, ** p<0.05, * p<0.1

All Specifications focus within the Old World excluding territories that have been subjected to a

Muslim Empire in the past.

See Appendix B for variables' definitions

Figure 4: Land Quality Across Virtual Countries with
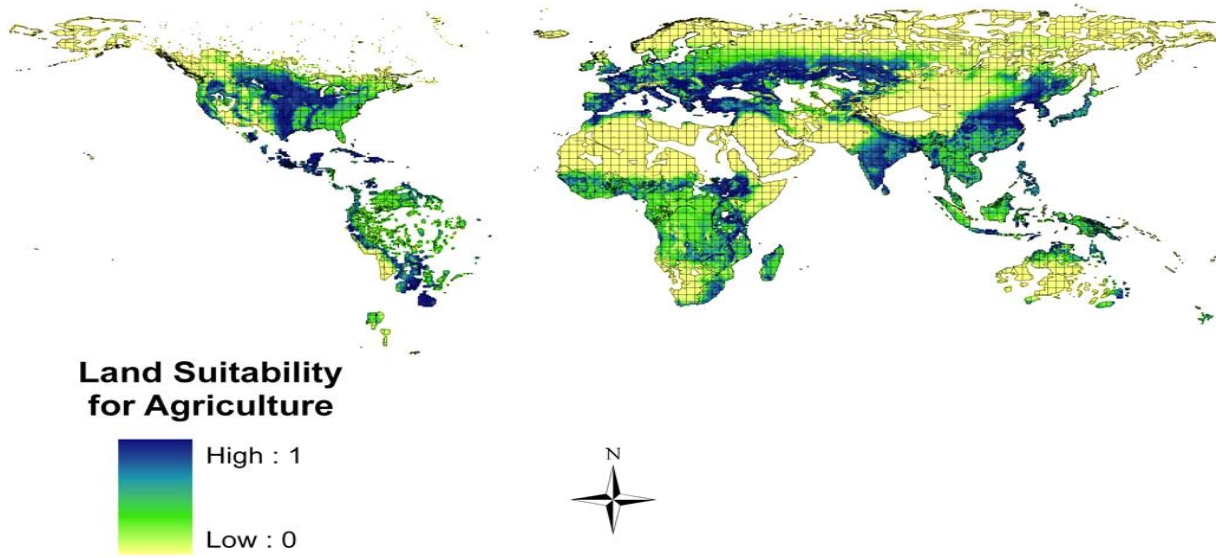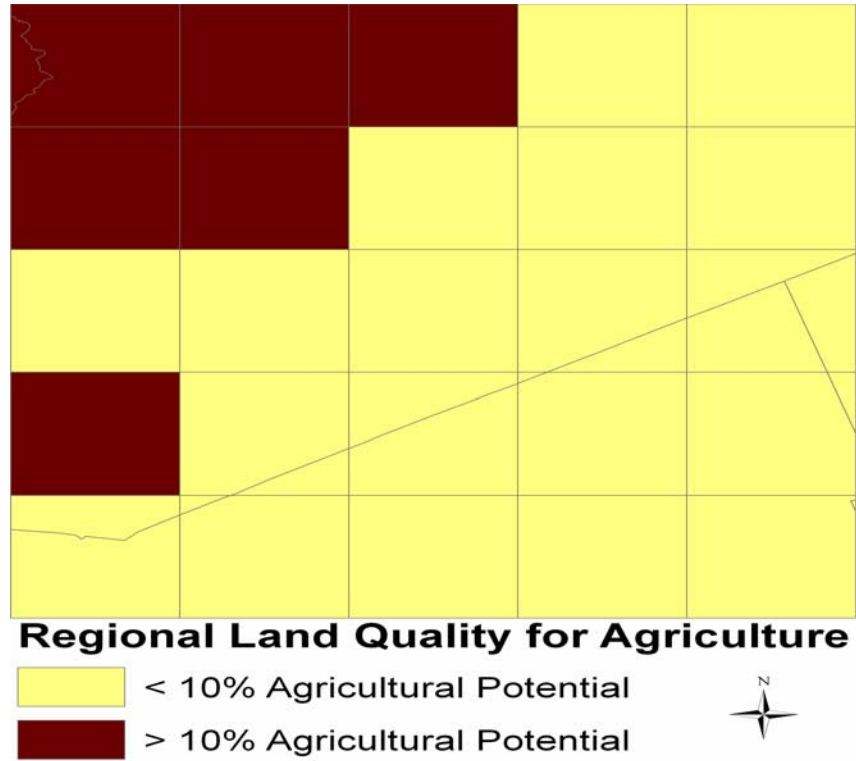Coverage on the Indigenous Religious Affiliation



Figure 5: Example of a Virtual Country



This Virtual Country falls between Iraq, Jordan, Lebanon and Syria.
Muslim Adherence Rate in 2005 is 99%

## Table 5a - Summary Statistics for the Virtual Countries Analysis

| _stats | Muslim %05 | Christian %05 | Buddhist %05 | EthnoRel %05 | Hindu %05 | Land Inequality (Gini) | Average Land Quality | Number of Ethnic Groups | Variation in elevation | Distance from Muslim Empires |
|---|---|---|---|---|---|---|---|---|---|---|
| mean | 0.22 | 0.48 | 0.05 | 0.12 | 0.02 | 0.23 | 0.33 | 6.74 | 0.23 | 2.81 |
| sd | 0.38 | 0.38 | 0.16 | 0.19 | 0.12 | 0.16 | 0.30 | 11.67 | 0.25 | 2.63 |
| max | 1.00 | 1.00 | 1.00 | 0.93 | 0.93 | 0.87 | 0.98 | 165 | 2.23 | 10.89 |
| min | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | 0.00 | 0.00 |

See Appendix B for variables' definitions

## Table 5b - Correlation Matrix for the Virtual Countries Analysis

| | Muslim %05 | Christian %05 | Buddhist %05 | EthnoRel %05 | Hindu %05 | Land Inequality (Gini) | Average Land Quality | Ln(Number of Ethnic Groups) | Variation in elevation | Ln(Distance from Muslim Empires) |
|---|---|---|---|---|---|---|---|---|---|---|
| Muslim%05 | 1.00 | | | | | | | | | |
| Christian%05 | -0.67 | 1.00 | | | | | | | | |
| Buddhist%05 | -0.15 | -0.32 | 1.00 | | | | | | | |
| EthnoRel%05 | -0.28 | -0.15 | 0.01 | 1.00 | | | | | | |
| Hindu%05 | -0.06 | -0.20 | -0.02 | -0.05 | 1.00 | | | | | |
| Land Inequality (Gini) | 0.14 | -0.08 | 0.15 | -0.12 | -0.07 | 1.00 | | | | |
| Average Land Quality | -0.21 | 0.09 | -0.02 | -0.05 | 0.15 | -0.52 | 1.00 | | | |
| Ln(Number of Ethnic Groups) | -0.02 | -0.03 | 0.02 | 0.20 | 0.07 | -0.08 | 0.18 | 1.00 | | |
| Variation in elevation | 0.12 | -0.16 | 0.17 | -0.03 | 0.01 | 0.33 | 0.06 | 0.24 | 1.00 | |
| Ln(Distance from Muslim Empires) | -0.46 | 0.39 | -0.20 | 0.18 | -0.17 | -0.08 | -0.06 | -0.06 | -0.09 | 1.00 |

See Appendix B for variables' definitions

**Table 6: Cross Virtual Country Analysis**

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| VARIABLES | Muslim% | Muslim% | Muslim% | Muslim% | Christian% | Hindu% | Buddhist% | Ethno-Religious% |
| Land Inequality (Gini) | 0.117*** | 0.080** | 0.068** | 0.097** | 0.034 | 0.008 | 0.119 | -0.169*** |
| | (0.037) | (0.034) | (0.032) | (0.046) | (0.087) | (0.012) | (0.076) | (0.062) |
| Average Land Quality | -0.066 | -0.120* | -0.202** | -0.202** | 0.100 | 0.003 | 0.083 | 0.035 |
| | (0.080) | (0.061) | (0.096) | (0.088) | (0.074) | (0.007) | (0.056) | (0.061) |
| Variation in Elevation | | 0.148*** | 0.188*** | 0.087** | 0.085* | -0.017 | -0.229*** | 0.018 |
| | | (0.055) | (0.052) | (0.040) | (0.045) | (0.019) | (0.042) | (0.041) |
| Mean Elevation | | -0.038* | -0.044** | -0.055** | -0.004 | 0.001 | 0.168*** | -0.014** |
| | | (0.019) | (0.021) | (0.023) | (0.019) | (0.001) | (0.022) | (0.006) |
| Ln(Distance from Mecca) | | -0.165** | -0.171* | -0.071 | 0.058 | -0.007 | -0.080** | 0.050 |
| | | (0.079) | (0.092) | (0.134) | (0.122) | (0.007) | (0.034) | (0.052) |
| Ln(Distance from Trade Routes in 600 AD) | -0.020 | -0.022 | -0.024 | 0.029* | -0.002 | 0.026*** | 0.001 |
| | (0.016) | (0.016) | (0.023) | (0.017) | (0.003) | (0.007) | (0.006) |
| Ln(Distance from Muslim Empires) | | | | -0.104*** | 0.043** | -0.003 | 0.001 | 0.023 |
| | | | | (0.026) | -0.021 | (0.002) | (0.010) | (0.020) |
| Ln(Number of Ethnicities) | | -0.042** | -0.055** | -0.060** | 0.008 | 0.001 | -0.008 | 0.077*** |
| | | (0.018) | (0.023) | (0.023) | (0.025) | (0.001) | (0.005) | (0.016) |
| Within Country Indicator | | -0.031* | -0.041** | -0.035** | 0.018 | 0.003 | -0.005 | 0.034*** |
| | | (0.016) | (0.018) | (0.018) | (0.028) | (0.003) | (0.009) | (0.012) |
| Ln(Area) | | -0.008 | -0.015 | -0.026 | 0.043 | -0.004 | -0.007 | -0.027 |
| | | (0.016) | (0.022) | (0.026) | (0.036) | (0.003) | (0.008) | (0.025) |
| Ln(Distance from Rome) | | -0.005 | -0.006 | 0.138 | -0.152* | 0.011 | 0.013 | -0.002 |
| | | (0.067) | (0.078) | (0.086) | (0.087) | (0.007) | (0.017) | (0.030) |
| Ln(Sea Distance) | | 0.050 | 0.033 | 0.022 | 0.015 | -0.001 | -0.070*** | 0.011 |
| | | (0.056) | (0.054) | (0.035) | (0.026) | (0.002) | (0.023) | (0.026) |
| Absolute Latitude | | 0.001 | 0.001 | 0.004 | -0.002 | 0.001 | -0.002 | 0.002 |
| | | (0.001) | (0.002) | (0.003) | (0.003) | (0.001) | (0.001) | (0.003) |
| Ln(Population Density in 1990) | | 0.005 | 0.012 | 0.022 | 0.013 | 0.001 | -0.007*** | -0.040*** |
| | | (0.008) | (0.013) | (0.016) | (0.015) | (0.001) | (0.002) | (0.005) |
| Country FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 1902 | 1902 | 1469 | 1136 | 1136 | 1136 | 1136 | 1136 |
| R² | 0.87 | 0.89 | 0.89 | 0.81 | 0.81 | 0.75 | 0.86 | 0.55 |

Standard errors in parentheses are clustered at the country level, *** p<0.01, ** p<0.05, * p<0.1
Column (3) focuses in the Old World. Specifications (4-8) focus within the Old World excluding territories that have been subjected to a Muslim Empire. See Appendix B for variables' definitions

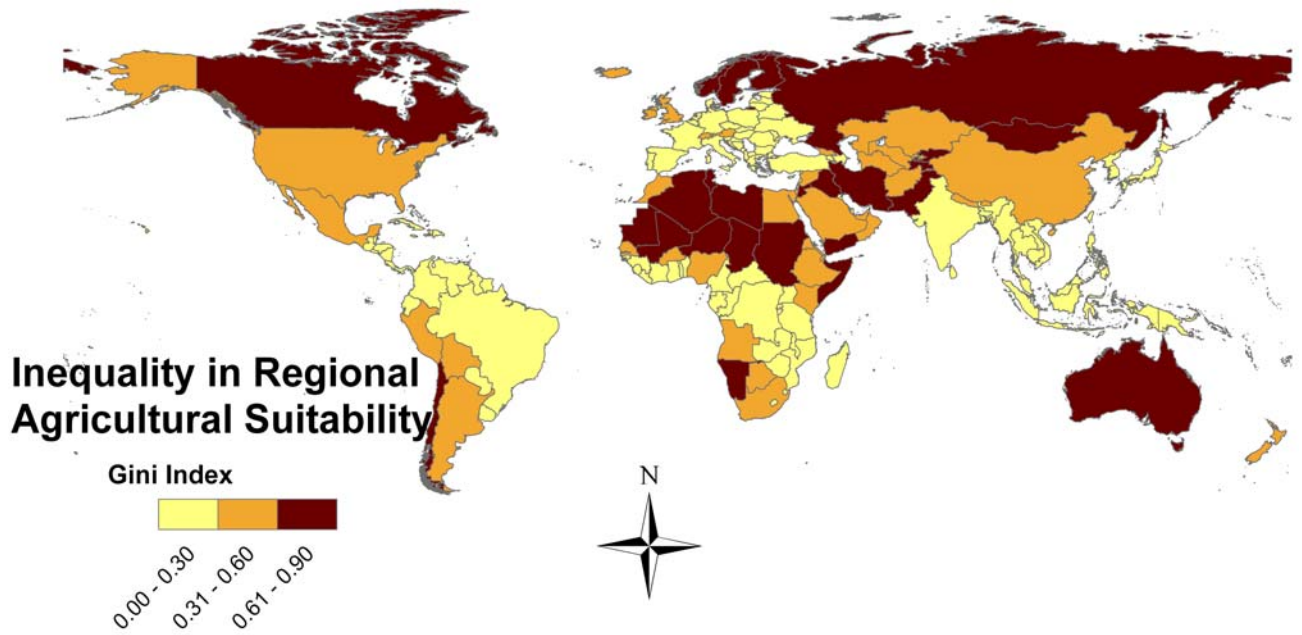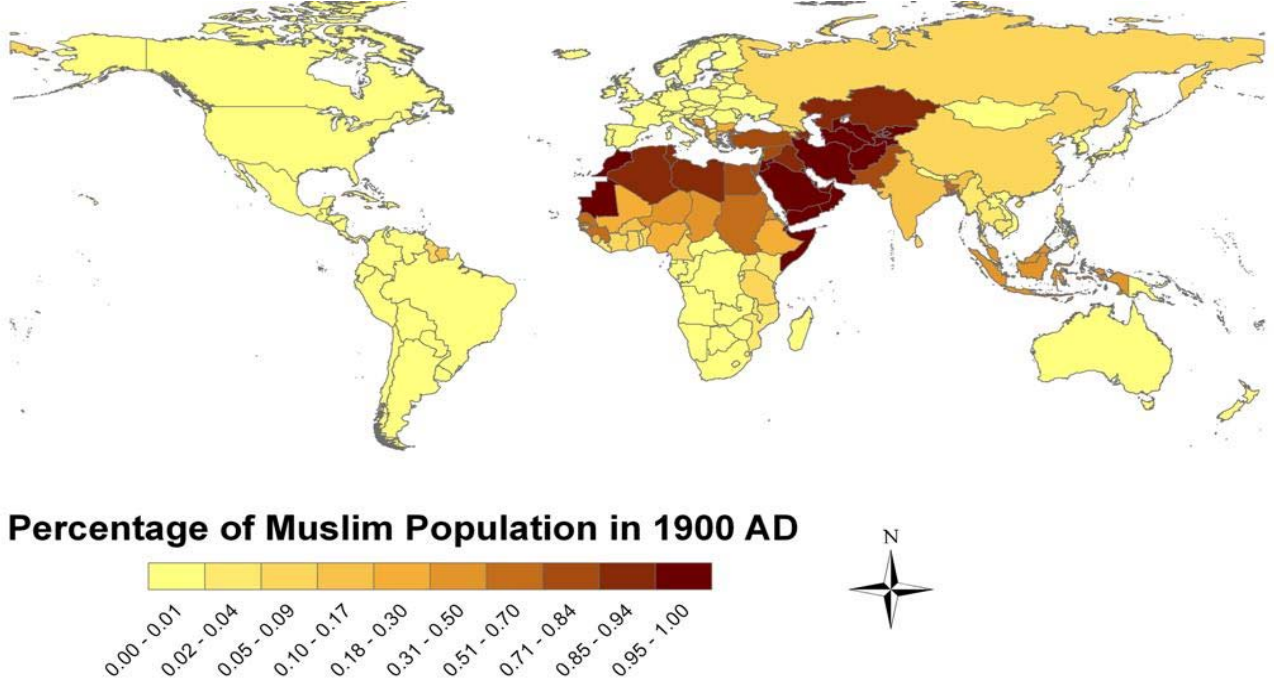Figure 6a: Inequality in Regional Suitability for Agriculture Across Countries



Figure 6b: % of Muslim Population in 1900 Across Countries

## Table 7 - Cross Country Analysis - Muslim World in 1900 AD

| VARIABLES | (1) Muslim1900 | (2) Muslim1900 | (3) Muslim1900 | (4) Muslim1900 | (5) Muslim1900 |
|---|---|---|---|---|---|
| Land Inequality (Gini) | 0.574** | 0.598*** | 0.558*** | -0.136 | 0.460** |
| | (0.225) | (0.164) | (0.195) | (0.094) | (0.219) |
| Average Land Quality | -0.205 | 0.040 | -0.140 | -0.112 | 0.136 |
| | (0.215) | (0.144) | (0.192) | (0.073) | (0.202) |
| Ln(Area) | | -0.009 | -0.022 | -0.004 | 0.026 |
| | | (0.015) | (0.027) | (0.003) | (0.018) |
| Ln(Distance from Mecca) | | -0.136* | -0.135* | -0.163 | -0.163 |
| | | (0.071) | (0.077) | (0.131) | (0.125) |
| Ln(Distance from Trade Routes in 600 AD) | | 0.010 | -0.018 | 0.033 | 0.041 |
| | | (0.030) | (0.034) | (0.031) | (0.029) |
| Ln(Distance from Rome) | | -0.072* | -0.099** | -0.008 | 0.054 |
| | | (0.040) | (0.047) | (0.032) | (0.050) |
| Ln(Distance from Muslim Empires) | | | | | -0.067 |
| | | | | | (0.044) |
| Mean Elevation | | -0.080 | -0.088 | 0.043 | -0.095 |
| | | (0.094) | (0.103) | (0.049) | (0.077) |
| Variation in Elevation | | 0.034 | -0.001 | -0.028 | -0.075 |
| | | (0.119) | (0.178) | (0.044) | (0.103) |
| Ln(Sea Distance) | | 0.011 | 0.035 | 0.002 | -0.027 |
| | | (0.036) | (0.043) | (0.005) | (0.052) |
| Mediterranean and North Africa | | 0.267** | 0.216* | | |
| | | (0.101) | (0.115) | | |
| Western Europe | | -0.177** | -0.165** | | -0.020 |
| | | (0.062) | (0.070) | | (0.077) |
| Absolute Latitude | | -0.003* | -0.003 | 0.001 | -0.002 |
| | | (0.002) | (0.002) | (0.001) | (0.003) |
| Asia | | 0.281*** | 0.307*** | | 0.130 |
| | | (0.075) | (0.085) | | (0.122) |
| Observations | 138 | 138 | 113 | 25 | 76 |
| R² | 0.23 | 0.63 | 0.63 | 0.48 | 0.45 |

Robust standard errors in parentheses, *** $p<0.01$, ** $p<0.05$, * $p<0.1$
Specification (3) focuses within the Old World i.e. Europe, Africa and Asia; (4) focuses within the New World i.e., Americas and the Pacific. Specification (5) focuses within the Old World in countries that have not been under a Muslim Empire. See Appendix B for variables' definitions

# Appendix B - Data Sources

## Geographical Variables

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

Source: Constructed using ArcGis.

**Area**: 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.[39]

**Average Land Quality**: Average suitability for farming based on climatic and soil characteristics within the respective unit of analysis.

Source: Michalopoulos (2008). The raw dataset is available at the Atlas of the Biosphere.[40]

In order to construct this index Ramankutty, Foley, Norman, and McSweeney (2002) empirically estimate the probability density function of the percentage of croplands around 1990 with respect to climate and soil characteristics. Then the authors combine the derived probability with data on climate and soil quality to predict regional suitability for agriculture at the resolution of 0.5 degrees latitude by 0.5 degrees longitude worldwide. 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 the climatic conditions weakly increase the suitability of land for agriculture. Regarding the soil suitability the traits considered are a measure of the total organic content (carbon density) and the nutrient availability (soil pH). The relationship of these indexes with agricultural suitability is non-monotonic. Low and high values of pH limit cultivation potential, since these values signal that soils are too acidic or too alkaline, respectively. Specifically, Average Land Quality, $lq$, is the product of two components capturing the climatic suitability for cultivation, $lq_{clim}$, and the soil suitability, $lq_{soil}$. Hence, $lq = lq_{clim}lq_{soil}$. Each component is constructed in the following way: $lq_{clim} = f_1(GDD)f_2(m)$, where GDD denotes growing degree days and $m$ is a moisture index capturing the availability of water to plants. Regarding soil characteristics, $lq_{soil} = g_1(C_{soil})g_2(pH_{soil})$, where $C_{soil}$ stands for soil carbon density and $pH_{soil}$ captures the acidity or alkalinity of soil. Each functional form is derived from the probability density function of actual cropland area versus each component. For example, in the case of $f_1(GDD)$ and $f_2(m)$ according to Ramankutty, Foley, Norman, and McSweeney (2002) a sigmoidal function best fits the observed empirical relationship between the fraction of a cell that was cultivated in 1990 and the $GDD$ and $m$ respectively. Specifically, $f_1(GDD) = 1/(1 + \exp(a(b - GDD)))$ and $f_2(m) = 1/(1 + \exp(c(d - m)))$ with $a = 0.0052$, $b = 1334$, $c = 14.705$ $and$ $d = 0.3295$. The functional forms of $g_1(C_{soil})$ and $g_2(pH_{soil})$ are the following: $g_1(C_{soil}) = (a/(1 + \exp(b(c - C_{soil})))) * (a/(1 + \exp(d(e - C_{soil}))))$ with $a = 3.9157$, $b = 1.3766$, $c = 3.468$

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[39]All geographical data from CID are available at: http://www.ksg.harvard.edu/CID

[40]It may be dowloaded from http://www.sage.wisc.edu/iamdata/grid_data_sel.php.

$$and \ d = -0.0791 \ and \ g_2(pH_{soil}) = \begin{cases} -2.085 + 0.475pH_{soil} & if & pH_{soil} \leq 6.5 \\ 1.0 & if & 6.5 < pH_{soil} < 8 \\ 1.0 - 2.0pH_{soil} & if & pH_{soil} \geq 8 \end{cases}.$$

**Distance from Muslim Empires**: Great-circle distance from the borders of the Muslim empires of the centroid a country, ethnic group or virtual country in thousand kilometers. Muslim empires include the Umayyads, Abassids, Karakhanids, Ghurids, Ghaznavids, Mughals, Ottomans, Mamluks, Seljuks, Timurids, Fatimids, Almoravids and the Almohads.

Source: Calculated using the empire maps constructed by Jarle Grøhn based on Black (2005).

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

Source: Calculated using the Haversine Formula.

**Distance from Trade Routes in 600 AD**: Great-circle distance from the nearest trade route 1800 $AD$ of the centroid a country, ethnic group or virtual country in thousand kilometers.

Source: Calculated using the trade routes mapped in Brice and Kennedy (2001) in 600 AD.

**Distance from Rome:** Great-circle distance from Rome of the centroid a country, ethnic group or virtual country in thousand kilometers.

Source: Calculated using the Haversine Formula.

**Distance from Trade Routes in 1800 AD**: Great-circle distance from the nearest trade route in 1800 $AD$ of the centroid a country, ethnic group or virtual country in thousand kilometers.

Source: Calculated using the trade routes mapped in Brice and Kennedy (2001) between 600 AD and 1700 AD. This information is supplemented by maps from Brien (1999) which contain information on trade routes within Europe, SE Asia, West Africa and China during the same time period.

**Mean Elevation**: Average elevation in kilometers within the unit of analysis, i.e. country or ethnic group or virtual country.

Source: The Atlas of Biosphere available at http://www.sage.wisc.edu:16080/atlas/.

**Asia:** Dummy variable equals 1 for countries in Asia.

Source: World Bank social indicators and fixed factors

**Western Europe:** Dummy variable equals 1 for countries in Western Europe.

Source: World Bank social indicators and fixed factors

**Mediterranean and North Africa**: Dummy variable equals 1 for countries in the Mediterranean, Middle East and North Africa.

Source: World Bank social indicators and fixed factors

**Population Density in 1990**: Population density in 1990 within the respective unit of analysis in thousand's of people per sq. km.

Source: Center for International Earth Science Information Network (CIESIN). Available at:

http://www.sage.wisc.edu/iamdata/grid_data_sel.php

**Land Inequality**: Inequality in the regional suitability for agriculture within the unit of analysis. Three separate measures are used namely the Gini index, the Theil index and the Mean Logarithmic Deviation.

Source: See **Average Land Quality**

**Sea Distance**: 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 ethnic groups and virtual countries the distance is constructed using the coastlines of seas, oceans dataset. Publisher: Global Mapping International, Colorado Springs, Colorado, USA. Series name: Global Ministry Mapping System. Series issue: Version 3.0

**Variation in Elevation**: Standard deviation in elevation measured in kilometers within the unit of analysis, i.e. country or ethnic group or virtual country.

Source: See **Mean Elevation.**

# Historical Variables

**Within Country Indicator**: Dummy equals 1 if a virtual country falls completely within a real country; constructed using ArcGis.

**Muslim%05**: Fraction of Muslim population in 2005 at the respective unit of analysis, i.e. ethnic group or virtual country in 2005 AD.

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

**Number of Ethnicities**: 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.

**Muslim%1900**: Fraction of Muslim population in 1900AD.

Source: Religion Adherence Data - McCleary and Barro (2005) available at

http://ksghome.harvard.edu/~rmcclea/data.html

**Muslim Majority**: Dummy variable equals 1 if **Muslim%05** > 50%

Source: See **Muslim%05**

# Appendix C - Dynamic Analysis

## 6.1 Dynamic analysis

In the static version of the model we established that in presence of regional gains from trade, i.e. large enough prices $(p > \underline{p})$ and inability of poor regions to overcome trade costs due to large inequality in land productivity (large $v_0$), the relative share of poor regions is a fundamental determinant of the emergence of the Islamic institution. We now conduct a dynamic analysis to see whether our argument remains valid in the long run, and describe the evolution of the economy under different geographical conditions.

### 6.1.1 Persistence of the Islamic Doctrine

A full Islamic contract comprises 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 $\lambda > \lambda_0^\xi$. The anti-*riba* law sways the rich to divert bequests from physical capital to public good investments that enhance labor productivity of all agents. Note that due to the public nature of *waqf*, inequality under Islam does not change along the process of development. However, the bequest and the Islam thresholds, referred to as $\tilde{\lambda}_t^c \equiv \tilde{\lambda}_t^c(I_{R,t}^G)$ and $\lambda_t^\xi \equiv \lambda^\xi(I_{R,t}^G)$ henceforth, may change due to $I_{R,t}^G$ increasing over time.

**Corollary 1** *Substituting the gross income in period 0, $(1-\alpha)$, with the gross income in period $t$, $I_{R,t}^G$, in the RHS of $f_R(\tilde{\lambda}_0^c)$ in Lemma 3 and $f_R(\lambda_0^\xi)$ 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 $\lambda_t^\xi$ 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 $\lambda_0^\xi$ exists and is unique, so under the Islamic contract $\lambda^\xi$ depends on gross income of the rich, $I_{R,t}^G$, and can be written implicitly using (19) as the value of $\lambda$ that satisfies the following implicit function

$$G(\lambda_t^\xi, I_{R,t}^G) = U_R^c(\lambda_t^\xi, I_{R,t}^G) - U_R^\xi(\lambda_t^\xi, I_{R,t}^G) \equiv 0. \tag{22}$$

By the Implicit function theorem

$$\frac{d\lambda_t^\xi}{dI_{R,t}^G} = -\frac{\frac{\partial G(\lambda_t^\xi, I_{R,t}^G)}{\partial I_{R,t}^G}}{\frac{\partial G(\lambda_t^\xi, I_{R,t}^G)}{\partial \lambda}} \tag{23}$$

which is positive as the denominator is negative from (8) when substituting $I_{R,t}^G$ for $I_{R,0}^G$, and the numerator is

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

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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 $f_R(\lambda)$. ∎

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

$$
\begin{cases}
I_{R,t+1}^G = (1 - \alpha)(1 + \gamma(1 - \lambda)[(1 - \underline{z^m}(\lambda))p(I_{R,t}^G - \mu) - \tilde{c}]) \\
I_{P,t+1}^G = \frac{I_{R,t+1}^G}{v_0}
\end{cases}
\tag{24}
$$

where we have used condition (C3) and equations (7), (12), (14) and (16). Note that income inequality is *constant* and equal to $v_0$ along the process of development. Gross income of the rich increases in every period and eventually reaches the steady state level

$$
I_{R,S}^G = (1 - \alpha)\left(1 + \gamma(1 - \lambda)\frac{p(1 - \alpha - \mu)(1 - \underline{z^m}(\lambda)) - \tilde{c}}{1 - p(1 - \alpha)\gamma(1 - \lambda)(1 - \underline{z^m}(\lambda))}\right)
\tag{25}
$$

that is the wage rate times the steady state level of investment in public goods (the ratio in the parentheses, 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 at its maximum level in the steady state with $I_{P,S}^G = \frac{I_{R,S}^G}{v_0}$. So, using (2) and (C3), $\frac{1-\alpha}{\mu}h_S < v_0$ is a sufficient condition to preclude the participation of poor into trade activities along the process of development $\forall\, t \geqslant 0$. Additionally, we know from (C2) that the poor are not in the position to leave bequests at $t = 0$. This is also true at the steady state as long as $I_{P,S}^N = \frac{I_{R,S}^G}{v_0} + \underline{z^m}(\lambda)\left(I_{R,S}^G - \mu\right) < \tilde{c}$, which holds for sufficiently large values of $v_0$ and $\lambda$.[41]

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 poor regions' size $\lambda_S^\xi$ where for values above $\lambda_S^\xi$ the rich remain loyal to Islam in the steady state, by simply substituting the rich's steady state level of gross income under Islam (25) into (22).

**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 $\forall\, \lambda \geqslant \lambda_S^\xi$.*

**P roof.** To check for the existence and uniqueness of $\lambda_S^\xi < 1$, first take the limit of (25) to get $\lim_{\lambda\to 1} I_{R,S}^G = 1 - \alpha$. Also substituting $\lambda^\xi = 1$ into expressions $f_R(\tilde{\lambda}_t^c)$ and $f_R(\lambda_t^\xi)$ in Lemma 3 and Proposition 1, respectively, we see that both values converge to $\frac{\tilde{c}}{p(1-\alpha-\mu)}$. From (C2) and (9) we know that $f_R(1) < \frac{\tilde{c}}{p(1-\alpha-\mu)}$, so that in the limit case of $\lambda \to 1$ the rich would prefer the Islamic contract, i.e.

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[41] Taking the limits $v_0 \to \infty$ and $\lambda \to 1$ gives $I_{P,S}^N = \underline{z^m}(\lambda)(1 - \alpha - \mu) < \tilde{c}$ from (C2) and (25), where we have used $I_{R,S}^G \to 1 - \alpha$ for $\lambda \to 1$.

$G(1, I_{R,S}^G) < 0$ in (22). 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. $\frac{\partial G}{\partial I_{R,t}^G} > 0$. It follows that $G(\lambda_0^\xi, I_{R,S}^G) > 0$. Finally, we know from Proposition 1 that $\frac{\partial G}{\partial \lambda} < 0$. It follows from the *Intermediate Value Theorem* that there exist a unique $\lambda_S^\xi > \lambda_0^\xi$ such that if $\lambda > \lambda_S^\xi$ then $G(\lambda) < 0$ and Islam persists in the long run, whereas if $\lambda < \lambda_S^\xi$ then $G(\lambda) > 0$ 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 $\lambda_0^\xi < \lambda < \lambda_S^\xi$, while it is founded and persists for $\lambda_S^\xi < \lambda < 1$. In the former case, once the contract is abandoned, the economy evolves into the *zakat*-only case.

### 6.1.2 Geography and the Evolution of Income

In economies where the share of the poorly endowed territories is relatively small, $\lambda < \underline{\lambda}$, there is no threat of conflict. Therefore, regions evolve along different economic trajectories and no institutions emerge. The *zakat* rate $\underline{z}^m(\lambda)$ is equal to zero in this region and the gross income of rich and poor follow the dynamics described by:

$$\begin{cases} I_{R,t+1}^G = (1 - \alpha) + \alpha[p(I_{R,t}^G - \mu) - \tilde{c}] \\ I_{P,t+1}^G = I_{P,0}^G = \frac{(1-\alpha)}{v_0} \end{cases} \tag{26}$$

where we have used condition (C3) and equations (5), (6), (14) and (16). Gross income of the poor remains constant whereas that of the rich increases every period due to condition (C4) and, as long as $p < 1/\alpha$, reaches the steady state level[42]

$$I_{R,S}^G = (1 - \alpha) + \alpha \left( \frac{p(1 - \alpha - \mu) - \tilde{c}}{1 - \alpha p} \right). \tag{27}$$

This may be decomposed into the labor income (first term) plus the returns on capital times the steady state level of capital bequests.

In an economy with an intermediate share of poor regions $\underline{\lambda} < \lambda < \lambda_0^\xi$, the threat of an ambush makes a *zakat* system attractive as a means of avoiding conflict. Characterizing the scenario in which redistribution does not suffice to allow poor regions to leave bequests, i.e. $I_{P,S}^N = \frac{(1-\alpha)}{v_0} + \underline{z}^m(\lambda)\left(I_{R,S}^G - \mu\right) < \tilde{c}$, the equations that describe the dynamics are:

$$\begin{cases} I_{R,t+1}^G = (1 - \alpha) + \alpha([1 - \underline{z}^m(\lambda)]p(I_{R,t}^G - \mu) - \tilde{c}) \\ I_{P,t+1}^G = I_{P,0}^G = \frac{(1-\alpha)}{v_0} \end{cases} \tag{28}$$

---

[42] If $p > 1/\alpha$, the income of the rich explodes in the long run when there are no institutions.

where we have used equations (6), (12) and (14).[43] The gross income of the rich $I_{R,t}^G$ grows over time, reaching the steady state level

$$I_{R,S}^G = (1-\alpha) + \alpha \left( \frac{[1 - \underline{z}^m(\lambda)]p(1-\alpha-\mu) - \tilde{c}}{1 - \alpha p[1 - \underline{z}^m(\lambda)]} \right) \tag{29}$$

that is smaller than (27) because of the term $[1 - \underline{z}^m(\lambda)]$.

Finally, comparing (25) to (26) and (27) reveals that the steady state income of the rich regions is always lower under Islam because of (i) lower return from public good investments and the dilution of *waqf* benefits and (ii) the fraction of gross income transferred to the poor due to a larger *zakat* rate $\underline{z}^m$.

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. Our findings are relevant to Galor and Moav (2004), where 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 investments in the form of religious endowments.[44]

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[43] In the contrary case, where the net income of the poor exceeds $\tilde{c}$ so that also they can leave bequests, the environment of conflicting interests may disappear leaving no need for any institutions in the long run.

[44] Galor, Moav, and Vollrath (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.

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