Taxing Identity
Theory and Evidence from Early Islam

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Abstract

A ruler who does not identify with a social group, whether on religious, ethnic, cultural or socioeconomic grounds, is confronted with a trade-off between taking advantage of the out-group population's eagerness to maintain its identity and inducing it to "comply" (conversion, quit, exodus or any other way of accommodating the ruler's own identity). This paper first analyzes the ruler's optimal mix of discriminatory and non-discriminatory taxation, both in a static and an evolving environment. The paper then uses novel data sources to test the theory in the context of Egypt's conversion to Islam between 641 and 1200. The evidence is broadly consistent with the theoretical predictions.

Keywords: Islam, poll tax, identity taxation, Laffer curve, legitimacy.

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"Muhammad was sent as a prophet and not as a tax collector."

Umar II, Caliph of the Arab Umayyad Empire from 717 to 720

1 Introduction

1.1 Motivation and main insights

Hostility toward populations on the ground of their religious, ethnic, linguistic, cultural, economic, political, or sexual-orientation identity is commonplace. At the core of this paper is a basic conflict faced by rulers in the treatment of these unwanted populations, between extracting members' willingness to pay for keeping their identity and inducing them to lose it (convert, assimilate, quit the organization or the country...). For instance, populist governments face a trade-off between pandering to their constituency's hostility toward rich entrepreneurs and executives and risking their moving activities abroad. This dilemma can also be found in organizations such as corporations, universities or political parties, as management may be torn between reducing the influence of individuals or groups standing in the way of the management's policy, and the loss and disruption that their departure would create. Numerous polities over two millennia imposed discriminatory taxes on Jews. More dramatically, the persecution of Jews by Nazi Germany reflected the regime's revealed preference for expressing its extreme hostility toward the minority over the substantial economic and moral cost inflicted on the country by the holocaust and the Jewish exile to the United States and other countries. [1]

Our lead historical context is taxation under the early Arab Caliphate following Muhammad's death in 632 CE. The Caliphate enforced its tax system in all its conquered territories in the Byzantine and Persian Empires. We limit ourselves in this paper to Egypt, because it is where localized papyrological records on individual-level tax payments under the early Arab Caliphate survived. [2] In the aftermath of the Arab conquest in 641 CE of the then-Coptic Egypt, the Caliphate's tax system provided incentives for Egypt's population to convert to Islam (see Section 2.2). [3] It consisted of both a discriminatory tax, levied on non-Muslims and removed upon the taxpayer's conversion to Islam, and a non-discriminatory (uniform) one that was paid regardless of the taxpayer's religion. From 641 until the mid-8$^{\text{th}}$ century, the discriminatory tax was the sum of a poll tax levied on non-Muslim free adult males, [4] and the (positive) difference between

1. Moser et al. (2014).

2. For other territories of the Caliphate, notably Iraq and Greater Syria, we have information on the aggregate tax revenue, but not on localized individual-level tax payments. Dennett (1950, p. 62), a leading 20$^{\text{th}}$-century historian of early Islamic taxation writes that, "we have far more evidence for the tax structure on Egypt, thanks to the preservation of invaluable source material in papyri, than for that of any other part of the empire."

3. On the eve of the Arab conquest, Egypt's population was mostly Coptic Christian, with two small (mostly) urban minorities of Jews and non-Coptic Christians. All non-Muslims were subject to the same (discriminatory) tax system. We focus on Copts, because they constituted the vast majority of Egypt's population. Since there were no Muslims in Egypt on the eve of the Arab conquest and since the population share of Arab settlers was tiny compared to Egypt's population, we use the terms "Muslims" and "converts" interchangeably.

4. Unlike the "poll" tax that was tied to voting in the late 19$^{\text{th}}$-century US, the Caliphate's poll tax was a head tax tied to religion. We prefer to use the term "poll tax" rather than "head tax," because this is the conventional term used in the historical literature on early Islam (e.g., Dennett 1950).

the land tax (*kharaj*) paid by non-Muslim landholders and the land tax (*ushr*) levied on converts (so the uniform tax was the *ushr* tax). Around the mid-8th century, the Caliphate increased the land tax paid by converts from the *ushr* rate to the *kharaj* rate. It further removed the *de jure* cap on the land tax that existed prior to the reform. Hence, from then on the discriminatory tax equated with the poll tax, and the uniform tax equated with the *kharaj* tax. The new system was enforced until 1856, when the poll tax was finally abolished. The tax reform led to a sharp rise in the uniform tax (Appendix Figure A.4). The exact date of the reform is uncertain, though, as well as whether it happened at the same time across all the Caliphate or not. We will date the reform at 750, but this should be interpreted as an approximate date. [5]

Theory The paper combines theoretical and historical/empirical analyses. On the theory front, the paper develops an optimal taxation framework of general interest. Its theoretical novelty resides in part in the ruler's preferences. The Normative Public Finance and Political Economy literatures both assume that the public decision-maker at least partly internalizes the welfare of, or values the votes of, all constituencies; at worst the ruler has a neutral attitude toward a particular constituency. By contrast, we allow for unwanted groups or identities. In the language of the Caliphate governance of Egypt, the ruler may be hostile to those holding Coptic beliefs. Alternatively, regardless of affinity considerations, the ruler may have extrinsic motivations (formal or informal incentives provided by the Caliphate) to increase the number of conversions to Islam. [6] There are historical examples of both types of rulers under the Caliphate. [7] This feature is not specific to early Islamic taxation and has various applications, both historical and contemporary (e.g., the provision of public goods to immigrants), which await empirical investigations.

In our theoretical framework, the ruler optimally levies both a uniform tax and a discriminatory (unwanted-population-specific) tax. We derive the conditions under which the discriminatory tax falls on the downward-sloping side of the Laffer curve. [Umar II's citation at the beginning of the paper indeed suggests a trade-off between revenue collection and conversions: Faced with a deteriorating poll tax revenue (Appendix Figure A.2), the Caliph, who was renowned for his piety, called for more conversions at the cost of a lower tax revenue, suggesting that public finances were on the downward-sloping side of the Laffer curve. [8]] This specificity produces a rich set of insights (most of the proofs can be found in Appendix Section B.4). Some are simple but unconventional: When on the downward-sloping side of the Laffer curve, the ruler taxes more his favored group, the more hostile he is toward the unwanted group (the more religious in the Muslim sense he is), but the result is reversed when on the upward-sloping side of the Laffer curve. Relatedly, the

5. Wellhausen (1902) and Becker (1902) date it at 738, under the Umayyads (661-750), whereas Morimoto (1981) pushes it forward to 775, under the Abbasids (750-1258). The earliest *surviving* Islamic jurist book that outlined the reformed tax system is Abu-Yusuf (1979) that was written around 786. However, Abu-Yusuf's tax system was probably enforced earlier and was likely first introduced by his teacher, Abu-Hanifa (699-767) who had been active in jurisprudence from 737 until his death.

6. As we will see, our model accommodates motivations that are more complex than these two.

7. Both types of motivation existed among Egypt's rulers. Governors such as Abdel-'Aziz ibn Marawan (685-709) were reportedly hostile to non-convert Copts (i.e. intrinsically motivated), whereas others such as al-Layth ibn al-Afdal (799-803) were friendly to non-converts, and hence extrinsically motivated.

8. Note that "prophet" in Arabic means that Muhammad was sent by God to convert people to Islam.

uniform and the discriminatory taxes may be complements rather than substitutes; the relaxation of a cap on the uniform tax then leads to an increase in the discriminatory tax.

Another prediction is that unwanted populations with a stronger (religious) identity face a higher discriminatory tax. This holds regardless of which side of the Laffer curve the ruler is operating on. We further show that, when on the downward-sloping side of the Laffer curve, the need to prevent revolts lowers both the discriminatory and non-discriminatory taxes, even when the marginal potential rebel renounces his identity (is a convert) and therefore does not pay the discriminatory tax.

Turning to the dynamics of optimal taxation, we then explore why the uniform tax may increase over time. The necessity to raise the uniform tax might seem evident in light of the reduction in the fiscal base associated with conversions. Yet it is not, for two reasons. As long as the rulers stay on the upward-sloping side of the Laffer curve, conversions in no way jeopardize future poll tax collection: It is then always feasible to raise the discriminatory tax revenue above historical levels. Furthermore, even if the downward-sloping side of the Laffer curve is reached, this is the outcome of the Caliphs' optimizing decisions. It is not clear a priori why the Caliphate would have in the past foregone discriminatory tax revenue and eroded the tax base, thereby constraining itself to later have to raise the uniform tax and possibly also incur the cost of a tax reform.

We show that the uniform tax, but not necessarily the discriminatory tax, may increase over time for four different reasons: (a) the budgetary need increases and this increase is absorbed by the uniform tax; (b) the rulers become more religious over time (by contrast, the uniform tax remains constant if the rulers become more tolerant over time, an asymmetric response); (c) there is some exogenous possibility that the rulers be chased out of power (out of the country), creating an option value for keeping one's identity; (d) the threat of internal rebellion weakens over time since past converts only economize on the uniform tax but not on the discriminatory tax when the rebellion succeeds (they have lower incentives to participate in a rebellion).[9] The last result is particularly interesting as it exhibits natural dynamics in an otherwise completely stationary environment. This happens when the marginal rebel is a convert. Converts do not internalize the future impact on the discriminatory tax, which will be paid only by non-converts. The ruler can thus "divide and conquer" by aptly lowering the uniform tax today to increase the fiscal prospects in the future.

Empirics Due to data scarcity, we focus on only two aspects of the model. Both enable us to address two main puzzles for the history of taxation under the Arab Caliphate (see Section 1.2).

(1) The first puzzle is *whether the discriminatory tax revenue fell due to conversions*. Appendix Figure A.2 suggests that it did, but historians have long debated this narrative. In the absence of localized data on discriminatory tax revenue, our model enables us to address this ques-

9. Results (a) and (d) hold only if the optimal discriminatory tax is on the downward-sloping side of the Laffer curve. The last result, suggesting a dynamic "divide-and-conquer" strategy, is of general interest and can be applied to a broad array of political strategies.

tion indirectly. A key insight is that more religious rulers raise the discriminatory tax. On the downward-sloping side of the Laffer curve, however, the resulting fall in tax revenue necessitates an increase in the uniform tax. The latter result is reversed if on the upward-sloping side.

We exploit the local variation in tax rates and conversions. We constructed a localized dataset at the individual level on poll and *kharaj* tax payments (the post-reform discriminatory and uniform taxes) from Egypt's papyrological tax records in 641-1100. While Egyptian tax papyri have been known to historians since 1900, they have never been employed quantitatively before. They are subject to two major caveats though: (1) they survived in only 4 out of 42 *kuras*, Egypt's administrative units in 641-1036, and (2) most papyri are dated within a period, such as a century or longer, which forces us to date all papyri between 641 and 1100, without being able to disentangle the pre-reform from the post-reform period.

We measure conversions at the village level by the non-presence of Coptic churches and monasteries in 1200. We also treat total tax revenue as an (fourth) outcome, where we draw on an extension of the model in which tax collection is delegated locally. We collected village-level data on total tax revenue per unit of taxable land from a cadastral survey in 1375. Both conversions (churches) and total tax revenue are observed for all *kuras*.

Our main regressor is the religious composition of local tax administrators, which we measure by Arab settlement in 700-969. Tax collectors were all (non-convert) Copts before 700. With increasing Arab settlement in rural Egypt in 700-969 though, Arab-settled *kuras* had a higher share of Arab tax administrators compared to non-Arab-settled areas, and thus presumably more religious (in the Muslim sense) tax collectors.

We first document that, while 25% of villages in *kuras* where Arabs did not settle in 700-969 still had a Coptic church or monastery by 1200, only 13% of villages in Arab-settled *kuras* did, implying more conversions in the latter *kuras*. Taxpayers in these *kuras* also paid, on average, a 25% higher discriminatory tax relative to the average, which amounted to 3% of the annual wage of unskilled manual workers and 29% of the *de jure* discriminatory tax on this occupational bracket. More importantly, we document that taxpayers in these *kuras* paid a uniform tax 24% higher than the average, which implies being on the downward-sloping of the Laffer curve. We also find that total tax revenue in 1375 is negatively associated with Arab settlement, but the correlation is not statistically significant. This suggests that the uniform tax increase fell short of offsetting the decline in discriminatory tax revenue in Arab-settled *kuras*, probably due to the convexity of the cost of land tax collection. We discuss a number of caveats to our local-level evidence including (1) the limited survival of tax papyri, (2) measurement error in Arab settlement, and (3) its potential endogeneity.

(2) The second historical puzzle is: *why did the Caliphate wait until circa 750 to undergo a costly reform enabling an increase in the uniform land tax on converts?* We introduce Egypt-level evidence to address this question. Our evidence is qualitative, because we observe taxes and conversions at only a few points in time, and because the tax reform was a Caliphate-wide one-time policy change. We find that the timing of the reform is consistent with a decline in both

uncertainty about Caliphate rule and threat of rebellion: As attacks by neighboring empires and civil wars within the Caliphate both subsided, and as convert population share increased, the Caliphate became more daring to increase the uniform tax on Muslims. We discuss other possible explanations of the reform which, we argue, are complementary to our explanation.

1.2 Related literature

The paper is related to a few strands of literature. It differs from the optimal taxation literature in at least two ways: the optimality of being on the downward-sloping side of the Laffer curve and the hysteresis effects associated with exit from the tax base. The paper shares with Becker (1957)'s theory of discrimination the feature that decision-makers have a distaste for minority membership: Becker's employers (or their majority employees) are assumed to derive a lower utility from minority employees at the same productivity and wage. Similarly, the ruler here dislikes the minority, but values its presence in the tax base. The theory of taste-based discrimination however is developed in a competitive labor market (actually, one of Becker's key insights was to show that for a given productivity, majority and minority wages are equalized whenever the fraction of employers with a taste for discrimination is smaller than some threshold), while our ruler acts as a monopolist.

Acemoglu (2006) is a rare contribution in which rulers have reasons to hurt some constituency. In his model, the ruling elite not only aims at extracting rents from the output of an enterprising middle-class via a tax on its output, but also may try to achieve other goals with the tax, thus exceeding the rent-maximizing tax rate. First, the elite may itself own firms and taxing the middle-class output discourages middle-class production and reduces the market wage. As Acemoglu emphasizes, this result hinges on limited tax instruments.[10] By contrast, we study optimal taxation. Second, the middle class might rebel relying on its financial power. That reason is complementary to our section on rebellion, which is based on manpower rather than money; as a consequence, the minority rebels when ill-treated by the majority in this paper, while it rebels when well-treated and therefore empowered in Acemoglu's contribution. Overall, both the rationales for hurting and the focus differ between the two papers.

Our results on the time-decreasing threat of rebellion relate to Dewatripont and Roland (1992)'s work on gradualism by a government wanting to reduce a firm's labor force. The government must offer exit bonuses that are preferred by a qualified majority of workers to a given status-quo.[11] There are a number of differences between their framework and ours. First, their model exhibits negative selection (and associated Coasian dynamics) rather than positive selection. Second, converts in our model can still be taxed in the future, while workers who have

10. For example, a tax on labor hired by the middle-class firms could take care of limiting competition for labor.

11. The government does not know individual workers' outside options, and so faces a trade-off: Massive redundancies might yield rapid efficiency gains, but at a great budgetary cost (there is a shadow cost of public funds). Dewatripont and Roland show that, with two periods, it is possible for a government to obtain a majority vote for a reform that intertemporally hurts majority interests. Some voters expect to lose in comparison to the status quo if the initial reform is rejected. It is then possible for the government to include this second-period minority in its first-period majority, and use it to hurt another group of workers who become the first-period minority.

accepted the exit bonus disappear from the game in their paper. Third, a Copt's ability to convert does not hinge on other Copts' decisions, while a worker's ability to quit depends on the approval of the government package by a majority of other workers. Finally, Dewatripont and Roland's planner is benevolent and in no case hostile to the population whose status it is trying to alter.

Our paper shares with the literature on the taxation of externalities and internalities (e.g. tobacco or pollution) the property that taxes may be on the downward-sloping side of the Laffer curve. This literature however does not study issues related to the tax structure and to the specific dynamics of taxation and rebellion under ratcheting of compliance (apostasy, costly return...); it also cannot guide the empirical evidence obtained in this paper.

A large literature studies optimal taxation with non-utilitarian welfare functions (e.g. Fleurbaey and Maniquet 2011). Saez and Stantcheva (2016) derive optimal taxation in an environment that is not necessarily welfarist (in particular, social welfare weights can depend on individual or aggregate characteristics which do not enter individuals' utilities). Their focus is on allowing various considerations, such as counterfactuals (what would have happened in the absence of taxes?), horizontal equity, libertarianism, equality of opportunity concerns, and poverty alleviation, to matter per se, independently of their consequences on the taxpayers' utility. Much work has also been devoted to investigate the impact of altruism on optimal taxation (e.g. Diamond 2006, Farhi and Werning 2010, and Kaplow 1995). These two literatures investigate neither the taxation of unwanted populations, nor its dynamic evolution as unwanted population members convert or leave the polity or organization.

The paper contributes to the economic history of the Middle East. Certain institutions, such as the Islamic trust (*waqf*) and inheritance, have been criticized for causing the relative stagnation of the region (Kuran 2012). Our paper complements Kuran's work by explaining the formation of the Islam tax system within a formal model and testing (some of) its implications. We also attempt to control for the role of *waqfs* in taxation (see Section 4.1.4).

The paper contributes to the economics of religion. One line of this literature emphasizes the impact of religious beliefs on economic outcomes (Barro and McCleary 2003, Botticini and Eckstein 2005, Becker and Woessmann 2009, Chaudhary and Rubin 2011). Instead of treating religious groups as fixed though, our paper documents how economic incentives can alter the group *formation* by inducing conversions. In this respect, our paper contributes to a recent empirical literature that attempts to elicit the willingness to pay to maintain one's identity (or beliefs) (Augenblick et al. 2016, Delavande and Zafar 2018). Another line of this literature explores how political authorities establish legitimacy through bargaining with religious authorities (Greif and Tadelis 2010, Chaney 2013, Belloc et al. 2016, Rubin 2017, Cantoni et al. 2018). Our paper emphasizes maintaining ruler's legitimacy via reducing the threat of rebellion as a key determinant of taxation and conversions. Third, Michalopoulos et al. (2018) show that areas with better access to trade routes, lower land productivity, and higher land inequality, were more likely to adopt Islam. They argue that this because of the latter's redistributive institutions that mitigated the

incentives for predation in these areas. Our paper complements their theory, which they show to hold in Sub-Saharan Africa and Asia, by highlighting taxation as a major tool of Islamization under the early Arab Caliphate. We also attempt to control for land productivity and land inequality in Section 4.1.4. A fourth group studies persecution as a non-price tool of discrimination (Voigtländer and Voth 2012, Anderson et al. 2017). Our paper complements this literature in two ways. First, the persecuted population has an exit option of adopting the oppressor's identity. Second, we study taxation as a price tool of discrimination (although our model also accounts for non-price tools).

Finally, the paper contributes to two historical debates. First, the falling discriminatory tax revenue is a recurring narrative in medieval Muslim chronicles. Inspired by major papyri discoveries from early Islamic Egypt, and by narratives of tax-induced conversion waves in two medieval Coptic chronicles that were uncovered circa 1900, pioneering historians such as Wellhausen (1902), Becker (1902), Bell (1910), and Grohmann (1932) endorsed this narrative. Their theory triggered fierce debates among later historians, though, and the question is thus far unresolved. While Saleh (2018) provided evidence on the tax-induced conversions, we endogenize taxation as an outcome, where we examine not only the discriminatory tax, but also the uniform tax. We also add novel localized data on the uniform tax and on total tax revenue. [12]

The second debate to which our paper contributes is about the canonical (post-reform) tax system that exempts Muslims from the poll tax, but forces them to pay the *kharaj* tax on land (and not the lower *ushr*/*zakat* tax). Whereas Muslim jurists claimed that this system had existed since Muhammad's lifetime, there is a general consensus among modern historians (Wellhausen 1902, Becker 1902, Morimoto 1981, Frantz-Murphy 2004, but not Dennett 1950) that it was a legal innovation during the 8th century. Within the latter viewpoint, it was suggested that the reform was the Caliphate's response to the trade-off between winning converts and maximizing tax revenue. [13] Our Egypt-level evidence suggests that the reform was driven by a decline in the threat of rebellion (possibly due to conversions), and in uncertainty about Muslim rule.

2 Historical background

2.1 Islamization of Egypt, Greater Syria, and Iraq

Following Muhammad's death in 632, the Rashidun and Umayyad Arab Caliphates, that ruled from 632 to 750, initiated a series of conquests that captured the Persian Empire and the southern and eastern parts of the Byzantine Empire. On the eve of the Arab conquests, all local populations of the conquered territories were non-Muslims: a large Christian majority and a small

12. Saleh (2018) documented that because the poll tax was regressive in income, *poorer* Copts were more likely to convert to Islam, leading non-converts to shrink into a better-off minority. This finding does not imply though that the tax was on the downward-sloping side of the Laffer curve, which depends on the tax elasticity of conversion.

13. According to Sijpesteijn (2013, p. 189), "*the question is now whether the Muslim authorities would have had reasons to start levying these* [higher land] *taxes on Muslims in the first quarter of the second century AH* [mid eighth century CE]. *The answer lies in the early Umayyad fiscal system and the problems it faced trying to ensure a continuous source of fiscal income while simultaneously serving the Muslim mission to win converts.*"

Jewish minority. During the centuries that followed, non-Muslims shrank from 100 percent of the local population in Egypt to 16 percent in 1200 and 7 percent in 1848, and to 9 percent in Greater Syria and 5 percent in Iraq in 1580 (Appendix Figure A.1).

Islamization was mostly driven by "voluntary" conversions of the local populations to Islam, rather than by (a) coercion, or (b) population replacement via Arab immigration and local populations' emigration, or else (c) fertility and mortality differences between Muslims and non-Muslims, and inter-marriages between Muslim males and non-Muslim females (which result by Islamic law in Muslim offspring): see Appendix Section A.2. Conversion to Islam was observed by the state, [14] and was automatically transmitted across generations (i.e. being a Muslim was an "absorbing state") owing to three Islamic laws: (a) apostates are sentenced to death, (b) the offspring of a Muslim male is automatically Muslim, and (c) Muslim females may only marry Muslim males.

2.2 Islamic taxation

Taxation in 632-750 To provide the conquered populations with incentives to convert to Islam, Arabs granted tax exemptions to converts. [15] Between 632 and circa 750, free non-Muslim adult males paid a poll tax (*jizya*), an annual per head cash tax; furthermore, non-Muslim *landholders* paid an annual land tax (*kharaj*) that was assessed as a lump-sum amount per *feddan* (= 6,368 square meters) that varied by crop and was paid in cash and/or kind. By contrast, Muslims were exempted from the poll tax, and Muslim landholders paid a reduced land tax (variously called tithe, *ushr*, *zakat*, *sadaqa*) that was assessed at a percentage of yield (5 or 10%) that varied by land quality and paid in cash and/or kind. Due to the lack of papyrological evidence on the *ushr* tax before 750, it has been argued that Muslim landholders actually paid no land tax before the reform (Sijpesteijn 2013, pp. 181-99). [16]

Both the *ushr* and *kharaj* taxes had an upper bound in Egypt: *Ushr* was capped at 10% according to *Hadith* (prophet's sayings), whereas the *kharaj* tax was bounded by peace treaties in territories that were annexed by the Caliphate by a treaty, such as Egypt (Frantz-Murphy 2004). [17] [18] But whereas *kharaj* land was tradable among non-Muslims only, *ushr* land was con-

14. A papyrological list of converts in 700-900 reveals that a convert had to declare his new faith in front of the authorities, adopt an Arabic name, become a client of an Arab patron, and enlist in the army to receive a stipend.

15. Taxes were collected locally and sent to the capital of each territory (e.g. Egypt, Greater Syria, and Iraq), where part of the revenue was forwarded to the Caliphate's capital.

16. We abstract here from other types of discriminatory taxes/subsidies. We should thus think of the observed discriminatory tax as a lower bound; an observation that strengthens our empirical finding of taxation on the downward-sloping side of the Laffer curve. (1) We abstract from miscellaneous taxes on non-Muslims, which were extended to Muslims after 750. In 632-857, these taxes were irregular ad-hoc levies collected for specific uses, such as military expenses, lodging for officials, governor's expenses, the village overhead expenses, and public projects. In 857-1171, the (miscellaneous) tax base expanded to include pasture, weir, and various crops and products. (2) We abstract from the military conscription on Muslims (a non-pecuniary tax), because (a) it was in return for a state stipend, (b) it was *not* widespread in Egypt, and (c) it was abolished starting from 833 on with the shift to recruiting imported slaves in the army. (3) We abstract from the (non-state) community taxes/subsidies that were administered by religious organizations (churches, monasteries, mosques), because we do not have evidence on their magnitudes, and because they were not enforced by the state.

17. *Kharaj* had no upper bound though in territories that were annexed by military force.

18. The actually enforced *kharaj* that we observe in the Egyptian papyri varied locally. See the discussion of the tax administration at the end of this section.

fined to Muslims. [19]

To sum up, the discriminatory tax in 632-750, i.e. the total tax differential between non-Muslims and Muslims, was equal to the poll tax plus the (positive) difference between the *kharaj* and *ushr* land tax rates. The uniform tax, which was imposed on both non-Muslims and Muslims, was equal to the *ushr* tax, which may have been equal to zero.

Tax reforms circa 750 Conversions to Islam caused the tax base and the poll tax revenue throughout the Caliphate to fall (Appendix Figure A.2). [20] In order to increase the discriminatory tax base, the Umayyads introduced several tax reforms before 750 including (a) levying the poll tax on monks and local elites, who were initially exempted, and (b) imposing the *kharaj* tax on churches and monasteries, which were also initially exempted, [21] Certain local governors attempted to deter conversions to Islam by imposing the poll and *kharaj* land taxes on converts, although these policies were reversed by Umar II.

But circa 750, the *canonical* Islamic tax system was established via two key reforms. First, the *de jure* land tax on Muslims was raised from the *ushr* to the *kharaj* rate, and Muslims were now allowed to purchase *kharaj* land from non-Muslims. Second, jurists removed any treaty-based upper bound on *kharaj*, by denying the historical existence of peace treaties in most of the conquered territories, including Egypt. Consequently, from that date on the discriminatory tax equated the poll tax, and the *de jure* uniform tax, the *kharaj* land tax, was decided upon Caliph's will. Also, as a result of this reform, the land tax became a larger source of tax revenue (Appendix Figure A.2). Landholders of *kharaj* land, whether Copts or Muslims, enjoyed *usufruct* rights and not property rights on their landholdings. This meant that the state could confiscate their land, which we can interpret as another increase in taxes on Muslim landholders. However, the (lower) *ushr* rate continued to be imposed on certain (elite) Muslims, who enjoyed private property rights on their landholdings (Morimoto 1981, pp. 184-186).

***De jure* tax rates** Appendix Figure A.3 shows the evolution of the *de jure* nominal annual discriminatory tax. In 641-750, it was equal to the poll tax (=1 dinar), plus the difference between the *kharaj* and *ushr* land tax rates ($\approx$ 0.96 dinar). Circa 750, the discriminatory tax, now equal to the poll tax, was imposed in three lump-sum amounts per person of 1, 2, and 4 dinars on the poor, middle, and rich respectively. The *de jure* nominal poll tax remained almost stable from 750 to 1000, increased slightly between 1101 and 1300, before it declined in 1301-1500. By contrast, the *de jure real* poll tax per person, and the *de jure* poll tax per dinar of wages, both declined after 900, and became negligible after 1250. [22] That was because the nominal tax did not increase,

19. Whereas landholders of *kharaj* land held *usufruct* rights on land, landholders of *ushr* land enjoyed property rights. Usufruct rights were (a) renewable upon payment of the *kharaj*, (b) inheritable upon state approval, and (c) non-eligible to be turned into *waqf*. To the contrary, property rights were (a) permanent, (b) inheritable without state intervention, and (c) eligible to be turned into *waqf*.

20. This narrative is debated among historians, though (see Section 1.2).

21. These exemptions were likely due to the persistence of Persian and Byzantine tax administration traditions.

22. A full analysis of the causes of the decline in the nominal poll tax between 1301 and 1500, and in the real poll tax between 900 and 1500, lies beyond the scope of the paper, because it took place after our period of study.

while both nominal prices and wages increased (Saleh 2018). Appendix Figure A.4 shows that the *de jure* uniform tax was low (equal to the *ushr* rate) before 750, but increased sharply after 750 as it was raised to the *kharaj* rate. It then fluctuated over time at ruler's discretion probably in response to aggregate shocks, but never went back to its pre-750 level.

Tax administration and *actually enforced* tax rates Egypt's (Arab) rulers (governors appointed by the Caliph) decided on the annual budget that was needed to pay the tribute to the Caliphate, and to finance the salaries of Egypt's top officials, the army, the police, the judiciary, and the bureaucracy. The total budget was then allocated across *kuras* according to their population size. A *kura*'s budget per capita may have been further correlated with its observable characteristics (e.g., income). Importantly though, local taxes were *not* raised to finance local public goods, which were financed instead by ad hoc tax levies (see footnote 16).

The actual assessment and collection of taxes from the individual taxpayers were delegated to the local authorities of each *kura*, and further down to the headmen of villages. Taxes varied locally, both across *kuras* and across individuals within a *kura*. Before 700, Egypt's rulers everywhere left taxation in the hands of the existing Coptic rural elites. But from 700 on, rulers started to penetrate the local tax administration by increasingly appointing Arabs as headmen of *kuras* (Morimoto 1981, pp. 66-91; 175-81). In response to a series of tax revolts between 726 and 866, Egypt's rulers resorted around 900 to tax farming, which remained in effect until 1813. Under that system, the rulers contracted out the tax collection of each *kura* to individuals (Morimoto 1981, pp. 231-3). Egyptian tax papyri in 641-1100 reveal that the actually enforced individual poll and *kharaj* taxes, the discriminatory and uniform taxes starting from 750, could be higher or lower than the *de jure* ones because different tax rates could be decided locally, and because enforcement was not always perfect. However, the actually enforced tax rates that we observe in the papyri are close to the *de jure* ones, on average.[23]

3 Theory

3.1 Model

Copts' religious preferences. There is a mass 1 of Copts. Copts care about remaining Copts and about money. They are heterogeneous in their willingness to pay for remaining Copts. Let $\theta \in (-\infty, +\infty)$ denote their willingness to pay for being Copt, distributed according to some smooth cumulative distribution $F(\theta)$ and density $f(\theta)$; one expects the mass to be concentrated primarily in the positive domain ($\theta > 0$). Let us assume that the hazard rate of the distribution is monotonic (a property that is satisfied by most familiar distributions): $d(f(\theta)/[1-F(\theta)])/d\theta > 0$.

Possible explanations include Egypt's 11th-century famine and the 14th-century Black Death.

23. The average poll tax in the papyri in 641-1100 is 1.5 dinar ($N = 552$), which is close to the average *de jure* rate in 641-750 (=1 dinar) and in 750-1100 (assuming that most taxpayers belonged to the low and middle brackets). The average *kharaj* tax in the papyri in 641-1100 is 1.32 dinar per *feddan* ($N = 27$), which is close to the *de jure* rate in 641-750 (=1 dinar), but lower than the post-750 rate.

Taxes. For simplicity, we assume equal landholdings, so each Copt holds one unit of land (each piece of land yields the same output). λ is the non-discriminatory land tax paid by all Copts, whether they convert or not (later, we will assume that λ is constrained at the *ushr* level so as to better account for the pre-750 taxation). τ is the extra cost imposed on non-converts (empirically, this discriminatory tax exceeds the poll tax by the difference between the *kharaj* tax and the *ushr* tax until 750, but for the purpose of the model we will call it simply "poll tax").

Let

$$U(\theta) \equiv \begin{cases} -\lambda & \text{for a convert} \\ \theta - \lambda - \tau & \text{for a non-convert} \end{cases}$$

denote the utility of type θ (we can ignore the fixed output from land here). A Copt converts if and only if $\theta < \theta^* = \tau$. The number of converts is therefore $F(\tau)$ and the revenue from the poll tax paid by non-converts is

$$R(\tau) = \tau[1 - F(\tau)].$$

The monotone hazard rate assumption implies that the revenue function is strictly quasi-concave. Let $\tau^m \equiv \arg\max\{R(\tau)\}$ denote the revenue-maximizing tax. We will say that the poll tax is on the "downward-sloping side of the Laffer curve" if $\tau > \tau^m$. In this region, an increase in the poll tax reduces tax revenue.

Ruler's objective function. We posit that the ruler's objective function is quasi-linear[24] in the uniform tax λ (or subsidy $\lambda \gtrless 0$); the ruler's preferences with respect to conversions are expressed by a function $V(\theta^*)$:

$$W(\theta^*) = V(\theta^*) - \lambda. \tag{1}$$

Section 3.2 will provide a number of illustrations for this reduced form. Given that the functional V is at this stage completely flexible, the key assumption in equation (1) is that the ruler ceteris paribus would prefer a lower uniform tax (linearity in λ is for simplicity). As we will see, this may be because the ruler stands for a dominant group which has to pay the uniform tax. This is particularly relevant to our historical context, where Egypt's rulers were reluctant to tax Muslims (both Arabs and converts). An alternative interpretation is that the ruler (an autocrat, a tax farmer) has an agenda with respect to conversions and is residual claimant for the poll tax revenue once the budget B has been channeled to the Caliphate. In this interpretation, $\lambda = R(\tau) - B$ is no longer a land tax but rather the share of the poll tax revenue kept by the ruler. While that interpretation is less applicable to taxation under the Arab Caliphate, it may apply to other contexts. Comparing two rulers with respective preferences V_1 and V_2, we define:

Definition 1 *Ruler 1 is said to be more religious than ruler 2 if* $V_1'(\theta^*) > V_2'(\theta^*)$ *for all* θ^*.

Sticking with the first interpretation of the model for expositional convenience, we assume that the ruler maximizes W subject to raising a budget B for the Caliphate: $\lambda + R(\tau) \geq B$, a constraint

24. The theory can be extended to a non-linear objective function, but at the expense of further assumptions on marginal rates of substitution among taxes.

which will be binding at the optimum:

$$\lambda + R(\tau) = B. \tag{2}$$

The objective function can then be rewritten as

$$W(\theta^*) = V(\theta^*) + R(\theta^*) - B.$$

We will assume that $V + R$ is strictly quasi-concave.

Discussion of the model

(a) *Alternative proselytic strategies.* Could the ruler benefit from replacing a discriminatory tax by an alternative approach such as coerced conversions?[25] Given his ignorance of individual preferences, his ability to reach his goals is constrained by incentive compatibility, the fact that more religious Copts are necessarily less likely to convert. A straightforward generalization of the analysis in Stokey (1979) and Riley and Zeckhauser (1983) for our model shows that the ruler obtains his highest welfare through a discriminatory tax, and so there is no restriction involved in assuming this particular approach to inducing conversions.

(b) *Discrimination through non-price instruments.* Relatedly, because direct discrimination may be prohibited by the constitution or a higher-level polity, we also observe more indirect forms of discrimination, such as neighborhood-based access to public goods, ethnicity-based patronage and incendiary rhetoric. Glaeser and Shleifer (2005) describe such forms of discrimination in 20$^{\text{th}}$-century US, staging an Irish-catholic/Anglo-Saxon-protestant conflict in Boston and a black/white conflict in Detroit. In both examples, the mayor induced over the years substantial emigration of the minority out of the city, reinforcing the incumbent's political power;[26] Glaeser and Shleifer call this the "Curley effect," after the name of a Boston mayor who was in power for most of the 1913-1951 period. A direct, ethnic or race-based, tax discrimination being prohibited by the federal government, the ruler's hostility toward the minority shifted to presumably less efficient forms of utility extraction. Their paper also documents Robert Mugabe's tactic in Zimbabwe, which led to substantial migration by white farmers.

Our model can accommodate such non-price instruments. Appendix Section B.1 demonstrates how for instance outgroup derogation and patronage can be modeled through our "$V(\theta^*)+R(\theta^*)$" framework. In both illustrations the optimal policy always lies on the downward-sloping side of the Laffer curve. The model can also accommodate emigration (see Section 3.2).

25. This does not mean that forced conversions cannot result from our model. Consider the European-African slave trade (suggested to us by Itzchak Tzachi Raz); Europeans force-converted Africans to Christianity, arguing that they were saving their souls from eternal hell (the Africans' actual utility obviously differed from the Europeans' perception of it). Forced conversions can be understood in the following way in our model: due to their "benevolent" intent, Europeans had a very high utility of conversion (a high c in the extrinsic motivation interpretation of V. See Section 3.2), and so the solution may have been a corner solution with all converting to Christianity (an outcome equivalent to forced conversion). Of course for this to hold, either there must be an upper bound on the support of θ, or the Africans' wealth was limited so that they could not pay a large τ, or both.

26. Migration then reduces resistance to the ruler over time because of the majoritarian electoral system. By contrast, our time-decreasing resistance in Section 3.6.2 will be based on a reduced stake for the converts.

3.2 Illustrations

(a) *Intrinsic motivation.* Suppose, first, that the ruler is utilitarian, but in a discriminatory way. Letting $U(\theta)$ denote type θ's utility, $1-\delta(\theta)$ denote the weight of type θ in the ruler's welfare function (so $\delta(\cdot) \gtrless 0$ is a discrimination factor, where $\delta' \geq 0$),[27] and normalize weights to be equal to 1 on average: $E[\delta(\theta)] \equiv \int_{-\infty}^{+\infty} \delta(\theta) dF(\theta) = 0$.

A standard utilitarian ruler would exhibit $\delta(\theta) = 0$ for all θ (and would choose $\tau = 0$). Hostility vis-à-vis type θ corresponds to $\delta(\theta) > 1$. The ruler's welfare is (up to a constant):

$$W(\theta^*) \equiv \int_{-\infty}^{+\infty} [1-\delta(\theta)]U(\theta)dF(\theta) = \int_{\theta^*}^{+\infty} [1-\delta(\theta)](\theta-\theta^*)dF(\theta) - \lambda,$$

and so[28]

$$V(\theta^*) = \int_{\theta^*}^{+\infty} [1-\delta(\theta)](\theta-\theta^*)dF(\theta). \tag{3}$$

(b) *Extrinsic motivation.* In the extrinsic motivation case, the ruler puts negative weight c on non-converts, perhaps because the Caliphate provides him with formal or informal incentives to induce conversions:

$$V(\theta^*) \equiv -c[1-F(\theta^*)],$$

and

$$W(\theta^*) \equiv V(\theta^*) - \lambda = (\theta^* - c)[1-F(\theta^*)] - B.$$

For both conciseness and expositional simplicity, we will conduct some extensions assuming that the ruler has extrinsic motivation: $V(\theta^*) = -c[1-F(\theta^*)]$.

(c) *Social incentives: norms and network externalities.* When contemplating becoming a Muslim, a Copt may take into account not only his own preferences (θ) and the material incentive (τ), but also the resulting perception of his choice within the Copt community. Suppose[29] that the potential convert has image concerns $\mu M^+(\theta^*) = \mu E[\theta|\theta \geq \theta^*]$ if he does not convert and $\mu M^-(\theta^*) = \mu E[\theta|\theta \leq \theta^*]$ if he does, where θ^* is the threshold type and $\mu \geq 0$ is a parameter of intensity of image concerns. $M^+(\theta^*)$ and $M^-(\theta^*)$ are the upward and downward truncated means, respectively (i.e. the expectations of θ conditional on θ being above or below θ^*). The

27. While type θ is unobservable by the ruler, the latter's feelings toward converts may well depend on the truncated distribution of types, as we depict. High-θ converts are likely to have limited religious fervor and to pay lip-service to their new Muslim faith. These considerations were often at play under the early Arab Caliphate. Arabs' derogatory treatment of converts was commonplace. A convert was required to be a client or a subordinate (*mawla*) of an Arab patron, and the conflict between Arabs and converts is well documented in history.

28. We can compare two rulers "1" and "2", corresponding to two different costs functions $\delta_1(\cdot)$ and $\delta_2(\cdot)$ such that

$$E[\delta_1(\theta)] = E[\delta_2(\theta)] = 0.$$

Definition 1′ *In the intrinsic motivation interpretation, ruler 1 is said to be more religious (in the Muslim sense) than ruler 2 if there exists θ_0 such that $\delta_1(\theta) < \delta_2(\theta)$ for $\theta < \theta_0$ and $\delta_1(\theta) > \delta_2(\theta)$ for $\theta > \theta_0$.*

Definition 2′ *In the intrinsic motivation illustration, for a given cutoff θ^*: (1) the ruler is hostile to non-converts $[\theta^*, +\infty)$ if the average discrimination factor among non-converts exceeds 1 (or equivalently the average weight put on non-converts is negative): $\int_{\theta^*}^{\infty} \delta(\theta)dF(\theta)/[1-F(\theta^*)] > 1$. (2) The ruler discriminates against the marginal convert if $\delta(\theta^*) > 0$.*

29. Following Bénabou and Tirole (2006, 2013), Besley et al. (2017), Chen (2017) and Jia and Persson (2017).

cutoff θ^* (or alternatively the tax $\tau(\theta^*)$ that induces θ^*) is then given by

$$\theta^* - \tau + \mu[M^+(\theta^*) - M^-(\theta^*)] \equiv \theta^* - \tau + \mu\Delta(\theta^*) = 0.$$

The variation of the threshold to the discriminatory tax is no longer 1 for 1 if $\mu>0$, and is given by:

$$\frac{d\theta^*}{d\tau} = \frac{1}{1+\mu\Delta'(\theta^*)}.$$

Let us assume that image concerns are not too large, $1 + \mu\Delta'(\theta^*)>0$, and so the equilibrium threshold is unique and $\tau(\theta^*)$ well-defined. The new revenue function is $\hat{R}(\theta^*) \equiv \tau(\theta^*)[1-F(\theta^*)]$. The analysis is unchanged, except that now

$$W(\theta^*) = -c[1-F(\theta^*)] + \hat{R}(\theta^*) - B = [\tau(\theta^*) - c][1-F(\theta^*)] - B.$$

Introducing social pressure adds a few interesting additional insights, though. If the distribution $f(\theta)$ is unimodal, the function $\Delta(\theta^*)$ is U-shaped. When conversions are rare, the reputational concern is driven mainly by the strong stigma attached to conversions (and so $\Delta'(\theta^*)<0$). The discriminatory tax has a strong impact on the threshold because it not only provides a material incentive for conversion, but it also releases the social stigma attached to conversions. When in contrast there are few Copts remaining, reputational concerns are mainly driven by the social prestige attached to resistance (and so $\Delta'(\theta^*)>0$); the discriminatory tax impact on the threshold is then less than 1 for 1. [30]

The model can also be extended to allow for *network externalities*. Suppose that (ignoring social norms) individuals put positive weight e_k (for externality) on the size of their religious community where k indexes the community ($k = C$ for Copts and $k = M$ for Muslims). Then the threshold is given by:

$$\theta^* - \tau + e_C[1-F(\theta^*)] \equiv e_M F(\theta^*).$$

Provided that the network externality parameters e_k are not too large (so as to avoid equilibrium indeterminacy), $d\theta^*/d\tau>1$. We can again define the inverse function $\tau(\theta^*)$.

When individuals are affected by a social norm or a network externality as just described, the revenue function must simply be written as $\hat{R}(\theta^*) = \tau(\theta^*)[1-F(\theta^*)]$.

(d) *Malthusian ruler.* Suppose now that agents care not only about consumption and identity, but also about the number of their children. We use a model à la Galor and Weil (2000) and enrich it through a religious identity decision. An agent's utility is [31]

$$U(\theta) = \max_{z\in\{0,1\}} \frac{\rho^{1-\alpha}}{\alpha^\alpha(1-\alpha)^{1-\alpha}} a^\alpha n^{1-\alpha} + \theta z$$

30. One can go further in the elasticity analysis by assuming that $\Delta''(\theta^*)>0$ (a hypothesis for which Jia and Persson (2017) find supporting evidence in a different context).

31. In this version, the agent cares about his own identity or, alternatively, about the identity of his dynasty.

s.t.

$$a + \rho n \leq y - \lambda - \tau z,$$

where z equals 1 if a Copt maintains his identity and 0 if he converts, a is consumption, n the number of children, y the endowment, ρ the cost of a child's upbringing, and $\alpha \in (0, 1)$. Hence

$$U(\theta) = y - \lambda + (\theta - \tau)z,$$

which yields, as in the model without fertility choice, cutoff

$$\theta^* = \tau.$$

Suppose now that the ruler is extrinsically motivated to reduce the number of Copts:

$$V(\theta^*) = -c[1 + \nu n(\theta^*)][1 - F(\theta^*)]$$

where some weight $\nu > 0$ is put on the indirect conversions (of children). Let us show that n is a decreasing function of θ^*. A non-convert's number of children is given by $\rho n = (1-\alpha)(y-\lambda-\tau)$. Furthermore, $\lambda + \tau = B - \tau[1 - F(\tau)] + \tau = B + \tau F(\tau)$ is increasing in τ whether τ is on the upward-sloping or downward-sloping side of the Laffer curve. Because $\tau = \theta^*$, $n(\theta^*)$ is a decreasing function of θ^*.

Note that the Caliphate, when raising the poll tax, achieves double benefits: directly by inducing the adult generation to convert, and indirectly by making holdouts poorer and therefore reducing their reproductive rate. Appendix Section A.2 fails to find empirical support for this indirect mechanism in our historical context, but it might be relevant to other contexts.

(e) *Emigration.* The model allows for emigration as a way for the unwanted population to comply with the ruler's identity (e.g., Jewish emigration from Nazi Germany). Suppose that identity is inalterable (race, ethnicity), so the only possible "compliance" is emigration. The remaining minority population corresponds to $\theta \geq \theta^* = \lambda + \tau \equiv \hat{\tau}$. Taking the case of extrinsic motivation for instance, and assuming the existence of a dominant group paying solely the uniform tax λ, $W = -c[1 - F(\hat{\tau})] + \hat{\tau}[1 - F(\hat{\tau})] - B = (\hat{\tau} - c)[1 - F(\hat{\tau})] - B$. Thus a simple relabeling shows that our model captures emigration as well. Emigration is irrelevant to our historical context, [32] but is prominent in some other ones.

(f) *Cohesiveness.* The ruler may also want to increase the cohesiveness of the polity. Democratic regimes and organizations sometimes function more efficiently when their membership is more homogeneous. For example, Hansmann (1996) argues that congruence in objectives facilitate both the flow of information and the fluidity of decision making in cooperatives. Besley et al. (2017) argue that districts with single party majority yield more cohesive policies, presumably

32. At the level of Egypt, (non-convert) Copts rarely emigrated from the country, because of their unique denomination that split from the Roman/Byzantine Church at the Council of Chalcedon in 451, and was thus considered heretical by both churches. At the local level, the state restricted migration across villages under the early Arab Caliphate (see the discussion of the data on Coptic churches and monasteries in Section 4.1.1).

because this cohesion facilitates agreement on the use of tax revenue and thereby raises incentives to collect tax revenue. Relatedly, Alesina et al. (1999) have shown that the provision of local public goods is facilitated by religious or ethnic homogeneity. Without applying a value judgment to such objectives, we can capture the ruler's demand for cohesiveness within the function $V(\theta^*)$. (g) *Political equilibrium.* The "ruler" need not be a unitary actor; instead, ruler preferences may result from political interaction among various powers. For example, policies with regards to Moriscos (Spain's converted Muslims) were the outcome of a power struggle between on one side the nobles, who exploited their Muslim vassals through forced labor services and a share of their harvest, and on the other side, the Church and the King, who attached higher value to religious matters. For instance, from 1238, date of the conquest of Valencia by King Jaume I of Aragon, through 1525, when Muslims were forced to convert to Christianity, the nobility succeeded in exploiting Muslims; it kept doing so after 1525, but lost the battle in 1609 when the Moriscos were expelled from Spain.[33]

3.3 Optimal tax structure: basic comparative statics

The first-order condition for ruler welfare maximization is

$$V'(\theta^*) + R'(\theta^*) = 0.$$

The uniform tax is then given by $\lambda^* = B - R(\theta^*)$. The strict quasi-concavity of the welfare function implies that $\tau^* > \tau^m$ if and only if $V'(\tau^m) > 0$.[34]

Examples. *Under extrinsic motivation*, the optimal discriminatory tax *always* lies on the downward-sloping side of the Laffer curve: $\max_{\{\tau\}}\{(\tau - c)[1 - F(\tau)] - B\}$ yields an optimal tax exceeding the level that maximizes $\tau[1 - F(\tau)]$.[35] By contrast, under *intrinsic motivation*, the discriminatory tax lies on the downward-sloping side of the Laffer curve if and only if at τ^m the ruler is hostile to the average non-convert: Maximizing $\int_\tau^\infty \{[1 - \delta(\theta)](\theta - \tau)dF(\theta) - [B - R(\tau)]\}$ yields an optimum to the right of τ^m if and only if the derivative of the first term in the maximand is positive at τ^m, or $M_\delta^+(\tau^m) \equiv \frac{\int_{\tau^m}^\infty \delta(\theta)dF(\theta)}{1-F(\tau^m)} > 1$.

Uniform tax ceiling. Next, suppose that the uniform tax is subject to a binding cap[36] $\lambda \leq \bar{\lambda} < \lambda^*$. The cap on the uniform tax implies a floor on discriminatory tax revenue: $R(\tau) \geq B - \bar{\lambda}$.

33. See Chaney and Hornbeck (2015) for a detailed study of the economic impact of this episode.

34. $\tau^* > \tau^m$ implies that $V'(\tau^m) + R'(\tau^m) = V'(\tau^m) > 0$, and conversely.

35. As Giacomo Ponzetto suggested to us, this extrinsic motivation modeling, properly reinterpreted, also covers the design of "sin taxes" (O'Donoghue and Rabin 2006). Consider a hyperbolic consumer with present bias parameter β (and otherwise no discounting). Consumption today brings immediate benefit b drawn from distribution $G(b)$ in $[0, \infty)$ and fixed delayed cost c. Let $F(\theta) \equiv G(\theta + \beta c)$. Given a sin tax τ for consumption, the cutoff is $\theta^* = b + \beta c = \tau$. So $R(\theta^*) \equiv \theta^*[1 - F(\theta^*)]$. And paternalistic preferences can be expressed as $\int_{\tau+\beta c}^\infty (b - c)dG(b) = \int_{\theta^*}^\infty [\theta - (1 - \beta)c]dG(\theta) \equiv V(\theta^*)$. The optimal cutoff, given by $(1 - \beta)c = \frac{1-F(\theta^*)}{f(\theta^*)}$, lies on the downward-sloping side of the Laffer curve. The equivalent of apostasy in this case (see Section 3.5) would correspond to a permanent withdrawal: once the individual has stopped consuming, she will stop consuming in the future regardless of realized benefits of consumption; this is a strong assumption in this context.

36. We focus on this case rather than the case of a floor ($\lambda \geq \underline{\lambda}$) because of the empirical evidence. As we note, the transformation of the *ushr* tax into a *kharaj* enabled rulers to raise λ, which suggests that the *ushr* tax acted as a cap rather than as a floor.

If $V'(\tau^m)>0$, the strict quasi-concavity of the revenue and objective functions implies that the constrained optimum, τ^{**}, satisfies $\tau^m \leq \tau^{**}<\tau^*$. If $V'(\tau^m)<0$, then the reverse inequalities hold: $\tau^*<\tau^{**} \leq \tau^m$.

Ruler religiosity. Finally, let us look at the impact of ruler religiosity on taxation. If ruler 1 is more religious than ruler 2 in the sense of Definition 1 (for all θ^*, $V_1'(\theta^*)>V_2'(\theta^*)$), then $\tau_1^*>\tau_2^*$.[37] If furthermore $V_2'(\tau^m) > 0$, $\lambda_1^*>\lambda_2^*$.

Proposition 1 ***(being on the downward-sloping side of the Laffer curve)***

(i) The optimal discriminatory tax τ^* is on the downward-sloping side of the Laffer curve if and only if $V'(\tau^m)> 0$. The optimal uniform tax is given by $\lambda^* = B - R(\tau^*)$.

(ii) Suppose that $V'(\tau^m)> 0$. Then, if the uniform tax is constrained to be lower than its optimal level, the discriminatory tax is also smaller than its optimal level in the absence of constraint on the uniform tax.

(iii) A more religious ruler taxes non-converts more heavily: If $V_1'(\cdot) > V_2'(\cdot)$, $\tau_1^* > \tau_2^*$. Furthermore, if both rulers are on the downward-sloping side of the Laffer curve ($V_2'(\tau^m) > 0$), then $\lambda_1^* > \lambda_2^*$.

The result in (ii) and the second part of (iii) of Proposition 1 are reversed if the optimal policy lies on the upward-sloping side of the Laffer curve: A cap on the land tax then *increases* the discriminatory tax; and a small increase in ruler religiosity *reduces* the tax burden on converts.

Copt religiosity. We must here focus on the extrinsic/intrinsic motivation example, which is explicit about how V depends on the distribution F, while the general formulation is not. Let $F(\theta - r)$ denote the distribution of willingnesses to pay to remain Copt (a higher r corresponds to an increase in religiosity).

Proposition 2 ***(impact of Copt religiosity on taxation)***

(i) When the ruler is extrinsically motivated, an increase in Copt religiosity (a) increases the discriminatory tax, (b) lowers the conversion rate, and (c) reduces the uniform tax.

(ii) When the ruler is intrinsically motivated, f is log-concave[38]*, and at the optimum the ruler is hostile against the marginal member of the non-convert population ($\delta(\theta^*) > 1$), a marginal increase in Copt religiosity implies an increase in the discriminatory tax.*

Copt income. The comparative statics with respect to Copt income are patchier. We refer to Appendix Section B.2 for an analysis.

Elastic budget. To allow for budget endogeneity, let the ruler's objective function be $V(\theta^*) + \Phi(B) - \lambda$, where $B = \lambda + R(\theta^*)$ and the utility from the budget, Φ, is increasing and concave.[39]

37. One has $V_1'(\tau_2^*) + R'(\tau_2^*) > V_2'(\tau_2^*) + R'(\tau_2^*) = 0$. The strict quasi-concavity of the objective function then implies that $\tau_1^* > \tau_2^*$.

38. From Prekova's theorem, a sufficient condition for a monotonic function taking value 0 at one of the bounds of its support to be log-concave is that its derivative is log-concave: $(f'/f)' \leq 0$.

39. The basic model is a special case of this extended model, with $\Phi(B) \equiv B$.

If the uniform tax is unconstrained, $\Phi'(B) = 1$ at the optimum, and therefore the discriminatory tax τ^* is the same as in the basic model: $V'(\tau^*) + R'(\tau^*) = 0$. This extended model satisfies the following properties:

(i) The necessary and sufficient condition for the ruler's optimum to lie on the downward-sloping side of the Laffer curve is still $V'(\tau^m) > 0$.

(ii) Index budget needs by a parameter ξ (the utility from the budget is $\Phi(B, \xi)$) such that $\Phi_{B\xi}(B, \xi) > 0$ (a higher parameter ξ increases the ruler's demand for money, but nothing else). Then an increase in budgetary needs leads to an increase in the uniform tax, with no impact on the discriminatory one.

(iii) Suppose that the uniform tax is constrained ($\lambda \leq \bar{\lambda}$), and that this constraint is binding. A reduction in the cap $\bar{\lambda}$ induces the optimal discriminatory tax τ^* to move toward the peak τ^m of the Laffer curve, staying on the same side of that curve. [40]

(iv) Proposition 2, on the impact of Copt religiosity on taxation, still holds.

Delegated budget collection. As we outlined in Section 2.2, Egypt's rulers delegated tax collection to the local authorities of each *kura*, but local budgets per capita may have been correlated with characteristics of *kuras* that were (potentially) observable by the rulers. We analyze the delegated budget collection in Appendix Section B.3, but we summarize our main findings here. The key assumption in this alternative setup is that the cost of collecting the land tax is at least slightly convex, which is a reasonable assumption.

First, the theory predicts that *kuras* with more religious Coptic populations face a higher budgetary requirement. Because of their religiosity, Copts in these *kuras* face a higher poll tax, but are nevertheless less likely to convert. Overall, authorities raise a higher poll tax revenue per capita. But because of the convexity of the cost of land tax collection, the land tax will not be reduced sufficiently to offset the higher poll tax revenue, hence resulting in a higher total tax revenue per capita. Second, we analyze the situation where local tax authorities vary in their religiosity. In this case, we find that more religious local tax authorities will raise a lower total tax revenue per capita, if all localities are operating on the downward-sloping side of the Laffer curve. This is because of two effects: (a) the ruler will want to reduce the distortion arising from the higher land tax imposed by more religious collectors (this distortion is due to the convexity of the land tax collection cost), and (b) the ruler will want to temper the zeal of high-religiosity collectors and incentivize low-religiosity collectors to trigger more conversions. It turns out that the two effects operate in the same direction, leading high-religiosity collectors to face a lower budgetary requirement by the ruler.

40. The first-order condition with respect to the discriminatory tax writes $V'(\tau^{**}) + \Phi'(B)R'(\tau^{**}) = 0$ as long as $B = \bar{\lambda} + R(\tau^{**}) \leq \bar{\lambda} + R(\tau^m)$, with $\Phi'(B) > 1$ increasing as the cap becomes tighter. For example suppose that $R'(\tau^*) < 0$ and $R'(\tau^{**}) \geq 0$, implying $\tau^* > \tau^m \geq \tau^{**}$, then $V'(\tau^{**}) + R'(\tau^{**}) \leq 0$, and so $\tau^{**} \geq \tau^*$, a contradiction.

3.4 Legitimacy

One obvious concern for rulers is the threat of rebellion. Tax revolts by non-converts and converts were commonplace in the Caliphate between 700 and 900 CE (see Section 2.2). This concern may impact the choice of taxes. [41] We capture Copts' possible revolt in a simple way. We assume that a successful rebellion kicks the Caliphate out of power and so taxes are no longer sent to the Caliphate. Revolting costs $\rho > 0$ to each rebel. The revolt is successful if and only if at least $1 - F(\hat{\theta})$ Copts rebel, [42] an assumption that reflects the fact that the gain from rebellion, $G(\theta)$, is weakly increasing in θ and so the most religious Copts are also the most eager to rebel:

$$G(\theta) = \begin{cases} \lambda + \theta & \text{for} \quad \theta \leq \tau \\ \lambda + \tau & \text{for} \quad \theta \geq \tau. \end{cases}$$

Assuming away coordination problems so that a rebellion indeed occurs whenever at least $1-F(\hat{\theta})$ are willing to incur cost ρ if they know the rebellion will succeed, the no-revolt constraint for the ruler is: [43]

$$G(\hat{\theta}) = \lambda + \min\{\tau, \hat{\theta}\} \leq \rho. \tag{4}$$

We are interested in situations in which the policy that would be optimal in the absence of revolt would trigger a revolt and is therefore infeasible: $\rho < \min\{\lambda^* + \hat{\theta}, \lambda^* + \tau^*\}$. We can consider two cases, depending on the level of τ^* in the absence of possibility of rebellion:

(a) *Marginal rebel is a convert:* $\hat{\theta} < \tau^*$

In this case (in which the revolt must have a large scale to be successful), the no-revolt constraint, which is binding, is

$$\lambda + \hat{\theta} = \rho < \lambda^* + \hat{\theta}.$$

Thus, λ, which is the only tax paid by converts, must be decreased, regardless of which side of the Laffer curve the unconstrained optimum lies, which implies that, on the downward-sloping side of the Laffer curve, the discriminatory tax must be decreased as well: $\tau < \tau^*$. The ruler lowers a tax that is not levied on the marginal rebel. By contrast, on the upward-sloping side of the Laffer curve, the discriminatory tax is increased.

(b) *Marginal rebel is a non-convert:* $\hat{\theta} > \tau^*$

The no-revolt constraint, which is binding, is then

$$\lambda + \tau = \rho < \lambda^* + \tau^*.$$

41. Another source of legitimacy that was suggested to us by Timur Kuran is that the Caliphate recruited converts in the army and rewarded them with a state (cash and in-kind) stipend (see footnote 16). However, while this theory may hold in other parts of the Caliphate, it was less applicable to Egypt whose Muslim army in 641-750 was "small and largely composed of the conquerors of the country and their descendants" (Kennedy 2013, p. 19).

42. Assuming that the success of a revolt depends only on the number of rebels ignores some other determinants of a successful rebellion, such as the homogeneity of the rebel population or its financial capability.

43. V does not depend on ρ: Even if the ruler internalizes the agents' utility, there is no rebellion cost on the equilibrium path; and anyway the internalization would not call for allowing a rebellion.

The discriminatory tax must be decreased, regardless of which side of the Laffer curve the unconstrained optimum lies.[44] This implies that $\hat{\tau} < \tau^* < \hat{\theta}$, so the marginal rebel remains a non-convert. The uniform tax must also be reduced if and only if the discriminatory tax is on the downward-sloping side of the Laffer curve.

Proposition 3 ***(revolt-constrained public finance)*** *Suppose that the no-rebellion constraint is binding* ($\rho < \lambda^* + \min\{\tau^*, \hat{\theta}\}$).

(i) When $\tau^* > \hat{\theta}$, the marginal rebel is a convert. Legitimacy requires lowering the uniform tax ($d\lambda/d\rho > 0$).

(ii) When $\tau^* < \hat{\theta}$, the marginal rebel is a non-convert. Legitimacy requires lowering the discriminatory tax ($d\tau/d\rho > 0$).

(iii) The two taxes τ and λ co-move as ρ varies, if and only if the fiscal system is on the downward-sloping side of the Laffer curve.

3.5 Dynamics of conversion and the land tax

Next, to investigate the potential causes of the increase in the uniform tax circa 750, we extend the analysis of the basic model to a multi-period context: $t = 1, 2, ..., T$ with discount factor $\beta < 1$. The ruler faces date-t budgetary need B_t at date t.[45] The ruler cannot use capital markets to smooth the budgetary need over time, which seems a reasonable assumption in our context.

We assume that unwanted population exit is definitive. Jewish intellectuals who left Germany for the United States did not come back once politics in Germany returned to normal. Individuals who convert to Islam and their children cannot reassume their previous religion by fear of apostasy. Even quits in organizations are rarely reversed. Absorbing exit implies a fair amount of hysteresis of the impact of public policies. The cutoff θ_t^* must satisfy: $\theta_t^* \geq \theta_{t-1}^*$ "apostasy constraint". We investigate the dynamics of taxation and its structure assuming that the ruler cannot commit to a policy.

Proposition 4 ***(dynamics of conversion and land tax)*** *In the following cases, the outcome is the same as with myopic principal(s) and myopic agents, leading to the following properties for the outcome* $\{\lambda_t, \tau_t\}_{t=1,...,T}$*:*

(i) In a stationary environment, the equilibrium involves a constant poll tax and land tax, equal to the static levels (τ^*, λ^*)*. All conversions occur at date 1.*

(ii) If the budgetary need changes (in an arbitrary way) over time, then the budget fluctuations are met solely through adjustments in the non-discriminatory tax: $\tau_t = \tau^*$ for all t (again all conversions occur at date 1) and $\lambda_t = \lambda_t^* = \lambda_1^* + (B_t - B_1)$ for all t.

(iii) If rulers become more pious over time ($V'_{t+1}(\theta^*) \geq V'_t(\theta^*)$ for all θ^*), then a) for all t, $\tau_t = \tau_t^* \geq \tau_{t-1} = \tau_{t-1}^*$ and there will be conversions at any date at which the ruler is strictly

44. Because $\rho - \tau + R(\tau) = B$, $d\tau/d\rho = 1/[1 - R'] = 1/[F + \tau f]$.
45. This budgetary need is taken to be deterministic, but the analysis can be extended to a random need.

more religious than the previous ones, and b) if $V_1'(\theta_1^*) \geq 0$*, then* $\lambda_t = \lambda_t^* \geq \lambda_{t-1} = \lambda_{t-1}^*$*: the land tax increases over time. By contrast, if the rulers become less religious over time, then there is ratcheting:* $\lambda_t = \lambda_1 = \lambda_1^*$ *and* $\tau_t = \tau_1 = \tau_1^*$ *for all* t*: date-*t *taxes are set at the preferred levels of the date-1 ruler.*

To grasp the intuition behind (apparently) myopic behaviors, consider a period t in which there are conversions, with type θ_t^* being indifferent between converting and staying Copt. At date $t+1$ (and a fortiori at later dates), this marginal type cannot expect any surplus from remaining Copt; indeed were the date-$(t+1)$ discriminatory tax τ_{t+1} to be smaller than θ_t^*, the date-$(t+1)$ ruler could raise τ_{t+1} slightly, increase revenue, and, due to apostasy, have no impact on the number of converts. Hence $\tau_{t'} \geq \theta_t^*$ for all $t' > t$, and Copts might as well behave myopically. To understand why the date-t ruler also plays as if he were myopic, suppose that the date-$(t+1)$ ruler will be more eager to convert Copts than him. The only way for the date-t ruler to affect his successor's behavior is to induce even more conversions than the latter; but this strategy lowers the current ruler's payoff relative to playing myopically both at date t and $t+1$ (as well as future dates actually). So the current ruler optimally plays his myopic optimum. Conversely, suppose that the date-$(t+1)$ ruler will be less eager to convert Copts than the date-t ruler; then picking the myopic optimum delivers double benefit for the date-t ruler, as the ratcheting associated with apostasy forces the date-$(t+1)$ ruler to adopt the date-t ruler's preferred policy. A more rigorous proof can be found in the Appendix.

Learning. Learning by the ruler may give rise to gradual conversions and a time-increasing uniform tax. Interestingly, the apostasy constraint implies that the ruler in general will want a low poll tax early- and hence a low land tax as well if on the downward-sloping side of the Laffer curve- so as to benefit from an option value: the ruler can easily raise the poll tax if the news justifies doing so, but cannot get converts to convert back if news suggest a less harsh poll tax. To illustrate this, imagine that there are two periods, $t = 1, 2$. The ruler does not know a real valued parameter r distributed according to prior distribution $H(r)$. This parameter may affect both V and R. For instance, r may stand for Copt religiosity (the number of date-1 converts is then $F(\tau_1 - r)$).

The ruler learns the parameter r at the end of date 1 by observing aggregate behavior (e.g. the number of converts). Thus the ruler solves at date 1:

$$\max_{\tau_1}\{E_r[V(\tau_1, r) + R(\tau_1, r) + \beta \max_{\tau_2(r) \geq \tau_1}\{V(\tau_2(r), r) + R(\tau_2(r), r)\}]\}$$

For example, when r is a Copt religiosity parameter, and letting $\tau^*(r)$ denote the optimal tax under full information about r,

$$\max_{\tau_1}\{E_r[(\tau_1 - c)[1 - F(\tau_1 - r)]] + \beta \int^{r^*(\tau_1)} (\tau_1 - c)[1 - F(\tau_1 - r)]dH(r)\}$$

where

$$\tau^*(r^*(\tau_1)) \equiv \tau_1$$

The term in the integral is decreasing in τ_1, capturing the option value.

While we cannot rule out learning as a potential explanation for the tax reform, we do not think that it is the primary explanation of its timing. The (decline in) poll tax revenue between 641 and 750 was observed by the Caliphate. Having learned about the underlying distribution of religiosity from the conversion rate that is implied by the poll tax revenue figures, Caliphs could have increased the uniform tax right after the first observed decline in the poll tax revenue in 661. The fact that they did not implies that there were other reasons behind the uniform tax increase.

3.6 Challenges to the Caliphate rule

An alternative explanation for the uniform tax increase circa 750 is the decline in challenges to the Caliphate rule. We consider two kinds of challenges: exogenous/external and endogenous/internal. The Caliphate rule could be toppled, and the discriminatory tax abolished, because of, say, a successful (re)conquest by a foreign non-Muslim empire (e.g., the Byzantines). We will represent this as a probability x_t that the Caliphate rule is toppled at date t conditionally on having been in power until that date. The Caliphate alternatively could come to an end because of a successful internal rebellion, as described in Section 3.4, in which political power is seized by non-converts, either entirely or partially. [46]

The key assumption in our study of repeated external or internal challenges to the Caliphate rule is that there is a positive probability (taken to be 1 in the study below) that the threat of the death penalty of apostates will prevent converts from converting back after the Caliphate is evicted. Alternatively, there is a (possibly, high) cost to converting back to Christianity. Indeed, were converting back completely costless, then no interesting dynamics would emerge from the possibility of termination of the Muslim rule. The existence of a positive cost of reverse conversion, and therefore of a loss of an option value when converting, is a realistic assumption. Even if the post-Caliphate state had fallen in non-Muslim hands, the death penalty on reverse-converts could have been enforced in a decentralized (non-state) way by isolated, but fanatical converts. Furthermore, non-convert Copts may actually have rejected reverse-converts, because, as indicated by medieval Coptic texts, they tended to think of converts as outcasts and traitors (in the language of our model, converts had signaled that they had a low θ). [47] Converts also lost access to Coptic support networks, in particular Coptic monasteries and churches. Finally, even though first-generation converts may have been crypto-Muslims, it is conceivable that genuine attachment to Islam grew from the second generation on. The fall of Muslim rule in Spain is illuminating in

46. External and internal threats to the Caliphate that may result in another group of Muslims seizing power are not directly relevant here, because the new Muslim state will likely continue to impose the discriminatory tax on non-converts (creating no option value of keeping the Coptic faith). This can happen due to a civil war within the Caliphate that brings another Caliph (dynasty) to power, which is an internal threat from the viewpoint of the Caliphate but external from the viewpoint of a given territory such as Egypt. It can also happen in the case of an internal rebellion in which converts capture political power.

47. The 7$^{\text{th}}$-century Coptic chronicle of John of Nikiu (1916, pp. 201) refers to tax-induced converts as "... Egyptians who had been false Christians [who] denied the holy orthodox faith and lifegiving baptism, and embraced the religion of the Moslem, the enemies of God." The 9$^{\text{th}}$-century Coptic chronicle of Ibn-Al-Muqaffa' (1910, pp. 116-7) described converts as people to whom "Satan did much harm."

this regard. Even though Muslim converts were now authorized, and even encouraged, to convert back to Christianity, they (mostly) did not until they were forced to reverse-convert. Many even chose to immigrate to North Africa to keep their religion. And those who were forced to convert to Christianity (Moriscos) were later expelled because they were not trusted by non-converts. This suggests that being Muslim was an absorbing state even in the absence of a Muslim political authority that enforces the death penalty of apostates.

3.6.1 External challenges and the option value of remaining Copt

We first analyze external challenges to the Caliphate due to a (re)conquest by a non-Muslim empire. Suppose that there is probability x_t that the Caliphate will be evicted at date t conditional on not having been evicted before date t, and so taxes levied for the Caliphate will not be in force from date t on. Everything else is kept constant across periods. We assume that Muslim rulers care not only about taxes and current conversions, but also about their "legacy": by inducing conversions today, they increase the number of Muslims tomorrow even if they no longer rule the country and they give themselves credit for this. The uncertainty about the Muslim rule makes Copts more reluctant to convert as they are now losing an option value.

Proposition 5 ***(option value under uncertain Muslim rule)*** *Under uncertainty about Muslim tenure, all conversions occur at date 1 ($\theta_t^* = \theta^*$ for $t = 1, ..., T$) and the magnitude of conversions is the same as in the absence of uncertainty ($x_t = 0$ for all t). Letting $K_t \equiv 1 + (\beta + ... + \beta^{T-t})x_{t+1}$, the date-$t$ poll tax is $\tau_t = K_t\theta^*$, the date-t poll tax revenue is $R_t = K_t\theta^*[1 - F(\theta^*)]$, and the land tax is $\lambda_t = B - R_t$. If furthermore, the conditional probability x_t of an ending of the Muslim rule is non-increasing, the poll tax and the poll tax revenue decrease over time and, for a constant budgetary need, the land tax increases over time.*

Intuitively, the possibility that the Muslim rulers be chased out of the country creates an option value of remaining Copt. This implies that the demand for remaining Copt is more inelastic early on and so the rulers can collect a fair amount of money from the poll tax. This explains the opposite dynamics of the poll and land tax revenues.

3.6.2 Internal challenges and time-decreasing resistance

Let us next look at internal challenges to the Caliphate, the dynamic generalization of the legitimacy model developed in the previous section: It takes $[1 - F(\hat{\theta})]$ rebels to topple the Muslim rule, and the individual cost of doing so is ρ.

A key insight is that the incentive to rebel decreases over time, as depicted in Figure 1 in the two-period case. Earlier converts' gain from a successful rebellion is limited to the uniform tax and no longer includes the preservation of their foregone identity. As Proposition 6 below shows, this implies that the ruler may raise taxes over time in an otherwise fully stationary economy. Assume in a first step that agents are myopic ($\beta = 0$); for instance, each generation cares about its own welfare, but apostasy implies that conversions apply to future generations.

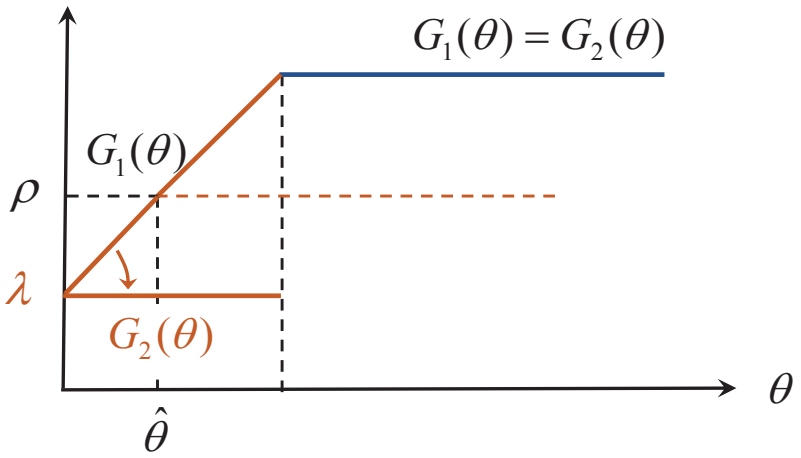

Figure 1 – **Time-decreasing resistance**

$G_t(\theta)$ = date-t gain from a successful rebellion at date t.

Proposition 6 ***(conversions weaken resistance over time)*** *Assume that agents are myopic and that $\rho < \lambda^* + \tau^*$ (otherwise there would not be a threat of rebellion).*

(i) Suppose that in the static analysis the marginal rebel is a convert and that the optimal static tax $\hat{\tau}$ lies on the downward-sloping side of the Laffer curve. The no-rebellion constraint becomes looser over time, as an agent has less to gain from a rebellion once converted. Both taxes increase between the first two dates as the resistance of converts is weaker than that of non-converts. There are new conversions at date 2 but not thereafter: $\hat{\tau}_1 = \hat{\tau} < \hat{\tau}_2 = \hat{\tau}_3 = ... = \hat{\tau}_T$, where $\hat{\tau}_2$ is the minimum of the solution on the downward-sloping side of the Laffer curve of $R(\hat{\tau}_2) = B - \rho$ and of τ^*. The uniform tax decreases from date 1 to date 2. In particular, if the rebellion cost ρ belongs to $(\lambda^*, \lambda^* + \tau^*]$, the date-1 taxes are $(\lambda_1, \tau_1) = (\hat{\lambda}, \hat{\tau})$ and the date-2 taxes are $(\lambda_2, \tau_2) = (\lambda^*, \tau^*)$.

(ii) If either the marginal rebel in the static analysis is a non-convert, or the optimal static tax $\hat{\tau}$ is on the upward-sloping side of the Laffer curve, the no-rebellion constraint is equally binding in all periods and taxes are constant over time. All conversions occur at date 1.

Suppose next that Copts are not myopic and apply the same discount factor β as the ruler to future utilities. We then need to assume that $T = +\infty$; for, with a finite horizon, the gain from a successful rebellion would decrease over time, generating an artificial increase over time in the cost of rebellion (expressed relative to future benefits). We assume that the cost of rebellion is $\rho/(1-\beta)$: while rebellion is a one-shot activity, we normalize its per-period cost to be ρ to facilitate the comparison with the static legitimacy model. The willingness to pay to remain Copt is θ per period.

One might guess that the Coptic resistance in this case would no longer subside over time, as the Copts internalize the fact that not rebelling will lead to an increase in future taxes. Interestingly, this is not the case. The reason has to do with the difference in objectives between marginal and inframarginal rebels. Suppose that the marginal rebel is a convert; he is then con-

cerned solely with the discounted flow of uniform taxes; by contrast, rebels who do not convert are affected by both the uniform and the discriminatory discounted taxes, as is the ruler. The ruler can soft-pedal uniform taxes and backload their flow so as to dissuade the converts from rebelling. Put differently he can divide and conquer the Coptic community. Once the resistance of the converts has been reduced, the ruler can then increase the discriminatory tax provided that it is indeed optimal to do so, which will be the case on the downward-sloping side of the Laffer curve (on the upward-sloping side of the Laffer curve, the increase in the uniform tax goes hand in hand with a decrease in the discriminatory tax, which apostasy precludes as agents cannot convert back).

Proposition 7 ***(forward-looking Copts)*** *Assume an infinite horizon, the same discount factor β for both Copts and ruler, that $\hat{\theta} < \tau^*$ (the marginal rebel is a convert), that $V'(\theta^*) > 0$ for $\theta^* < \tau^*$,*[48] *that the rebellion-unconstrained optimum is on the downward-sloping side of the Laffer curve ($R'(\tau^*) < 0$), and that $\lambda^* \leq \rho < \lambda^* + \hat{\theta}$ (already converted agents do not rebel when the optimal no-rebellion tax scheme is in place; and the threat of rebellion is ex ante binding). Then, there exists ρ_o such that for all $\rho \in [\rho_o, \lambda^* + \hat{\theta})$ there exists an equilibrium with the following properties: The ruler backloads the uniform tax so as to persuade the converts not to rebel: He sets λ_1 such that $\lambda_1 + \frac{\hat{\theta}}{1-\beta} + \frac{\beta\lambda^*}{1-\beta} = \frac{\rho}{1-\beta}$. The uniform tax for $t \geq 2$ is equal to $\lambda^* > \lambda_1$. The date-1 discriminatory tax τ_1 is given by $R(\tau_1) + \lambda_1 = R(\tau^*) + \lambda^* = B$ and satisfies $\tau_1 < \tau^* = \tau_2 = \tau_3 = ...$: conversions occur at dates 1 and 2.*

Remark As we earlier noted, the absence of uncertainty precludes the existence of actual (on-the-equilibrium-path) revolts. Introducing some uncertainty about the value of ρ or $\hat{\theta}$ in general leads to a positive probability of an on-the-equilibrium-path revolt. While a full treatment of this lies outside the scope of this paper, a few interesting points can be made. First, while the converts' willingness to revolt is reduced by their inability to convert back, their goals become more aligned: their incentive to rebel comes from economizing the uniform tax, and their heterogeneity in religiosity is no longer relevant; so the converts rebel en masse if they rebel at all. Second, at date 1, all potential rebels are Copts; at date 2, some of the rebels may well be Muslims as well. This is relevant to the history of tax revolts under the Caliphate (see Section 2.2).

Finally, recall that the Caliphate tax system was initially constrained by a cap on the uniform tax (the land tax levied on Muslims- the *ushr*-, unlike the *kharaj*, was set exogenously: the Prophet had set it at a fixed 10% rate). The reform removing this constraint happened only about a century after the invasion, when rulers changed the tax system so as to be able to levy the *kharaj* on converts and to remove the treaty-based cap on the *kharaj*. Why did the rulers not give themselves more degrees of freedom right away? The following corollary offers a possible explanation for the delay. This explanation will not require the introduction of a fixed cost of

48. This property is always satisfied in the extrinsic motivation illustration and the non-price-discrimination examples of the Appendix. It holds in the intrinsic motivation example if at $\theta^* = \tau^*$ the ruler is hostile to non-converts.

reforming the tax system to eliminate this constraint, even though the existence of such a cost is reasonable as going against the Prophet's recommendation was presumably costly.

Corollary 1 ***(delayed tax-system reforms due to time-decreasing resistance)*** *Because the threat of rebellion constrains the uniform tax and this threat is reduced over time as the benefit from rebelling decreases with conversion, the cost imposed by a cap on the uniform tax may be low or nil early on and substantial later. Hence tax reforms may be delayed even if the cost of modifying the tax system is small.*

4 Empirics

The model generates a wide set of predictions (Appendix Table C.1). We focus on only two aspects, because (1) they enable us to address two main puzzles for the history of early Islamic taxation, and (2) we lack the detailed data that are needed to test the other predictions. Given the data scarcity and the lack of a natural experiment though, our findings remain suggestive, and their interpretation rests on theory and history.

First, did the discriminatory tax revenue fall due to conversions? In the absence of localized data on discriminatory tax revenue, the model enables us to address this question indirectly. The theory predicts that more religious rulers will impose higher discriminatory tax to induce more conversions. If the optimal discriminatory tax is on the downward-sloping side of the Laffer curve, the discriminatory tax revenue will fall, which will necessitate increasing the uniform tax. The latter result will be reversed if on the upward-sloping side. To tell the two possibilities apart, we exploit the local variation within early Islamic Egypt in the religious composition of the local tax authorities, tax rates, and conversions.

Second, the model offers four possible reasons for why the uniform tax, but not necessarily the discriminatory tax, may have increased circa 750: a) a budgetary need increase is absorbed by the non-distortionary land tax; b) Caliphs may become more religious over time (by contrast, we saw that the uniform tax remains constant if they become less religious over time, an asymmetric response); c) there is some possibility early on that the Caliphate will be toppled; d) the threat of rebellion weakens over time as past converts, while still economizing on the uniform tax when the rebellion succeeds, no longer benefit from being able to remain Copt (so they have overall lower incentives to participate in a rebellion). Notice that a) and c) hold irrespective of which side of the Laffer curve the Caliphate is operating on, whereas b) and d) hold only if on the downward-sloping side. To evaluate the role of each of these variables, we introduce Egypt-level qualitative evidence. The evidence depicts the evolution in 641-847 of (proxies for) these four determinants, in order to specify qualitatively which one(s) is the most likely explanation. [49]

49. See Appendix Section C.1 for the data sources that are used in the local-level and Egypt-level evidence.

4.1 Local-level evidence

4.1.1 Data

Conversions Our first outcome is conversions, which we measure at the village level by a dummy variable that takes value 1 if a village did not have any Coptic church or monastery circa 1200. The list of villages is constructed from the 1477 cadastre. This variable arguably captures conversions between 641 and 1200 under the following assumptions: (1) Every village had at least one Coptic church or monastery in 641 (recall that all villages were 100% Copt in 641). While we cannot test this assumption, we note that in current-day Muslim-majority Egypt every village has at least one mosque. Also, aggregating our variable to the higher district level (which relies on a much weaker assumption) yields similar results. (2) If the vast majority of a village's population had converted by 1200, all its Coptic churches and monasteries would have been demolished or transformed into mosques. We have historical accounts of such events. We also obtain similar results if we employ an alternative list of Coptic churches and monasteries that dates back to 1500 (Appendix Table C.7), and if we use Copt population share in the 1848 population census (Saleh 2018). (3) No new churches or monasteries were built between 641 and 1200. This was actually dictated by Islamic law, which banned the construction of new churches or monasteries. (4) We observe the same set of villages in both 641 and 1200. This is supported by Ramzi (1954) who demonstrates that most villages in the 1477 cadastre date back to ancient Egypt. (5) There was no significant population movement across villages. This was enforced by the state that imposed restrictions on mobility in rural Egypt which lasted until 1857. People were not allowed to leave their villages, and if they did, they were forced to go back. The papyrological record has numerous cases of "fugitives" who fled their villages illegally to avoid taxation, and were forced to go back.

Appendix Figure C.3 shows the spatial distribution of this variable at the district level, i.e. the proportion of villages in each district that did not have any Coptic church or monastery in 1200. According to this measure, converts were already in the majority by 1200: the median district had 86% of its villages without any church or monastery (mean = 84%). But there was considerable heterogeneity; for example, conversions were more widespread in the eastern Delta.

Discriminatory and uniform taxes The second and third outcomes are poll and *kharaj* tax rates, the discriminatory and uniform taxes respectively starting from circa 750.[50] We collected individual-level data on poll and *kharaj* land tax payments in dinars from Egypt's papyrological tax registers and receipts in 641-1100. We excluded tax papyri from unknown locations, because we are not able to match them to *kuras*.

Tax papyri are subject to a few caveats. First and foremost, poll (and *kharaj*) tax records survived in only 4 (respectively, 8) out of 42 *kuras*, and about 95% of the records come from exactly two *kuras*, both located in the Nile Valley: *Ashmunayn* and *Qahqawa*, respectively known

50. Between 641 and circa 750, the Arabic term (*jizya*) meant "taxes in cash" that included both the poll tax and the cash land tax. The term was confined after the reform to mean the poll tax. The term (*kharaj*) was first used to describe the land tax in 776. We did not face this problem in our final tax papyri sample, though.

before 641 as *Hermopolis* and *Aphrodito*. Furthermore, we excluded *kharaj* tax records from 4 *kuras* with fewer than 4 records,[51] and we dropped 52 observations in *Ashmunayn* and *Qahqawa* with *kharaj* payment outliers (> 5 dinars per person). We chose 5 dinars per person as an upper bound on *kharaj*, in order to have a similar range of *kharaj* payments, and thus similar landholding distribution, across *kuras* (see the fourth caveat below).[52] Appendix Figure C.3 shows the location of *kuras* in our final sample. All *kuras* (except one in the case of the *kharaj* tax) are in the Nile Valley. Both the small number of *kuras* with surviving tax papyri, and their concentration in the Nile Valley, raise a natural concern about the representativeness of the tax papyri. While we are not able to increase the number of *kuras* with tax papyri, three remarks bolster our confidence in our tax papyri sample: (1) Papyri survived in certain areas but not others due to exogenous factors: the papyri of the Nile Valley were more likely to survive than those of the Delta, owing to the Valley's dry climate. Random events further uncovered papyri in specific locations within the Valley.[53] (2) We provide additional evidence on taxation, by examining a third tax outcome which we observe for all *kuras*: village-level total tax revenue per unit of taxable land in 1375 (see below). (3) We estimate the effects of tax authorities' religiosity on conversions (churches) in 1200 and on total tax revenue in 1375 within *kuras* with tax papyri, and the results are qualitatively similar to those for the full sample, thus lending support to the national representativeness of the two tax papyri samples (see Section 4.1.3 and Appendix Tables C.5 and C.6).

The second caveat about tax papyri is that most documents are dated within a range (a century or longer), rather than a specific date. We thus decided to pool all papyri in a single cross-section, and date them between 641 and 1100, without being able to distinguish between the pre- and post-750 periods. The only exception here is *Qahqawa* whose records belong to the pre-750 period, but even in this case, we decided to pool *Qahqawa*'s records with the other *kuras*, and date them between 641 and 1100, in order to have sufficient variation across *kuras*.[54]

Third, there are no data on *ushr*, the pre-750 uniform tax. However, this is likely due to the fact that the tax was not enforced by the state (see Section 2.2).

Fourth, *kharaj* records are payments on an individual's total landholding, and not per unit of land (landholding area is seldom recorded). Hence, using these records in the analysis relies on the assumption that *kuras* had the same landholding distribution.[55] Appendix Figure C.2,

51. The excluded *kuras* are *Dalas wa Abu-Sir* ($N = 2$), *Ihnas* ($N = 2$), and *Aswan* ($N = 1$) in the Nile Valley, and *Basta* ($N = 1$) in the Delta. Including these *kuras* in the analysis yields similar results.

52. Including these outliers gives us larger coefficients, yet with greater standard errors (less precision).

53. For example, the tax papyri of *Aphrodito* (*Qahqawa*), which has the largest number of observations in our sample, were discovered in 1901 by local farmers while digging a well. The papyri were then distributed among farmers, and the remaining documents ended up in museums, including the British Museum.

54. There is a concern that the cross-*kura* variation in tax rates may be attributable instead to the time variation in tax rates before and after 750. In particular, the pre-750 *kharaj* payments in *Qahqawa* were part of the discriminatory tax on non-converts (= poll tax + *kharaj* - *ushr*), whereas the post-750 *kharaj* payments in the other *kuras* are the uniform tax that was paid by both non-converts and converts. These two "*kharaj*" taxes may have thus been different due to the tax reform's abolition of the cap on the *kharaj* rate (see Section 2.2). To mitigate this concern, we note that the average (pre-750) *kharaj* payment in *Qahqawa* is close to the (post-750) rate in *Damsis* and *Fayum*, which suggests that the *kharaj* on non-converts before 750 was close in magnitude to the *kharaj* paid by both non-converts and converts after 750.

55. Al-Nabulusi reports village-level data for *Fayum* under the Ayyubids (1171-1250) on total *kharaj* revenue, among a whole set of miscellaneous taxes, but he does *not* record the total area of landholdings, and so it is not

which shows the frequency histogram of individual tax payments by *kura*, suggests that this is a plausible assumption, when we exclude the *kharaj* payment outliers (> 5) in *Ashmunayn* and *Qahqawa*. The distribution of poll and *kharaj* tax payments is skewed to the right in all *kuras*. Furthermore, in *Ashmunayn* and *Qahqawa*, poll tax payments range from 0 to 8, and *kharaj* tax payments from 0 to 5, but the ranges are smaller in the other *kuras* due to their smaller sample size. *Ashmunayn* has, on average, higher poll and *kharaj* tax payments than *Qahqawa*.

Total tax revenue Because of the tax papyri limitations, and the potential endogeneity of local budget requirements, we provide further evidence on taxation by examining an additional outcome: total tax revenue (we do not have localized data though on the revenue from discriminatory and uniform taxes separately). We collected village-level data on state valuation of total tax revenue (*'ibra*) per unit of taxable land from the cadastral surveys of 1375 and 1477. The *'ibra* was the state's estimate of the tax worth of each village when assigned to tax contractors. [56] A village's *'ibra* was equal to the sum of its estimated revenues from the poll tax, the *kharaj* tax, and the other miscellaneous taxes. Tax contractors paid this "price" in advance to the state, and were residual claimants of the actual total tax revenue (which we do not observe). Conducted under the Mamluks (1250-1517), the 1375 and 1477 cadastres are the earliest extant data source on the (estimated) total tax revenue and taxable area of every Egyptian village. Although these are *estimates* from a later period, they can be arguably used as a proxy for the *actual* total tax revenue under the early Arab Caliphate. Essentially, the state started to record estimates of tax revenue, instead of the actual revenue, with the shift from direct state taxation to tax contracting, which took place under the Fatimids (969-1171). Hence, the estimates from 1375 and 1477 were arguably based on the actually collected tax revenue before the shift to tax contracting, i.e. under the early Arab Caliphate. [57]

Religious composition of tax authorities Our main regressor is the religious composition of local tax authorities, which we proxy for at the *kura* level by a dummy variable that takes value 1 if at least one Arab tribe settled in the *kura* between 700 and 969. Arab settlement arguably captures the share of Arabs in the local tax administration of each *kura*. Before 700, (non-convert) Copts were in charge of the local tax administration. With the rise in Arab permanent settlement in rural Egypt between 700 and 969, they replaced local Coptic elites as large landholders, tax administrators, and headmen in *kuras* where they settled. Consequently, these *kuras* faced a larger share of Arab (Muslim) tax administrators, compared to *kuras* where Arabs did not settle

possible to compute *kharaj* per unit of land from this source.

56. *'Ibra* was recorded in *jayshi* dinars; a hypothetical unit of account $\equiv 13.3/20$ dinars.

57. For one, cadastres, by which the state collected data on taxable area and (estimates of) tax revenue, were exceedingly rare due to their high cost, taking place once every century. Ramzi (1954) lists only 6 cadastres between 641 and 1375 in the following years: 729, 869, 1079, 1177, 1298, and 1315. Only the first two cadastres took place before the shift to tax contracting, and hence recorded the actually collected tax revenue. For another, estimates of tax revenue after the shift to tax contracting were sticky over time, hardly changing from one cadastre to the next. The village-level correlation between the *'ibra* per unit of taxable land in 1375 and 1477 is 0.92, although a century had elapsed between the two cadastres. The 1375 and 1477 cadastres were in fact updates of the 1315 cadastre (which did not survive), yet they did *not* update the 1315 data on the taxable area.

and Coptic elites thus remained in charge of the tax administration. Notice though that we do not have a measure of religiosity among Arab tax administrators, i.e. at the *intensive* margin.[58] Appendix Figure C.3 shows the locations of Arab tribes. Arabs were more likely to settle in the eastern and western Delta than in the central Delta, and in the northern Nile Valley than in the south.

Control variables We control for Copt religiosity and income before 641, as suggested by our model. As a proxy for Copt religiosity, we use a dummy variable that takes value 1 if it is believed, according to Coptic traditions, that a village was visited by the Holy Family during its legendary biblical flight to Egypt. The list of villages that lie on this route is based on a book that is attributed to Theophilus, the patriarch of Alexandria in 384-412. However, since the book's date is debated with some scholars dating it to the post-641 period, this variable must be interpreted with caution. We still prefer to include it as a control variable, because the invention of the route likely reflected pre-641 beliefs about the religious prominence of certain locations, due to their saints and martyrs, or their biblical mentions. In fact, the route was first mentioned in Roman-era sources that even precede Theophilus. The legendary route was an important belief (and a source of pride) for the average Copt both historically and today.[59] As a proxy for Copt income, we employ the natural logarithm of urban population circa 300. Urban population is defined as the sum of the population of Greek cities (metropolis) and the capital of each *nome* (Egypt's administrative units during the Roman period). Using urbanization as a proxy for income is standard in the economic history literature, since urban populations were richer on average.

4.1.2 Empirical strategy

We first examine the effects on taxation and conversions of the religious composition of tax administrators, where we estimate a separate regression for each outcome.[60] We first treat Arab settlement as exogenous, and estimate the following regressions using Ordinary Least Squares:

$$conversion_v = \beta_0^1 + \beta_1^1 settlement_k + X_{vk}\beta_2^1 + \epsilon_v^1 \tag{5}$$

$$tax_i = \beta_0^2 + \beta_1^2 settlement_k + X_k\beta_2^2 + \epsilon_i^2 \tag{6}$$

58. We are not able to use the standardized difference between the number of religious and secular buildings (as in Chaney (2013)) as a measure of religiosity of tax authorities at the local level, because data on religious and secular buildings are *not* representative of *kuras* outside Cairo.

59. If the route was invented before 641, the possibility of self-sorting of pious (non-convert) Copts to locations on the route, or of claiming the Holy Family visit by locations that were pious before Christianity, are not concerns per se. Our goal here is to provide a plausible measure of the average level of psychological attachment to Coptic Christianity of the local Coptic population before 641. If non-convert Copts were more likely to move to these locations, this will probably increase the average piety of the local population of these locations, but will not change how we interpret the variable. If the Holy Family visited initially pious locations, it still remains a plausible measure as it will capture the persistence of "piety" both before and after the first century CE.

60. We do not estimate a system of simultaneous equations which allows for correlation of the error terms across equations, because each equation is estimated using a different sample.

$$taxrevenue_v = \beta_0^3 + \beta_1^3 settlement_k + X_{vk}\beta_2^3 + \epsilon_v^3 \quad (7)$$

where $conversion_v$ is a dummy variable that takes value 1 if there was not any Coptic church or monastery circa 1200 in village v in *kura* k; tax_i is the poll or *kharaj* tax in dinars paid by individual i in *kura* k in 641-1100, $taxrevenue_v$ is state valuation of total tax revenue per unit of taxable land in 1375. The main regressor is $settlement_k$; a dummy variable that takes value 1 if at least one Arab tribe settled in *kura* k between 700 and 969.

In line with the determinants of our model, we control for proxies of Copt religiosity and income. Specifically, the vector X includes: (1) a dummy variable indicating if an area is believed to have been visited by the Holy Family during its biblical flight to Egypt [61], and (2) the logarithm of urban population of *kura* k circa 300 (see Section 4.1.1). We argue that the remaining determinants of outcomes in Table C.1 (uncertainty about Caliphate rule, threat of rebellion, and the *de jure* cap on the uniform tax), are unlikely to vary locally. [62] First, all *kuras* likely faced the same external challenges to Arab tenure. Because the Nile Valley and Delta lacked natural barriers, all *kuras* were subject to Arab central power in *Fustat*, and faced the same threat of (re)conquest by neighboring non-Muslim empires. The main exceptions here are frontier cities that switched hands between empires, such as Aswan at the southern border that was constantly under the threat of Nubians, and Alexandria that was threatened by the Byzantines. These frontier *kuras* are *not* included in the empirical analysis, though. Second, even though local Coptic elites may have resisted Arabs passively via adopting a more lenient tax enforcement towards taxpayers in their constituencies, they were not able to pose a threat of active (militant) rebellion that could drive Arabs out of power, unless they coordinated with elites in other *kuras*. Indeed, all tax revolts that did take place in Egypt involved multiple *kuras*. Third, the *de jure* cap on the uniform tax before 750, the *ushr* rate, was imposed universally on all *kuras* in Egypt, and in fact throughout the whole Caliphate. After 750, the cap on the uniform tax was removed universally too.

Standard errors are clustered at the *kura* level, the level of aggregation of our main regressor, Arab settlement. However, since the number of *kuras* (clusters) is only 4 in equation (6), this may bias the standard errors downwards (Cameron et al. 2008). [63] We thus estimate the p-values in equation (6) using the Wild Cluster Restricted (WCR) bootstrap for the OLS regressions, where we follow the procedures in MacKinnon and Webb (2018) and MacKinnon et al. (2018).

4.1.3 Findings

Conversions We first analyze the effect of the religious composition of local tax authorities on Copt conversion to Islam. Columns (1)-(4) in Table 1 shows that villages located in *kuras* that received Arab tribes in 700-969 were more likely to have no Coptic churches or monasteries in 1200 by 8 percentage points compared to 75% in *kuras* where Coptic elites remained in power.

61. This variable is measured at the village level, except in equation (6) where it is observed at the *kura* level.
62. Note that we treat the local budget (which is a determinant in our model) as an outcome in equation (7).
63. This is less of a concern though in equations (5) and (7), where the number of clusters (40-42 *kuras*) exceeds the 30-clusters threshold.

Since all *kuras* were (almost) 100% Copt before 641, this finding suggests that *kuras* where Arabs settled witnessed relatively more conversions to Islam between 641 and 1200. Furthermore, villages located in *kuras* that lied on the Holy Family route, and thus had more religious Coptic taxpayers, were less likely to convert (have no Coptic churches or monasteries) by 1200. The effect of urbanization on conversion is not statistically significant, by contrast. Including all regressors in column (4) yields similar results to those in columns (1)-(3). We interpret the positive effect of Arab settlement on conversions as consistent with the model (Appendix Table C.1). The theory is indeterminate, however, with respect to the effects of Copt religiosity and income, and so our findings in this respect neither confirm nor infirm the model.[64]

Finally, to evaluate the representativeness (or lack thereof) of *kuras* with poll and *kharaj* tax papyri, we estimated the effects on conversions within these *kuras* only, and we obtained qualitatively similar results to those for the full sample (Appendix Table C.5).

Table 1 – **Arab settlement, conversions in 641-1200, and total tax revenue in 1375**

	=1 if no Coptic church or monastery in 1200				State valuation of total tax revenue per unit of taxable land in 1375			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
=1 if Arab settlement	0.082			0.077	-0.093			-0.195
	(0.033)**			(0.033)**	(0.311)			(0.314)
=1 if on H. Family route		-0.597		-0.600		0.975		0.874
		(0.081)***		(0.080)***		(0.436)**		(0.449)*
Log (urban population)			0.022	0.016			0.418	0.431
			(0.026)	(0.029)			(0.282)+	(0.284)+
Obs (villages)	1817	1817	1817	1817	1543	1539	1543	1539
Clusters (*kuras*)	42	42	42	42	40	40	40	40
R^2	0.01	0.03	0.00	0.04	0.00	0.00	0.01	0.01
Mean dep. var.	0.84	0.84	0.84	0.84	3.45	3.45	3.45	3.45

Notes: Tax revenue (*'ibra*) is in *jayshi* dinars (≈13.3/20 dinars) per *feddan* (= 6,368 square meters) of taxable land. Standard errors clustered at the *kura* level are in parentheses. * p <0.10, ** p <0.05, *** p <0.01. A constant is included in all regressions.
Sources: See Appendix Section C.1.

Discriminatory tax The findings with respect to the discriminatory tax are shown in columns (1)-(4) of Table 2. Within the 4 *kuras* for which we have poll tax papyri, individuals in *kuras* where Arabs settled in 700-969, and were thus subject to a higher share of Arab tax administrators, paid on average a higher poll tax in 641-1100 by 0.29 dinar (25% of the average poll tax), than those in *Qahqawa* where Arabs did not settle and Coptic elites remained in charge of the local tax administration. This amounts to 3% of the annual wage of the low-income poll tax bracket

64. Estimating the effect on the non-presence of Coptic churches and monasteries in 1500, yields similar results to those for 1200, but the effect of Arab settlement is weaker (Appendix Table C.7). This is likely because (a) Arabs were no longer tax administrators under the Mamluks (1250-1517); in fact, Arab settlement subsided after 969 as they lost their privilege as a military aristocracy to Turks, and (b) conversions between 1200 and 1500 were likely driven by other causes in addition to taxation, including the state persecution of Copts.

(manual low-skilled workers) in 661-969, and 29% of the *de jure* annual poll tax on that bracket (=1 dinar). Furthermore, we find that taxpayers in *kuras* that lied on the legendary route of the Holy Family, and thus had more religious Coptic populations, paid 25% more of the average poll tax obligation. Taxpayers in more urbanized *kuras* (measured circa 300) also paid a higher poll tax by 0.13 dinar (11% of the average poll tax). The results hold qualitatively but lose their statistical significance, when including the three determinants in the same regression in column (4), due to the high multicollinearity between regressors and the small number of *kuras*. But whereas the coefficients on the Holy Family route and urbanization have much smaller magnitudes than when entered separately, the coefficient on Arab settlement retains its magnitude. We interpret the positive coefficients on Arab settlement and the Holy Family route as consistent with the predictions of the model in Table C.1. The theory is indeterminate though with respect to the effect of Copt income, and hence the finding of a positive coefficient on urbanization does not confirm or infirm the model.

Table 2 – **Arab settlement and tax rates in 641-1100**

	Poll tax in dinars per person				*Kharaj* tax in dinars per person			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
=1 if Arab settlement in 700-969	0.290			0.214	0.361			0.528
	[0.009]***			[0.577]	[0.021]**			[0.654]
=1 if *kura* on Holy Family route		0.285		0.007		0.346		0.062
		[0.111]$^{+}$		[0.343]		[0.461]		[0.157]
Log (urban population) circa 300			0.131	0.032			0.159	-0.101
			[0.079]*	[0.291]			[0.116]$^{+}$	[0.139]$^{+}$
Obs (individuals)	408	408	408	408	408	408	408	408
Clusters (*kuras*)	4	4	4	4	4	4	4	4
R^2	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.02
Mean dep. var.	1.14	1.14	1.14	1.14	1.40	1.40	1.40	1.40

Notes: The number of individuals is identical ($N = 408$) in both the poll tax and *kharaj* tax samples. This is by chance. They are different samples and from different locations. P-values are in brackets: These are estimated using Wild Cluster Restricted (WCR) bootstrap, with clustering at the *kura* level, Webb weights, and 999,999 replications. $+$ p <0.15, * p <0.10, ** p <0.05, *** p <0.01. A constant is included in all regressions.
Source: See Appendix Section C.1.

Uniform tax The results on the uniform tax are shown in columns (5)-(8) of Table 2. These results must be interpreted with caution since *kharaj* payment is on an individual's total land-holding, and not per unit of land, and thus, any effects are attributable to the cross-*kura* variation in both the *kharaj* rate per unit of land *and* the distribution of landholdings. We observe that taxpayers in *kuras* that received Arab tribes in 700-969 paid a higher *kharaj* tax by 0.36 dinar (26% of the average *kharaj*). Assuming that land distribution is the same across the 4 *kuras* for which we have *kharaj* papyri, we interpret this result as consistent with the model, if the optimal discriminatory tax was on the downward-sloping side of the Laffer curve. However, we note that if *kharaj* payment captures the cross-*kura* variation in land distribution, rather than the tax per

unit of land, this result would suggest that Arabs settled in *kuras* with a bigger share of large landholdings (higher land inequality). The results also reveal that being on the Holy Family route did not have a statistically significant impact on the uniform tax, but that *kuras* that were more urbanized during the Roman period paid a higher *kharaj* tax by 0.16 dinar (11% of the average *kharaj*). However, the theory is indeterminate with respect to these two effects (unless we impose further assumptions), and so we do not interpret the coefficients on Copt income and religiosity as confirming or infirming the model. When we include all three regressors in the same regression in column (8), the coefficient on Arab settlement remains positive, but loses its statistical significance.

Total tax revenue Given the limitations of the tax papyri evidence, we introduce additional evidence from village-level data on state valuation of total tax revenue (*'ibra*) per unit of taxable land (*feddan*) in 1375, which is observed for all *kuras*. The results are shown in columns (5)-(8) in Table 1.[65] Consistent with our analysis of the delegated budget collection in Section 3.3, we find a negative, yet statistically insignificant, association between Arab settlement in 700-969 and total tax revenue per unit of taxable land. This suggests that the land tax was used to partially offset fluctuations in poll tax revenue, but the complementarity between the two taxes was not perfect, potentially because of the convexity of the land tax collection cost. Being on the Holy Family route (Copt religiosity) and urbanization during the Roman period (Copt income) are both positively associated with the estimated total tax revenue per unit of taxable land in 1375. The positive effect of Copt religiosity is consistent with our theoretical predictions. Indeed, these findings suggest that more religious and richer villages were "over-taxed," in the sense that the land tax did not decrease enough to completely offset the higher poll tax revenue in these areas, thus yielding a higher total tax revenue.

We also estimated the effects on total tax revenue in 1375 within tax papyri *kuras* only (Appendix Table C.6). We obtained qualitatively similar results to those for the full sample in the case of the *kharaj* tax papyri, but not in the case of the poll tax papyri.

4.1.4 Caveats to the local-level evidence

Our findings suggest that Coptic taxpayers in Arab-settled areas paid a higher discriminatory tax and witnessed more conversions to Islam. Tax administrators in these areas compensated (partially) for the revenue loss by increasing the uniform tax. This interpretation is consistent with the predictions of our model when the discriminatory tax is on the downward-sloping side of the Laffer curve. There are two caveats to this interpretation, though. The first is that Arab settlement may not be capturing the religious composition of the local tax administration. The second is the potential endogeneity of Arab settlement.

65. Results for the following cadastral update in 1477 are similar to those in 1375 (Appendix Table C.8).

Measurement error Arab settlement may not capture the share of Arabs among local tax administrators, or their average (Muslim) religiosity. First, Arabs were Muslims, and hence their settlement may merely reflect a mechanical effect on Islamization. However, Egypt's Islamization was mostly due to conversions rather than demographic factors. Arab immigration was small relative to the Egyptian population, and Muslims (both Arabs and converts) did not have higher fertility or lower mortality than non-converts (see Appendix Section A.2).

Second, Arab settlers may have coerced people to convert. And even if not, violence may still have been necessary to enforce the discriminatory tax, which was presumably unpopular. We think that this is an unlikely interpretation because: (1) Coerced conversions were rare. Coptic chronicles from the 7^{th} and 9^{th} centuries do not contain any narratives of forced conversions, although they do mention waves of tax-induced conversions. (2) Although the tax was unpopular, it is not certain that the individual tax burden was higher under the Arabs than the Byzantines, which would have required extra violence by Arabs. (3) Arabs controlled Egypt via capturing the Byzantine garrisons. We control for the presence of Byzantine garrisons circa 600 as a measure of Arab military presence in Appendix Table C.2, and Arab settlement retains its effect.

Third, Arab settlement may reflect higher state capacity. Arab tax administrators were presumably more loyal to the state than their Coptic counterparts. Yet, the negative (or null) effect of Arab settlement on total tax revenue in Table 1 rules out this interpretation. If higher state capacity is what drives the positive effects of Arab settlement on both poll and *kharaj* taxes in Table 2, we should observe a positive effect on total tax revenue, which is not what we find.

Fourth, Arab settlers may have persuaded taxpayers in their constituencies of the attractiveness of Islam, thus inducing more conversions. But this does not explain why these areas faced higher discriminatory and uniform taxes.

Endogeneity of Arab settlement *(a) Additional controls.* The identification assumption in equations (5)-(7) is that the cross-*kura* variation in Arab settlement is exogenous to baseline characteristics of *kuras*, which may be driving both conversions and taxation. This assumption may be violated due to (1) reverse causality: Arab settlers may have settled in *kuras* with higher taxes or larger convert populations, and (2) omitted variables: Arab tribes may have settled due to other unobservable pre-641 characteristics of *kuras* that can also account for variation in conversions and taxes.

To mitigate this concern, we first control for an additional set of variables, which are inspired by alternative theories of Islamization and taxation in the literature.[66] First, Michalopoulos et al. (2018) show that Islamization was correlated with lower land productivity and higher land inequality. They argue that this because of the latter's redistributive institutions that mitigated the incentives for predation in these areas. To account for local variation in land productivity, we control in all our regressions for wheat yield per *feddan* in 1844.[67] The results are shown

66. We are not able to include all the additional controls in the poll and *kharaj* taxes regressions (equation (6)), because of the perfect multicollinearity with some of our regressors given the small number of *kuras*.

67. Although our measure comes from 1844, we argue that it is a good measure for three reasons: (1) This is the

in columns (1)-(8) in Appendix Table C.2 and the coefficient on Arab settlement retains its magnitude. To account for the impact of land inequality on conversions, we include a dummy variable that equals 1 if there was at least one *autopract* estate in a given *kura* circa 600; the *autopragia* was a privilege granted to large landholders in late Byzantine Egypt allowing them to pay taxes directly to the capital and to collect taxes in their constituencies. It can be thus used to capture the degree of land concentration in each *kura*. The results are shown in column (3) in Appendix Table C.2 and are qualitatively similar to those in Table 1.

Second, Kuran (2012) argues that the *waqf* system, a tax-exempt religious endowment that enabled landholders to protect their property rights against arbitrary confiscation by the state, was one reason behind the economic stagnation of the region, as they locked in capital in unproductive investments. While land confiscation was prohibited after the Arab conquest, it became more common under the Mamluks (1250-1517).[68] One may thus argue that Arab-settled areas may had lower tax revenue in 1375, because more land was dedicated to *waqf* and thus paid no tax. This is not the case though for two reasons: (1) we measure tax revenue per unit of *taxable* land, i.e. we exclude tax-exempt land from the denominator, and (2) we control for the share of tax-exempt land in column (8) in Table C.2 and Arab settlement retains its (negative) effect.

Third, an alternative specification would allow Arab settlement effects to vary with the level of Copt religiosity. We control for the interaction term in columns (2)-(3) and (7)-(8), and the results are qualitatively similar to the original results, while the interaction term itself is mostly statistically insignificant.

(b) Instrumental Variables. Our second approach to deal with the potential endogeneity of Arab settlement is to employ an instrumental variable (IV) methodology, where we predict Arab settlement from the following first-stage regression:

$$\begin{aligned} settlement_k = \; & \alpha_0 + \alpha_1 DistancetoArish_k + \alpha_2 BorderDesert_k \\ & + \alpha_3 (DistancetoArish_k \times BorderDesert_k) + X_k \alpha_4 + v_k \end{aligned} \tag{8}$$

where $DistancetoArish_k$ is *kura*'s distance to *Arish*, a small town in the Sinai peninsula close to Egypt's northeastern borders, that was the first to be captured by Arabs in 639 due to its proximity to the Arab peninsula (the Arab Conquest was by land from the northeast); $BorderDesert_k$ =1 if a *kura* borders desert land, which is the case for all *kuras* except those in central Delta (see Appendix Figure C.9).[69] Columns (1)-(3) in Appendix Table C.3 suggest that the IVs are relevant:

earliest localized measure of agricultural productivity for Egypt that we are aware of. It is thus superior than the widely used Food and Agriculture Organization Global Agro-Ecological Zones (FAO-GAEZ)'s measure of potential crop suitability that is based on the period 1961-1990. (2) Our measure captures wheat yield under basin irrigation that used the natural Nile inundation (and not under the post-1800 perennial irrigation that used the post-1800 summer canals). Basin irrigation was the predominant method of irrigation used in rural Egypt up to 1800, and local variation in productivity in basin-irrigation areas changed little over time. (3) The FAO-GAEZ measure of potential wheat suitability under low-input irrigation-based cultivation shows no variation within Egypt. Rain-fed cultivation shows all of Egypt as unsuitable for wheat cultivation. This is not surprising given that Egypt does not receive a significant amount of rainfall.

68. Caliph Umar I (reigned from 634 to 644) prohibited Arabs from confiscating land in conquered territories. Consequently, the vast majority of land remained in the hands of the local (non-Muslim) populations (Sijpesteijn 2013, p. 81), on which the *kharaj* land tax was levied. Only public domain and royal (Byzantine or Persian) land was confiscated by, and distributed among, Arabs (Dennett 1950, p. 69), on which the *ushr* land tax was levied.

69. While we are able to use both variables and their interaction term as IVs in equations (5) and (7), where we

Arabs were more likely to settle in *kuras* closer to both *Arish* and desert land. For one, proximity to *Arish* largely determined the extent to which Arabs were willing to travel, although there were exceptions to this rule.[70] For another, Arabs preferred *kuras* that bordered desert land, where they practiced hunting and horse riding and enjoyed having a similar environment to that of the Arab peninsula, and hence *kuras* in central Delta were less attractive to them. Furthermore, we argue that both distance to *Arish* and bordering desert are valid IVs: They are exogenous, because they are determined by geography, and they arguably satisfy the exclusion restriction, once we control for Copt religiosity and income.[71] The results are shown in Appendix Table C.4, and the effect of Arab settlement retains its magnitude.

4.1.5 Summary

The local-level evidence is broadly consistent with the model. Muslim religiosity of tax authorities, as captured by Arab settlement in 700-969, has positive and statistically significant effects on the discriminatory tax and conversions. Using the model's notation, ruler religiosity in *kura* 1 that received Arab settlers (e.g., *Ashmunayn*) is greater than in *kura* 2 that did not (e.g., *Qahqawa*), *ceteris paribus*: $V_1'(\theta^*)>V_2'(\theta^*)$. The difference in discriminatory tax revenue per capita between *kuras* 1 and 2 is $R(\tau_1) - R(\tau_2) = \tau_1[1 - F(\tau_1)] - \tau_2[1 - F(\tau_2)]$. Evaluating this difference using the predicted values of Copt population share and the discriminatory tax from the IV regression results in Appendix Table C.4 yields: $[1.36\times(1-0.87)]-[(1.07\times(1-0.75)] = -0.09$. This implies that the optimal poll tax lied on the downward-sloping side of the Laffer curve; *kura* 1, where Arab settlers imposed a higher poll tax, had *lower* poll tax revenue per capita by 0.09 dinar (9% of the average), due to the more extensive conversions among its Coptic population.[72] The findings also imply that the demand for conversion was elastic with respect to the poll tax: $[(F(\tau_2) - F(\tau_1))/F(\tau_1)] \div [(\tau_2 - \tau_1)/\tau_1] = [(0.25 - 0.13)/0.13] \div [(1.36 - 1.07)/1.07] = 3.41$.

The positive effect of Arab settlement on the *kharaj* tax suggests that tax authorities compensated for the decline in the poll tax revenue by increasing the uniform tax that was paid by both converts and non-converts, although we cannot rule out that the effects may be attributable to cross-*kura* differences in landholding distribution. Our IV estimates in Appendix Table C.4 suggest that $\lambda_1 L_1 - \lambda_2 L_2 = 1.65 - 1.31 = 0.34$, where L is the average landholding per person

observe all 42 *kuras*, we use only $DistancetoArish_k$ as an IV in equation (6), because all tax papyri *kuras* (except one) are bordered by desert. We further had to drop the vector X_k from the IV regression in equation (6), because of the almost perfect multicollinearity between distance to *Arish* and the controls in the first stage.

70. Regardless of the distance to *'Arish*, Arabs were more likely to settle closer to frontier towns such as *Aswan* in the south and Alexandria in the north. Also, Arabs were more likely to settle in western Delta than in central Delta, which is closer to *'Arish*, arguably due to western Delta's proximity to desert land.

71. Appendix Table C.3 reveals that *kuras* that were further away from *Arish* were less likely to be on the Holy Family legendary route, but did not differ from other *kuras* with respect to urbanization during the Roman period, or the presence of Byzantine garrisons on the eve of the Arab conquest. *Kuras* in the central Delta (which did *not* border desert) were more likely to be on the Holy Family route and had a larger urban population circa 300, but were not different from other *kuras* with respect to Byzantine defenses.

72. Extrapolating the findings to the continuous case, the elasticity of the poll tax revenue per capita with respect to tax authorities' religiosity is: $\frac{V'(\theta^*)}{R(\tau)} \times \frac{\partial R(\tau)}{\partial V'(\theta^*)} = \frac{V'(\theta^*)}{\tau[1-F(\tau)]} \times \frac{\partial \tau[1-F(\tau)]}{\partial V'(\theta^*)} = \frac{V'(\theta^*)}{\tau[1-F(\tau)]} \times \{\frac{\partial \tau}{\partial V'(\theta^*)} \times [1 - F(\tau)] + \frac{\partial[1-F(\tau)]}{\partial V'(\theta^*)} \times \tau\}$. Evaluating this elasticity using the IV point estimates in Appendix Table C.4 at the sample means of Arab settlement, poll tax, and Copt population share yields: $\frac{0.75}{1.14\times0.16} \times \{0.29\times0.16+(-0.12)\times1.14\} = -0.37$.

in the *kura*: *Kharaj* per unit of land in *Ashmunayn* was higher than in *Qahqawa*, if the land distribution was the same in the two *kuras*.

We further examine the effect of religiosity of tax authorities on total tax revenue per unit of taxable land in 1375. We observe a negative yet statistically insignificant effect, suggesting that local tax authorities used the uniform tax to partially compensate for changes in poll tax revenue.

Finally, as predicted by the model, we document that Copt religiosity, measured by the legendary route of the Holy Family, has a positive and statistically significant impact on the poll tax rate. Copt religiosity is also positively correlated with total tax revenue, which is consistent with our theoretical predictions under delegated budget collection.

4.2 Egypt-level evidence

We are not able to provide econometric evidence at the level of Egypt on the determinants of conversions and taxation over time, because we only observe these outcomes at a few scattered points in time (Appendix Figures A.1, A.3, and A.4). However, our model can help explain the Caliphate-wide tax reforms circa 750 that increased the *de jure* uniform land tax from the *ushr* to *kharaj* rate, and removed the treaty-based upper ceiling on *kharaj* that (presumably) existed in certain conquered territories including Egypt prior to 750 (Figure A.4).[73] Our model explains this fiscal policy change by an increase in Caliph religiosity, and/or budgetary needs, and/or by a decrease in uncertainty about Caliphte tenure, and/or the threat of rebellion. We note here that the local-level evidence in the previous section lends support to the discriminatory tax being on the downward-sloping side of the Laffer curve. This enables us to focus on the predictions of *positive* effects on the uniform tax of Caliph religiosity and the threat of rebellion, which hinge upon this assumption. In this section, we document the evolution of proxies for these variables from 641 until the end of the First Abbasid Period in 847. We then assess whether one (or more) of these determinants can account for the tax reform of 750. Nevertheless, since the reform was a Caliphate-wide one-time policy change, it is not possible to formally disentangle the effects of these variables, and we thus rely on theory and history.

4.2.1 Data

We measure *Caliph religiosity* by two proxies: (1) a dummy variable that takes value 1 if the Caliph ruling in a given year is *not* known for holding palace literary and music parties that involved drinking alcohol with his companions (*munadama*), and (2) the difference between the standardized number of religious and secular buildings built in a given year, from Chaney (2013).[74] We measure *budgetary needs* by the yearly number of major military battles initiated

73. We do not observe the trends of conversions and the discriminatory tax before and after 750. For one, we only have reliable estimates of non-Muslim population share in 641 and 1200, but not in between. Courbage and Fargues (1997)'s estimates for 641-813 rely on the too strong assumption of perfect tax enforcement (Figure A.1). For another, we cannot compare the *de jure* discriminatory tax before and after 750, because it started to be imposed in three brackets from 750 on, and we do not observe the distribution of the tax base (Figure A.3).

74. We do not observe the size of each building, but given that we are interested in the change over time of the difference between the number of religious and secular buildings, this concern is arguably mitigated.

by the Caliphate against its (non-Muslim) neighboring empires; funding foreign conquests was presumably the largest expenditure on the Caliphate's budget. *Uncertainty about Caliphate rule*, which stems from *external* threats to the Caliphate is captured by the yearly number of major military battles that were initiated by (non-Muslim) neighboring empires against the Caliphate. This variable is correlated with the *internal threat of rebellion*, because taxpayers are more likely to rebel when there is a foreign attack on the Caliphate. Hence, we interpret foreign attacks as capturing both external and internal threats. We also use two additional measures of the *threat of rebellion*: (1) a dummy variable that takes value 1 if there was a major civil war in a given year that threatened the Caliphate tenure, and (2) a dummy variable that takes value 1 if the Nile level in a given year fell in the top or bottom 5% of the Nile maximum levels in 641-1517 (Chaney 2013). The rationale behind using these two measures is that taxpayers are presumably more likely to rebel, if there is a civil war within the Caliphate that might weaken its grip on Egypt, and if agricultural output witnesses an adverse shock (too high or too low a Nile level) that makes taxpayers less likely to meet their tax obligations. [75] [76]

4.2.2 Findings

Caliph religiosity Appendix Figure C.5 shows the evolution of our two proxies of Caliph religiosity. First, the Rashidun and Umayyad Caliphs in 641-750 were less likely to organize palace parties (i.e. were more religious) than their Abbasid successors in 750-847. Put differently, based on this proxy, we fail to find evidence on an increase in Caliph religiosity at the time of the tax reform. Second, there is little variation in the difference between (the standardized number of) religious and secular buildings in 641-847. This is probably due to data limitations, since most recorded buildings belong to later episodes. But with this caveat in mind, this variable does not suggest either an increase in Caliph religiosity at the time of the reform.

Budgetary needs Appendix Figure C.6 shows that our proxy of the Caliphate's budgetary needs, the yearly number of military battles that were initiated by the Caliphate against its neighboring empires, in fact *dropped* after 750. This is not surprising as most major conquests of the Caliphate took place during the Rashidun and early Umayyad periods. Thus, based on this proxy we do not find evidence on an increase in budgetary needs at the time of the reform.

Uncertainty about Caliphate rule and threat of rebellion Appendix Figure C.7 shows our proxy of the uncertainty about Caliphate rule (foreign attacks), and our three proxies of the threat of rebellion (foreign attacks, civil wars, Nile shocks). First, major military attacks by neighboring empires (mostly, the Byzantines) dropped after 750. Second, civil wars were commonplace in 641-750, and in two historical incidents, rival Caliph(ate)s seized control: the Umayyads, starting from 661, and Ibn al-Zubayr (temporarily) in 684-685. Although civil wars within the Caliphate continued to take place after 750, they dropped on average as the Abbasids

75. We are grateful to Roberto Galbiati for his suggestions in this regard.
76. Nile shocks may also capture *Copt income*, though, since the Nile level determined agricultural output.

were able to consolidate their power. Third, Nile shocks do not show, by contrast, any change in trend before and after 750. Overall, the first two findings suggest that uncertainty about Caliphate rule and the threat of rebellion of Egyptian taxpayers both declined. According to our model, this decrease may account for the tax reform circa 750. As the probability of a foreign (re)conquest, and of the threat of rebellion triggered by civil wars within the Caliphate, both decreased, the Caliphate became more daring to raise the uniform tax on converts.

4.2.3 Alternative explanations of the tax reform

There are alternative explanations of the tax reform. First, one can argue that the fall in tax revenue was the reason behind the Umayyad civil war in 744-750, and their subsequent fall in 750. The Umayyads may have been unwilling to experiment with the reform because they did not want to tax Arabs, but the Abbasids were more willing to do so and thus initiated the reform. This interpretation is not sufficient though in our view. It does not explain why the Umayyads let tax revenue fall and did not remedy the problem by reducing the discriminatory tax. That said, explaining the political regime change from the Umayyads to the Abbasids, while allowed (exogenously) in our model, lies beyond the scope of our paper.

A second explanation attributes the reform to the decline in discrimination (price or non-price) against non-Arab Muslims under the Abbasids. We offer two arguments here. First, our model does not distinguish between Arabs and non-Arab converts among taxpayers. All Muslim taxpayers in our model are (non-Arab) converts, while Arabs are the Caliphate or the ruler. We think that this is plausible because Arabs did not form a large taxbase in Egypt. Second, we think that the decline in "Caliph religiosity" in Appendix Figure C.5 may be interpreted more broadly as an increase in tolerant (religion-neutral) policies under the Abbasids.

4.2.4 Summary

We interpret the Egypt-level evidence as suggestive of the role of the decline in external and internal threats to the Caliphate in driving the increase in the uniform tax around 750. The population share of converts grew between 641 and 750, thus probably depressing the threat of rebellion even further. Although the tax reform changed the religious composition of rebels in Egyptian tax revolts to now include both converts and non-converts, instead of non-converts alone, which had been the case in the pre-reform revolts (Appendix Figure C.8), the Abbasids eventually managed to suppress the post-reform revolts by violence, and thus kept the new tax system intact.

5 Conclusion

The paper made two contributions. It first developed a simple model of optimal one-shot and repeated taxation/extraction by a government or a corporation that trades off its hostility towards a group's identity and its reluctance to let exile, conversions or quits erode the contribution base. It

provided a set of comparative-statics results (summarized in Table C.1) on how discriminatory and non-discriminatory taxes and the erosion of the contribution base are impacted by the ruler's and the governed's identity preferences. Changes in these explanatory variables as well as uncertainty about the ruler's tenure generate interesting fiscal and identity dynamics. The paper identified which results are sensitive to being on the downward-sloping side of the Laffer curve. Finally, it noted that the permanent loss of identity dampens one's incentive to rebel, and showed that the threat of rebellion against fiscal extraction peters out over time, even when those who have altered their identity stay in the constituency (as is the case for religious conversions).

The second contribution is empirical/historical. The paper considered one particular historical event, the incentivized conversion of Egyptian Copts following the Arab conquest in the 7$^{\text{th}}$ century. While the historical context that we considered was most likely similar throughout the whole Arab Caliphate that spanned the current-day Middle East and North Africa region, we focused on Egypt because its dry-climate Nile Valley preserved the best data source on taxation under the early Arab Caliphate, the tax papyri. Building on novel data sources, including tax papyri in 641-1100, data on churches and monasteries in 1200, and proxies for religiosity of tax authorities and for Copt religiosity and income, we first provided local-level evidence, showing that enforcer religiosity increased conversions and both the discriminatory and non-discriminatory taxes, suggesting taxation on the downward-sloping side of the Laffer curve. The discriminatory tax increased with Copt religiosity, as predicted. Then, using proxies for Caliph religiosity, budget needs, uncertainty about Muslim tenure, and threat of rebellion, the Egypt-level qualitative evidence allowed us to shed some light on factors that may have triggered the Caliphate-wide circa 750 tax reform lifting the cap on the non-discriminatory tax. The evidence comes in favor of a reduced threat of rebellion/ higher expected Caliphate tenure, and against an increase in Caliph religiosity or budgetary needs, as drivers of the tax reform. Understanding the determinants of this reform matters because it is an attempt to endogenize a major "Islamic" institution: the canonical post-750 tax system, instead of treating it as "Islamic," exogenous, and ahistorical, in the sense that it has always existed since the beginning of Islam.

The theory can in principle be tested in a variety of historical environments where a discriminatory policy was used to induce an unwanted group to change its identity by adopting that of the ruling group, and where the optimal mix of discriminatory and uniform policies evolved in response to changes in taxpayers' identity composition. Examples of identity-based policies abound. Before the Arabs, the Romans introduced a poll tax from which citizens were exempted, and eventually Roman citizenship became universal under Emperor Caracalla. Jews were taxed throughout European history, starting with Roman Emperor Vespasian's *Fiscus Judaicus* in the first century CE and lasting in many parts of Europe until the 18$^{\text{th}}$ or 19$^{\text{th}}$ century. During the Reformation, conversion of German cities from Catholicism to Protestantism was partly induced by German rulers' promise to Catholics that they could avoid paying the tithe to the Catholic church once they converted to Protestantism (an option that did not exist before), making it relatively cheap to switch to Protestantism. And interestingly, the state subsequently introduced

a uniform "secular" state tax on converted Protestant cities.

In modern economies, taxes can be targeted less explicitly toward unwanted populations. For instance, the 1942 one-off Varlik Vergisi (wealth) tax in Turkey was imposed on all citizens' fixed assets, such as land, buildings, businesses, and industrial enterprises. While on paper a non-discriminatory tax, it affected most severely Jews, Greeks, Armenians, and Levantines, who controlled a large portion of the economy, and led to their exodus. Finally, while the optimal intervention for the ruler is a tax in our paper, it may take other forms in different environments. Communist countries used Communist Party membership (a form of "conversion") to screen citizens for positions. Local and national governments' policies with respect to the provision of local public goods for migrants (training, housing, bureaucratic hassle, intolerance toward harassment...) would be equally worth of empirical investigation.

In- and out-migration played a minor role in post-Arab-conquest Egypt, but was prominent in some other historical episodes, during which oppressed groups dwindled in size. Extending our exploratory theoretical treatment of migration and performing empirical work along these lines would be fascinating. For that, one will need to delve in greater depth into the foundations of the ruler's preference function V. For example, does the ruler care primarily about population homogeneity? Or does he take a more religious stance of caring about conversions, and if so, how does he conceive his legacy (narrowly as the fraction of minority members in the polity, or broadly as his impact on worldwide conversions)? Particularly interesting would be the study of the strategic interaction, static and dynamic, among multiple rulers to offload or to the contrary attract the minority.

Intergenerational transmission of identity/culture, or changes thereof, is another exciting area of future research. Contrary to the literature on cultural persistence, which often treats religious and ethnic groups as fixed entities, our paper explored how group membership can change in response to incentives, thus endogenizing group formation. Nevertheless, we assumed that identity (θ) is different from group membership and is perfectly transmitted across generations: A convert does not change his θ over time, but only loses the Coptic label and the access to facilities for practicing their faith. Yet even though converts may be crypto-members of their new group in the beginning, they can change their beliefs over time or across generations, growing a genuine attachment to the new identity. We leave the modeling of this process to future research.

While the empirical evidence we presented in the paper is broadly consistent with the theoretical predictions, we also issued a number of caveats associated with data limitations inherent to this historical period, namely the extremely small number of districts where tax papyri survived, and our inability to observe changes in taxation and conversions over time at a frequency high enough to permit a rigorous econometric analysis. We therefore view this paper as a first step toward further empirical and theoretical studies of optimal taxation with time-persistent status changes and their implications for the tax structure and the dynamics of ruler's legitimacy. We hope that it will stimulate empirical work building on other data sets, which will allow more structural estimations. We leave these promising alleys for research to future work.

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Appendix

A Historical background

A.1 Long-term trends of Islamization and taxation

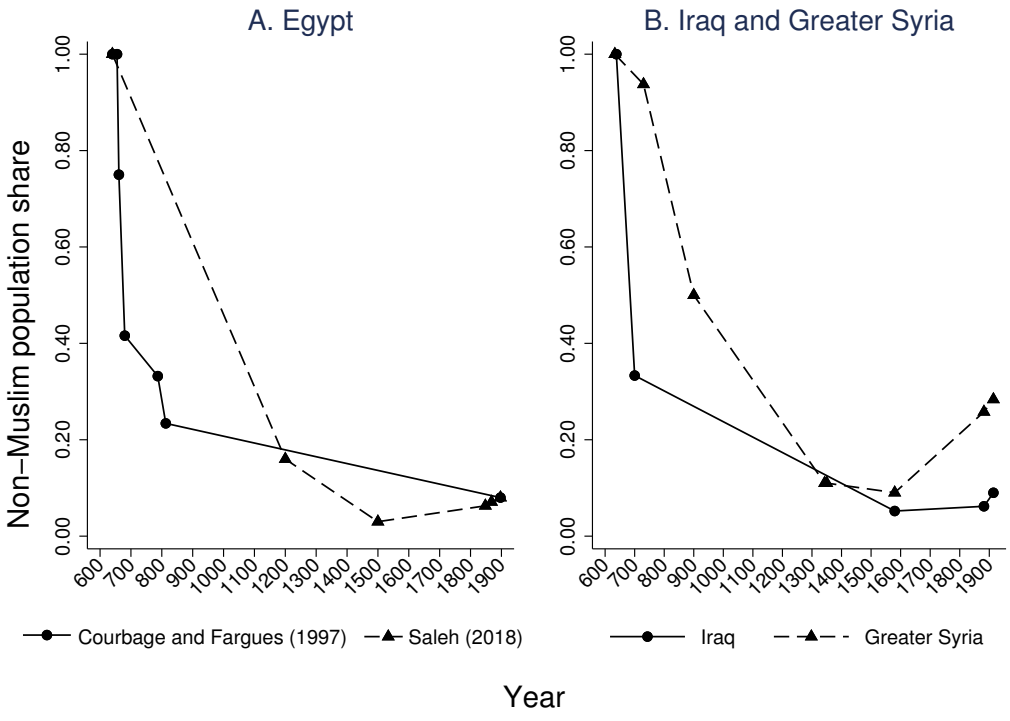

Figure A.1 – **Non-Muslim population share in 632-1914**

Notes: Courbage and Fargues (1997)'s estimates are based on the poll and land tax revenues assuming perfect tax enforcement. Saleh (2018)'s estimates for Egypt in 1200 and 1500 are based on the proportion of Egypt's villages that had at least one Christian church or monastery, and in 1848 and 1868 on two individual-level samples of Egypt's first and second population censuses that were digitized by Saleh (2018).
Sources: Courbage and Fargues (1997) and Saleh (2018).

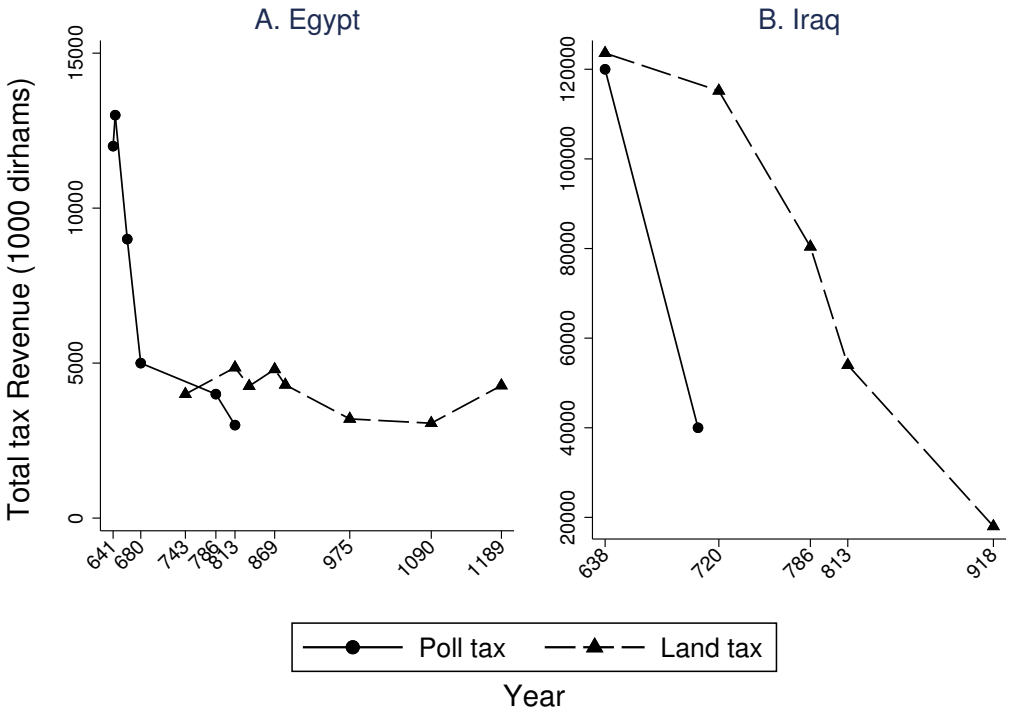

Figure A.2 – **Total poll and land tax revenues in 638-1189**

Source: Courbage and Fargues (1997).

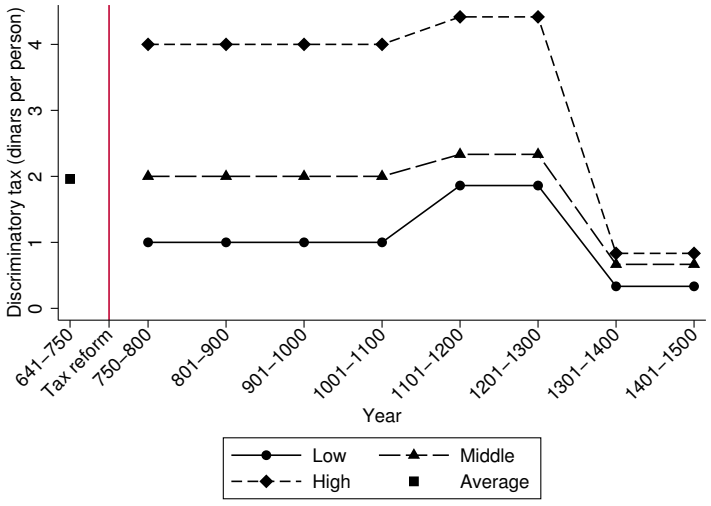

Figure A.3 – ***De jure*** **annual nominal discriminatory tax in 641-1500**

Notes: The discriminatory tax in 641-750 is equal to the poll tax (dinars per person) plus the difference between *kharaj* and *ushr* tax rates on land (dinars per *feddan* = 6,368 square meters). We added up the two components under the presumption that each Coptic taxpayer owns one unit of land. In 641-750, the *ushr* tax rate was 5-10% of the yield, while the *kharaj* tax rate was imposed in cash (1 dinar per *feddan*) plus 0.5 *ardabb* (= 70 kilograms) of wheat. To transform the *ushr* and *kharaj* rates into dinars per *feddan*, we assumed that a *feddan* produced 11 *ardabbas* of wheat based on Ibn-Mamati (1991), and used the average wheat price during this period based on Ashtor (1969). The discriminatory tax in 750-1500 is equal to the poll tax. A dinar weighs 4.25 grams of gold.
Sources: Tax rates in 641-750 are from Agapius (1910) and Ibn-Abdul-Hakam (1974) according to Morimoto (1981)'s interpretation, who breaks down the tax of 2 dinars per person in Ibn-Abdul-Hakam (1974) into a 1-dinar poll tax and a 1-dinar *kharaj* tax. Tax rates in 750-1100 are from jurists' handbooks (Abu-Yusuf 1979, Al-Qadi Al-Nu'man 1963), and in 1100-1500 from officials' handbooks (Ibn-Mamati 1991, Al-Qalqashandi 1914).

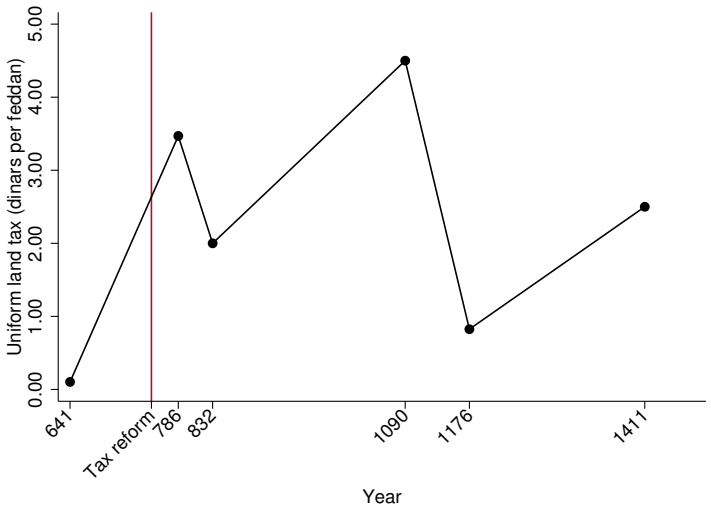

Figure A.4 – ***De jure* annual nominal uniform land tax in 641-1500**

Notes: The uniform land tax is equal to the *ushr* rate in 641-750 and to the *kharaj* rate in 750-1500. In 641-750, the *ushr* tax rate was 5-10% of the yield, while the *kharaj* tax rate in 750-1500 was imposed in cash (dinars per *feddan* = 6,368 square meters), in kind (*ardabbs* of wheat per *feddan* or a share of the yield), or both. To transform the *ushr* and *kharaj* rates into dinars per *feddan*, we assumed that a *feddan* produced 11 *ardabbas* of wheat based on Ibn-Mamati (1991), and used the average wheat price during the relevant period based on Ashtor (1969). A dinar equals 4.25 grams of gold. An *ardabb* equals 70 kilograms.
Sources: Secondary medieval narratives in 641 and 832 (Agapius 1910, Ibn-Abdul-Hakam 1974, Al-Maqrizi 1500) according to Morimoto (1981)'s interpretation, jurists' handbooks in 786 (Abu-Yusuf 1979), and officials' handbooks in 1090, 1176, and 1411 (Ibn-Mamati 1991, Al-Qalqashandi 1914).

A.2 Conversion or demographic Islamization?

An alternative theory of Egypt's, and the region's, Islamization traces the process to population replacement, in the sense that Arabs (Muslims) replaced the local non-Muslim populations of the region, rather than to conversions to Islam among the local populations. In the absence of Copts' conversion to Islam, five demographic processes could have driven the decline in Egypt's non-Muslim population share between 641 and 1200, and subsequently through 1848 (Figure A.1) (Fargues 2001):[77] Muslim immigration into Egypt, Coptic emigration, Muslims' higher fertility (net of child mortality), Muslims' lower adult mortality, and intermarriage between Coptic females and Muslim males (the opposite scenario is prohibited) without pre-marriage conversion, which results by law in a Muslim offspring.[78] These processes, we argue, are *not* the main causes of Islamization.

Muslim immigration Arab immigration, the largest Muslim immigration wave in Egypt between 641 and 1200, was small compared to the Egyptian (Coptic) population. In 641, Egypt's population (2.7 million) was three times that of the Arab peninsula (1 million) (Russell 1958, p. 89). Russell (1966) estimates the number of Arab immigrants in 650 at 100,000. Furthermore, Arab immigration subsided after 833 with the shift to recruiting slave armies and the stoppage of

77. This section draws on and expands the discussion in Saleh (2018, pp. 425-426).
78. A marriage in which a Coptic male converts to Islam prior to marriage is excluded because the mechanism of converting the offspring in this case is paternal conversion, and not cross-marriage per se.

state stipends to Arabs, which led Arabs to lose their military aristocratic position to Turks. It is also important to note that if Arab immigration were the sole driver of the decline in Egypt's non-Muslim population share between 641 and 1200, we would normally expect Arabs (Muslims) to be better off, on average, than Copts, because Arabs dominated by law the top white-collar positions in the military, judiciary, police, and the high-level bureaucracy, and because Copts were subject to a higher tax. This prediction contradicts though the papyrological evidence in 641-969 that shows that Copts were better off than Muslims; they were over-represented among white-collar workers and artisans and under-represented among farmers and unskilled non-agricultural workers (Saleh 2018).

Copt emigration Copts rarely emigrated from Egypt, because of their unique Christian denomination that differed from both Catholics and Greek Orthodox Christians. Until today, Coptic Christianity has been considered a "heretical" "non-Chalcedonian" Oriental Orthodox Christian denomination, which split from the Roman/Byzantine Church at the Council of Chalcedon in 451. Egypt's Chalcedonian Christians, who remained loyal to the Roman/Byzantine Church, formed a small minority called the *Melkites*.

Coptic-Muslim fertility difference Even if Arab immigration was small compared to Egypt's population, Muslims could have gradually replaced Copts over time if they had more children. [79] While this alternative hypothesis (which rules out Copt conversions to Islam) still does not explain why Copts were better off than Muslims as early as in 641-969, we attempt to test it directly using the 1848 and 1868 census samples which were digitized by Saleh (2013). Because these censuses predate Egypt's demographic transition, which started in the second half of the twentieth century, they provide a glimpse of the demographics of medieval (Malthusian) Egypt. They also allow us to measure the number of *surviving* children, which is arguably a better measure of the *desired* number of children than the number of children *ever born*, which we do not observe. Specifically, our measure is fertility net of child mortality: the number of surviving children below 10 years and below 1 year. Measuring fertility from the population censuses is subject to two caveats, though: (1) We only observe children who reside with their parent(s) at the time of the census. But this is less of a concern for children below 10, who are more likely to live with their parent(s). (2) We do not observe the father and mother of every individual in the censuses (except for children of the household head), but we inferred the (potential) father and mother from the relationship to the household head (the household structure). The findings in Table A.1 reveal that Muslim males do *not* have more surviving children than Coptic males, whether we count the number of surviving children below 10 years of age or below 1. This null finding

79. In 641, Egypt's (coptic) population was about 2.5 million, and Arab immigrants were about 100,000 (4%). In 1200, Egypt's population was 2.3 million, with Muslims constituting 84% (1.9 million) and Copts 16% (0.3 million). This implies that over the course of 560 years (641 to 1200), Arabs grew by 18 times (0.53% annually), while Copts lost 88% of their population (declined by 0.38% annually). In order for Arab (Muslim) settlers to grow from a small minority (4%) in 641 to the majority (84%) by 1200 by fertility privilege alone (without Coptic conversions), total fertility rate must have been at least 2.3 child per woman for Muslims, and 1.8 for Copts, *assuming that there were neither (child) mortality nor migration.*

holds within each occupational group: unskilled non-agricultural workers, farmers, artisans, and white-collar workers. Furthermore, Muslim females have *fewer* children under 10 than their Coptic counterparts, especially in households headed by farmers and white-collar workers, but the difference is statistically insignificant if we measure fertility by the number of surviving children under 1 (except for females in households headed by white-collar workers).

Table A.1 – **Coptic-Muslim fertility difference in 1848 and 1868**

	Males				Females			
	(1) Children <10	(2) Children <10	(3) Children <1	(4) Children <1	(5) Children <10	(6) Children <10	(7) Children <1	(8) Children <1
Copt	-0.050	-0.128	0.015	0.012	0.159	0.085	0.034	0.013
	(0.067)	(0.120)	(0.029)	(0.052)	(0.069)**	(0.075)	(0.023)	(0.022)
Farmer		0.067		0.050		0.243		0.073
		(0.062)		(0.015)***		(0.037)***		(0.012)***
Artisan		-0.070		-0.027		0.374		0.091
		(0.092)		(0.025)		(0.101)***		(0.029)***
White-collar		0.424		0.086		0.109		0.032
		(0.090)***		(0.030)***		(0.085)		(0.013)**
Copt * Farmer		0.261		-0.036		0.320		0.022
		(0.153)*		(0.048)		(0.121)***		(0.037)
Copt * Artisan		0.042		0.049		-0.223		-0.005
		(0.228)		(0.069)		(0.206)		(0.063)
Copt * White-collar		-0.118		0.012		0.373		0.147
		(0.188)		(0.066)		(0.213)*		(0.061)**
Constant	1.836	1.768	0.328	0.301	1.198	1.120	0.211	0.188
	(0.036)***	(0.059)***	(0.012)***	(0.011)***	(0.022)***	(0.027)***	(0.007)***	(0.006)***
Obs (individuals)	22119	22119	22119	22119	14780	14780	14780	14780
Clusters (districts)	106	106	106	106	98	98	98	98
R^2	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.01
Mean dep. var.	1.54	1.54	0.23	0.23	1.20	1.20	0.21	0.21

Notes: Robust standard errors clustered at the district level are in parentheses. * p <0.10, ** p <0.05, *** p <0.01. The omitted group is unskilled non-agricultural Muslim workers.
Source: The 1848 and 1868 population census samples (Saleh 2013) and an over-sample of non-Muslims in Cairo in 1848 and 1868. Census samples are pooled and restricted to Copts and Muslims aged 15 to 60 years. Regressions are weighted by sample design. Because almost all females have missing occupations, we assigned the household head's occupational title to all household members with missing occupations, including females. Number of children is inferred from the relationship to the household head, and includes only surviving children residing with their parent(s) at the time of the census.

Coptic-Muslim adult mortality difference Measuring adult mortality from the population censuses is more challenging, because we do not observe deaths. Saleh (2018) measures adult life expectancy among Copts and Muslims by comparing the age distribution between 1848 and 1868. The findings in Table A.2 (taken from the Online Appendix of Saleh (2018)) show that Muslims had lower adult mortality (higher life expectancy) at younger ages (10-29 or 10-39), but higher adult mortality (lower life expectancy) at older ages (30-79 or 40-79). However, the differences are small in magnitude, and may be attributable to statistical caveats in the 1848 and 1868 censuses,

namely, (1) the gap (20 years) that separates the two censuses is longer than ideal (5 or 10 years) as it increases the chance of population movement, and (2) age heaping (tendency to report age as a number ending in "0" or "5") and age exaggeration (for older individuals); since both phenomena are negatively correlated with socioeconomic status, they are less prevalent among Copts.

Cross-marriages without pre-marriage conversion Another way of replacing the Coptic population is by Arab (Muslim) males marrying (possibly more than one) Coptic females, as the off-spring in this case will be Muslim. Cross-marriages between Muslim males and Coptic females were rare as suggested by the dearth of cross-marriage contracts in the papyri in 641-969. The 1848 and 1868 population census samples record only two cross-marriages.

B Theory

B.1 Discrimination through non-price instruments

Consider for instance *outgroup derogation*. Suppose that the ruler or the majority group has some intrinsic increasing utility $V(s)$ from slur level s. Let $1/\theta$ denote the sensitivity to slurs of minority member $\theta \in (0, \infty)$; normalizing the migration cost to 1, type θ migrates if and only if $\theta \leq \theta^* = s$. Suppose that there are n_1 members of the favored group and n_2 members of the disfavored one, and that public good B is financed through a non-discriminatory tax. Then the tax levied on the disfavored group is $R(\theta^*) = \frac{n_2[1-F(\theta^*)]}{n_1+n_2[1-F(\theta^*)]}$ and so the utility of a ruler who stands only for the majority interests is $W(\theta^*) = V(\theta^*) + R(\theta^*) - B$. Note that the optimal policy always lies on the downward-sloping side of the Laffer curve ($R'(\theta^*)<0$), which is natural since "taxing" the minority through slurs (or violence) brings no revenue.

Next consider *patronage*. Suppose that for each civil service job opening, there are both a majority and a minority candidates. The ruler takes a minority member if and only if her quality advantage is $\theta \geq \theta^* > 0$. Let $V(\theta^*)$ denote the patronage benefit for the majority, an increasing function. The quality of public goods, expressed in monetary terms, is $R(\theta^*)$, a decreasing function. If for instance all citizens must compensate a poor quality of public services by an equivalent increase in private expenditures, then the ruler's welfare, $V(\theta^*) + R(\theta^*)$, can be decomposed into the familiar two terms. Again, the optimal policy always lies on the downward-sloping side of the Laffer curve. ■

B.2 Copt income

Suppose that agent θ's utility is the small-tax linear approximation $\theta x - \alpha(\lambda + \tau x)$ (where x is 1 if the agent remains Copt and 0 otherwise). The parameter α is a proxy for the marginal utility of income. The cutoff is then $\theta^* = \alpha\tau$. We further assume that the function V is independent of α (which is the case for extrinsic motivation).

Table A.2 – **Estimating adult life expectancy from the 1848 and 1868 population census samples**

Age Group	Copts				Muslims			
	Estimated size in 1848	Estimated size in 1868	Estimated life expectancy (method 1)	Estimated life expectancy (method 2)	Estimated size in 1848	Estimated size in 1868	Estimated life expectancy (method 1)	Estimated life expectancy (method 2)
0-9	90,740	117,801	NA	NA	1,148,827	1,458,614	NA	NA
10-19	32,981	51,600	41.45	42.9	377,685	603,264	43.44	44.82
20-29	33,290	52,466	44.59	44.59	406,293	622,071	49.08	48.73
30-39	40,100	36,657	30.44	32.2	457,208	481,535	32.97	32.65
40-49	27,031	26,187	25.46	24.72	348,101	360,926	25.9	23.79
50-59	15,325	25,345	22.61	21.02	243,063	288,588	21.83	19.98
60-69	11,406	12,595	17.67	16.1	171,180	195,387	16.88	13.53
70-79	7,849	10,899	11.52	9.03	99,442	111,561	12.26	8.68
80+	7,094	5,107	NA	NA	125,336	78,559	NA	NA

Notes: The handbook of the United Nations Population Division (2002, pp. 5-20) outlines a methodology for estimating adult mortality from any two consecutive censuses that are separated by an interval of x years, where x is a multiple of 5. The methodology uses the relative sizes of age cohorts, defined in groups of 5-year intervals, in the two censuses in order to estimate the probability of survival to an age $y + x$, conditional on being of age y in the first census. A slightly different methodology, the synthetic survival ratio, calculates the growth rate of each age cohort in order to make the methodology applicable to any census interval, i.e. not necessarily a multiple of 5. We applied the two methods to the census samples of 1848 and 1868, in order to estimate adult mortality by religious group. A few caveats arise though: (a) the time interval separating the two Egyptian censuses (20 years) is too long to apply the two methodologies; ideally, the interval should be around 5 or 10 years, (b) we do not have 100-percent samples of the two censuses and so there is a sampling error in estimating the size of each age cohort, and (c) there is a problem of age misreporting; in particular, age heaping and age exaggeration, which is typical in historical censuses and even contemporary censuses in developing countries. Age misreporting is likely correlated with socioeconomic status and may thus vary in a non-random way across religious groups, where Muslims are more likely than Copts to misreport their true age. In order to mitigate age misreporting, we defined age groups in intervals of 10 years instead of 5 years.
Source: The 1848 and 1868 population census samples. This table is reproduced from the Online Appendix of Saleh (2018).

The ruler's objective function, assumed strictly quasi-concave, is then: $V(\theta^*)+\tau[1-F(\alpha\tau)] = V(\theta^*)+\frac{R(\theta^*)}{\alpha}$. This yields:[80]

Proposition 8 ***(Copt income)*** *Suppose that preferences are $\theta x - \alpha(\lambda+\tau x)$ and that V does not depend on α.*

(i) When the optimal discriminatory tax is on the downward-sloping side (resp. upward-sloping side) of the Laffer curve, the higher the Copts' marginal utility of income, the more (resp. fewer) conversions take place under optimal taxation.

(ii) If the curvature of the ruler's objective function is bounded away from 0, then as long as the discriminatory tax is not too far away from the peak of the Laffer curve, the discriminatory tax (resp. the uniform tax) decreases (resp. increases) with the Copts' marginal utility of income. ■

B.3 Delegated budget collection

The text assumes that each district faces the same budget request (per inhabitant). However, Egypt's ruler, who is faced with an overall budget demand B from the Caliphate, may well have information about district heterogeneity. In that case, the budgetary demand on district i, B_i (such that $\sum_i B_i = B$), will depend on the characteristics of the district. We assume that the ruler cannot observe how the amount B_i is collected. Let us investigate the consequences of this alternative set-up and compare the results with those in the text. For notational simplicity only, we assume that the districts have the same population (none of the formulae below is affected by this normalization).

Heterogeneity in Copt religiosity. Suppose that the Caliph cares about the number of conversions (cost c per non-conversion). Let r_i denote the Copt religiosity in district i (the distribution of religiosity is $F(\theta - r_i)$). Let us also assume that the cost of collecting the land tax is at least slightly convex (which is reasonable, although we took it linear in our model): it costs $\psi(\lambda_i)$ to collect λ_i, with $\psi(0)=0$, $\psi'(0)=1$, $\psi''>0$. With a linear cost of collecting the land tax, the ruler would be indifferent to a transfer of land tax from one district to another and the budget allocation would exhibit some indeterminacy.

Assume that there is a single budget request (the Caliph's), that is dispatched optimally across districts by the ruler, i.e. solves:

$$\max\{-\sum_i [c[1-F(\tau_i - r_i)] + \psi(\lambda_i)]\}$$

subject to

$$\sum_i [\tau_i[1-F(\tau_i - r_i)] + \lambda_i] \geq B.$$

Letting μ denote the shadow price of the budget constraint, the first-order conditions with respect

80. To prove (i), note that $d\theta^*/d\alpha = R'/\alpha[\alpha V'' + R'']$. To prove (ii), use $d\theta^* = \alpha d\tau + \tau d\alpha$.

to λ_i is:

$$\psi'(\lambda_i) = \mu \Rightarrow \lambda_i = \lambda \text{ for all } i.$$

As for the poll tax, one has for all i:

$$\max\{\mu\tau_i[1 - F(\tau_i - r_i)] - c[1 - F(\tau_i - r_i)]\}$$

It is convenient to optimize over $\hat{\tau}_i \equiv \tau_i - r_i$:

$$\max\{\mu(\hat{\tau}_i + r_i)[1 - F(\hat{\tau}_i)] - c[1 - F(\hat{\tau}_i)]\}$$

Note that, from the envelope theorem, the maximand of this new program must decrease strictly with r_i.

The cross-partial derivative of the new maximand with respect to $\hat{\tau}_i$ and r_i is negative and so at the optimum $\hat{\tau}_i$ is non-increasing in r_i. Now suppose that the revenue from the poll tax, $(\hat{\tau}_i + r_i)[1 - F(\hat{\tau}_i)]$, were to be smaller in district i than in district j where $r_i > r_j$. We know also that $\hat{\tau}_j \geq \hat{\tau}_i$, and so $1 - F(\hat{\tau}_i) \geq 1 - F(\hat{\tau}_j)$. Therefore, the maximand for r_i is weakly smaller than that for r_j, a contradiction.

The optimum can be decentralized simply by requesting budget B_i from district i for all i. The resulting program for tax collector i satisfies the same first-order conditions (for the same shadow price μ).

So poll-tax revenue, and therefore total revenue is bigger in high-religiosity districts. The results obtained in the text for a non-discriminatory budget ($B_i \equiv B$ for all i) extend to the case of differentiated budget, except of course for the budget itself, which grows with Copt religiosity.

Heterogeneity in religiosity of local tax collector

Suppose now that districts are equally religious (same $F(\theta)$), but the tax collectors in the various districts have different religiosity. They differ, say, in their parameter c_i of aversion toward remaining Coptic. Faced with budget request B_i, the district-i collector solves:

$$\max\{-[c_i[1 - F(\tau_i)] + \psi(\lambda_i)]\}$$

subject to

$$\tau_i[1 - F(\tau_i)] + \lambda_i \geq B_i.$$

The first-order conditions are

$$\psi'(\lambda_i)R'(\tau_i) + c_i f(\tau_i) = 0$$

and

$$\frac{\partial \lambda_i}{\partial B_i} + R'(\tau_i)\frac{\partial \tau_i}{\partial B_i} = 1$$

τ_i is weakly increasing in c_i and decreasing in B_i, while λ_i is weakly increasing in c_i.

For a given budget request, a more religious tax collector always levies a higher poll tax and also a higher land tax. But of course budgets differ across districts as they are allocated optimally

by the ruler:

$$\max\{-\sum_i [c[1-F(\tau_i(B_i)] + \psi(\lambda_i(B_i))]\}$$

subject to

$$\sum_i B_i \geq B.$$

This yields first-order condition:

$$\psi'(\lambda_i)R'(\tau_i)\frac{\partial \tau_i}{\partial B_i}(1-\frac{c}{c_i}) = (c-c_i)f(\tau_i)\frac{\partial \tau_i}{\partial B_i} = \psi'(\lambda_i) - \mu,$$

where μ is the shadow price of the constraint.

The analysis reveals the existence of two forces:

— *Minimization of the distortion due to the unequal intensity of the land tax:* a more religious local collector levies a higher land tax, inducing more distortion (from the convexity of ψ). Therefore, relaxing the collection requirement for highly-religious-collector districts and tightening it for districts with less religious collectors reduces the overall distortion: if $c_H > c_L$, then $B_H < B_L$.

— *Incentivizing tax collectors*: there is another effect, however. The ruler would like to temper the zeal of high-religiosity collectors ($c_i > c$, where c is the ruler's religiosity) and conversely increase the poll tax levied by less religious collectors ($c_i < c$). He can do this only indirectly through the allocated budgets. Increasing the budget request on a high-religiosity collector forces the latter to reduce the poll tax so as to levy more revenue and in that sense to match more closely the ruler's wishes. This incentive effect calls for $B_H \leq B_L$ if $c_H > c_L$.

To illustrate the distortion effect, one can look at situations in which incentives cannot be changed (as in the case of two groups of collectors, one neutral, and the other extremely religious: $c_L = 0 < c_H = \infty$); then only the first effect is present and the high-religiosity-collector districts face a low budget request. To illustrate the incentive effect, suppose that $\psi(\lambda_i) = \lambda_i$ for $\lambda_i \leq \bar{\lambda}$ and $= +\infty$ for $\lambda_i = \bar{\lambda}$, and so at the optimum there is no distortion from land taxation. Letting $\tau^*(c_i) \equiv \arg\max\{\tau_i - c_i)[1-F(\tau)]\}$ denote district i's preferred poll tax rate, assume that $B \leq n\bar{\lambda} + \sum_{c_i<c} R(\tau^*(c_i)) + \sum_{c_i \geq c} R(\tau^*(c_i))$, where n is the number of districts. Then the ruler can force $\tau_i = \tau^*(c)$ from more religious tax collectors ($c_i \geq c$) by demanding budget $B_L \equiv \bar{\lambda} + R(\tau^*(c))$. By contrast, he cannot force less religious tax collectors to increase their poll tax beyond $\tau^*(c_i)$ as they would rather reduce the land tax if they were allocated a budget below $B_i = \bar{\lambda} + R(\tau^*(c_i)) > B_L$.[81] Note that if $c_i \geq c$ for all i, all districts are allocated the same budget.

B.4 Proofs

Proof of Proposition 2.

81. Unless $B_i < R(\tau^*(c_i))$ if $\lambda_i \geq 0$ is binding. Assume that extra money can be redistributed to the citizens, so $\lambda_i \geq 0$.

(i) Under extrinsic motivation, the ruler solves $\max_{\{\tau\}}\{(\tau-c)[1-F(\tau-r)]-B\}$, implying that at the optimum $0<\frac{d\tau}{dr}<1$ (using the log-concavity of $1-F$); and so the tax increases and the conversion rate, $F(\tau-r)$, decreases with r. Finally, the land tax is $\lambda=B-\tau[1-F(\tau-r)]$ and so, using the first-order condition, $\frac{d\lambda}{dr}=f(\tau-r)[c\frac{d\tau}{dr}-\tau]<0$ as $\frac{d\tau}{dr}<1$ and $\tau>c$.
(ii) The first-order condition is:

$$\frac{\partial W}{\partial \tau}=f(\tau^*-r)\left[-\tau^*+\int_{\tau^*}^{\infty}\delta(\theta)\frac{f(\theta-r)}{f(\tau^*-r)}d\theta\right]=0.$$

The log-concavity of f, together with the fact that $\delta(\theta)>0$ for all $\theta\geq\tau^*$ implies that the term in brackets is increasing in r. Thus if $\partial W(\tau^*(r),r)/\partial\tau=0$, $\partial W(\tau^*(r),r+\varepsilon)/\partial\tau>0$ for $\varepsilon>0$ and small. And so τ^* must increase as r increases.[82] ■

Proof of Proposition 4. The poll tax τ_t is levied on Copts who have not yet converted and so keep "consuming" the Coptic religion at date t. One may wonder whether, once the least religious Copts have converted and the remaining Copt population is more religious than the initial one, the ruler might be tempted to raise the poll tax, with implications for the land tax.

Let us first note that Copts in equilibrium behave myopically (as if $\beta=0$):

$$\theta_t^*=\max\{\tau_t;\theta_{t-1}^*\}$$

(using the convention that $\theta_0^*=-\infty$ so that there is no constraint at date 1). This property is trivially satisfied at date T, the last period of the game.[83] To see that $\theta_{T-1}^*=\max\{\tau_{T-1};\theta_{T-2}^*\}$, note that at date T the ruler will never choose a poll tax below θ_{T-1}^* and so there is no option value for the marginal type from not converting; for, the ruler's date-T payoff for $\tau_T<\theta_{T-1}^*$ is $V_T(\theta_{T-1}^*)+\tau_T[1-F(\theta_{T-1}^*)]$ and therefore is strictly increasing in τ_T. The optimality of Copt myopic behavior then follows by induction. We therefore can write the ruler's date-t welfare as:

$$W_t(\tau_t;\theta_{t-1}^*)=V_t(\max\{\tau_t;\theta_{t-1}^*\})+\tau_t[1-F(\max\{\tau_t;\theta_{t-1}^*\})]-B_t$$

and his intertemporal welfare as $\sum_{t=1}^{T}\beta^{t-1}W_t(\tau_t;\theta_t^*)$.

A key observation is that as long as myopically optimal policies (in which both the ruler and the Copts behave as if $\beta=0$) lead to more conversions over time, then the equilibrium of the dynamic conversion game is the sequence of myopically optimal policies.[84] Intuitively, the apostasy constraint is then non-binding. More precisely, we will consider the myopically unconstrained optimal policy given by $\{\lambda_t^*,\tau_t^*\}$ where $\tau_t^*\equiv\arg\max_{\{\tau\}}\{W_t(\tau)\}$, $\lambda_t^*=B_t-R(\tau_t^*)$ and $W_t(\tau)\equiv W_t(\tau;-\infty)=V_t(\tau)+\tau[1-F(\tau)]-B_t$. Because $\theta_t^*\leq\theta_{t+1}^*\leq\theta_{t+2}^*...$, ruler t can constrain future rulers only by choosing $\tau_t>\theta_{t+1}^*$. By so doing, and using the strict quasi-

82. When V, but not R, depends on a parameter ξ such that $\frac{\partial^2 V}{\partial\theta^*\partial\xi}>0$ and $V'(\tau^m,\xi)>0$ (note that τ^m does not depend on ξ if R does not), then an increase in ξ leads to an increase in both taxes. This is the case for instance if ξ measures the ruler's religiosity or hostility. As shown by the Copt religiosity example, this positive co-variation need not hold if the parameter ξ affects the revenue as well.

83. While the proof here relies on backward induction from a finite horizon, the result applies to an infinite horizon as well.

84. We refer to Tirole (2016) for an analysis of games with positive selection in a general principal-agent context, including for cases in which the "apostasy constraint" is binding. We here content ourselves with stating new results.

concavity of W_t, he moves the threshold away from his bliss point θ_t^*, at date t as well as in any future period t' such that $\tau_t > \theta_{t'}^*$. Thus ruler t is better off behaving myopically.

Conversely, suppose that (for expositional simplicity only) there are two periods and $\theta_1^* > \theta_2^*$. What does ruler 2 do if ruler 1 picks his bliss point $\tau_1 = \theta_1^*$? Ruler 2 then has second-period payoff $W_2(\tau_2)$ for $\tau_2 \geq \theta_1^*$ and $V_t(\theta_1^*) + \tau_2[1 - F(\theta_1^*)] - B$ if $\tau_2 \leq \theta_1^*$. The latter function is strictly increasing in τ_2 and so the constrained optimal τ_2 for the date-2 ruler is equal to $\theta_1^* = \tau_1$ (using again the quasi-concavity of W_2). Hence by picking $\tau_1 = \theta_1^*$, ruler 1 obtains his bliss point in both periods. ■

Proof of Proposition 5. Let us ignore the apostasy constraint and verify ex post that it indeed is not binding at the ruler's optimal policy. At date T, the ruler selects $\theta_T^* = \theta^*$, where $\theta^* = \arg\max\{V(\theta) + \theta[1 - F(\theta)]\}$. So $R_T = R(\theta^*) \equiv \theta^*[1 - F(\theta^*)]$. At date $T-1$, the cut-off for tax τ_{T-1} is given by

$$(1 + \beta x_T)\theta_{T-1}^* = \tau_{T-1}$$

And so $R_{T-1}(\theta_{T-1}^*) = (1 + \beta x_T)\theta_{T-1}^*[1 - F(\theta_{T-1}^*)] = (1 + \beta x_T)R(\theta_{T-1}^*)$.
The ruler solves at $T-1$

$$\max\{[V(\theta_{T-1}^*) + R_{T-1}(\theta_{T-1}^*) - B] + \beta x_T V(\theta_{T-1}^*) + \beta(1 - x_T)[V(\theta^*) + R(\theta^*) - B]\}$$
$$= \max\{(1 + \beta x_T)[V(\theta_{T-1}^*) + R(\theta_{T-1}^*)] - B + \beta(1 - x_T)[V(\theta^*) + R(\theta^*) - B]\}$$

And so $\theta_{T-1}^* = \theta^*$ and indeed the apostasy constraint is not binding.

More generally, at date t, a Copt knows that he will convert at date $t+1$ if the ruler has not been evicted by then. And so

$$[1 + (\beta + \beta^2 + ... + \beta^{T-t})x_{t+1}]\theta_t^* = \tau_t$$

and the ruler's benefit from proselytism at date t is $V(\theta_t^*) + (\beta + \beta^2 + ... + \beta^{T-1})x_{t+1}V(\theta_t^*)$. And so $\theta_t^* = \theta^*$. In equilibrium the date-t revenue from the discriminatory tax is

$$R_t = [1 + (\beta + \beta^2 + ... + \beta^{T-t})x_{t+1}]\theta^*[1 - F(\theta^*)]$$

■

Proof of Proposition 6. Let us first assume that in the static model the marginal rebel is a convert, and so the land tax is constrained to be such that $\lambda = \hat{\lambda}$ where $\hat{\lambda} + \hat{\theta} = \rho$ (see proposition 3). Suppose that at date 1 the Muslim ruler sets taxes $\lambda_1 = \hat{\lambda}$ and $\tau_1 = \hat{\tau}$ such that $\hat{\lambda} + R(\hat{\tau}) = B$ and $\hat{\lambda} + \hat{\tau} = \rho$. This tax scheme is the best that can be achieved from the point of view of date 1 without generating a rebellion. At date 1, $F(\hat{\theta})$ convert.

The key observation is that at date 2, the converts will not participate even in a successful rebellion as long as $\lambda_2 \leq \rho$, because at that point of time they already have abandoned their Coptic religion and therefore are unaffected by an increase in the poll tax. So there is overall less resistance to taxation. The no-rebellion constraint at date 2, $\lambda_2 \leq \rho$ is therefore looser than the

date-1 no-rebellion constraint. This implies that

$$\lambda_2 = \min\{\rho, \lambda^*\} \quad \text{and} \quad R(\tau_2) = B - \lambda_2.$$

Because $\lambda_2 > \lambda_1$, $R(\tau_2) < R(\tau_1)$ and so $\tau_2 > \tau_1$ if the optimal tax $\hat{\tau}$ is on the downward-sloping side of the Laffer curve. So if $\lambda^* \leq \rho$, the ruler obtains his first-best welfare at date 2 and a fraction $F(\theta^*) - F(\hat{\theta})$ convert at date 2. In contrast, if $\lambda^* > \rho$, then $\lambda_2 = \rho \geq \lambda_1$ and $R(\tau_2) = B - \rho \leq R(\tau_1)$. The fraction of new converts is then smaller than $F(\theta^*) - F(\hat{\theta})$. When the optimal tax is on the upward-sloping side of the Laffer curve, the relaxation of the rebellion constraint also would allow the ruler to raise the non-discriminatory tax, which would enable reducing the discriminatory one (as $R' > 0$). However, the apostasy constraint ($\theta_2^* \geq \theta_1^*$) implies that there is no point reducing the pool tax; so an optimal tax is $\tau_2 = \tau_1$ and $\lambda_2 = \lambda_1$ (the outcome is the same as in the static context). [85]

Next, suppose that the marginal rebel is a non-convert in the static model and so the marginal rebel is still affected by both taxes at date 2. At date 1, taxes are given by $\lambda_1 + \tau_1 = \rho < \lambda^* + \tau^*$ and $\lambda_1 + R(\tau_1) = B$. [86] In contrast with the other case, the no-rebellion constraint is not relaxed at date 2: $\lambda_2 + \tau_2 \leq \rho$, and so $\lambda_2 = \lambda_1$ and $\tau_2 = \tau_1$. There are no new conversions at date 2. The same holds if the optimal tax is on the upward-sloping side of the Laffer curve. ■

Proof of Proposition 7. Our strategy to prove Proposition 7 consists in, first, computing an upper bound on the ruler's welfare, and, second, building an equilibrium that reaches this upper bound.

Because the no-rebellion constraint is lifted once type $\hat{\theta}$ has converted, let $T \leq \infty$ denote the date of type $\hat{\theta}$'s conversion. We consider a sub-constrained program for ruler welfare maximization (the ignored constraints will be satisfied in the equilibrium constructed in the second half of the proof):

$$\max\{\sum_{t=1}^{\infty} \beta^{t-1}[V(\theta_t^*) + R(\tau_t) - B]\},$$

subject to the date-1 no-rebellion constraint,

$$\sum_{t=1}^{T-1} \beta^{t-1}[R(\tau_t) - B + (\hat{\theta} - \tau_t)] + \sum_{t=T}^{\infty} \beta^{t-1}[R(\tau_t) - B] \geq -\frac{\rho - \hat{\theta}}{1 - \beta},$$

the apostasy constraint,

$$\theta_t^* \geq \theta_{t-1}^* \text{ for all } t,$$

the fact that type $\hat{\theta}$ converts only at date T,

$$\theta_t^* \leq \hat{\theta} \text{ for } t < T \text{ and } \tau_t \geq \hat{\theta},$$

85. Note that the ruler cannot select $\tau_1 < \hat{\tau}$ when $\hat{\tau} \leq \tau^m$, as this would require raising λ_1 above $\hat{\lambda}$, violating $\lambda_1 + \hat{\theta} \leq \rho$.

86. Proposition 3 implies that $\tau_1 < \tau^*$ and $\theta_1^* < \hat{\theta}$, and, provided that the discriminatory tax is on the downward-sloping side of the Laffer curve, $\lambda_1 < \lambda^*$.

and the absence of no-rebellion constraint after date T,[87]

$$\tau_t = \max\{\tau^*, \theta_T^*\} \text{ for all } t \geq T+1.$$

Letting μ denote the shadow price of the date-1 no-rebellion constraint, the reduced Lagrangian $\mathcal{L}$ (which includes only that constraint) admits derivative at date T:

$$\frac{\partial \mathcal{L}}{\partial \tau_T} = \beta^{T-1}[V'(\tau_T) + (1+\mu)R'(\tau_T)] = 0.$$

Suppose that $R'(\tau_T) > 0$. Then, $V'(\tau_T) + R'(\tau_T) < 0$, which from the quasi-concavity of $V + R$, implies that $\tau_T > \tau^* > \tau^m$, a contradiction. Hence $\tau_T \geq \tau^m$, implying that $V'(\tau_T) + R'(\tau_T) \geq 0$, and so (a) $\tau_T \leq \tau^*$ and (b) $\tau_t = \tau^*$ for all $t \geq T+1$. This yields $\lambda_T + \frac{\hat{\theta}}{1-\beta} + \frac{\beta\lambda^*}{1-\beta} = \frac{\rho}{1-\beta}$.

Prior to T the optimal allocation is stationary. Because the payoff at and after date T is fixed and the per-period payoff prior to T is constant, the optimum has $T = 1$ or $T = \infty$. For ρ sufficiently close to $\lambda^* + \hat{\theta}$, the upper bound for the ruler's utility for $T = 1$ is:

$$[V(\tau_1) + R(\tau_1) - B] + \frac{\beta}{1-\beta}[V(\tau^*) + R(\tau^*) - B]$$

where

$$B - R(\tau_1) + \frac{\beta}{1-\beta}[B - R(\tau^*)] = \frac{\rho - \hat{\theta}}{1-\beta}.$$

Thus, for ρ close to $\lambda^* + \hat{\theta}$, τ_1 is close to τ^* and the upper bound on ruler welfare is arbitrarily close to the outcome in the absence of threat of rebellion (which is the infinite repetition of tax structure $\{\lambda^*, \tau^*\}$).[88] By contrast, let us show that the no-conversion-of-$\hat{\theta}$ ($T = +\infty$) upper bound delivers a lower ruler payoff. The per-period payoff is then $V(\theta^*) + R(\tau) - B$, where $B - R(\tau) + \tau - \hat{\theta} \geq \rho - \hat{\theta}$ from the no-rebellion constraint. Thus, the per-period payoff is $V(\theta^*) - \rho + \tau$, where, furthermore, $\theta^* = \tau \leq \hat{\theta}$. Its maximum solves: $\max\{V(\tau) - \rho + \tau\}$ subject to $\tau \leq \hat{\theta}$. We know that $V'(\tau) + R'(\tau) > 0$ for $\tau < \tau^*$; a fortiori $(V(\tau) + \tau)' > 0$ for $\tau < \tau^*$, and so the upper bound for the ruler's per-period payoff is $V(\hat{\theta}) - \rho + \hat{\theta} < (1-\beta)V(\tau_1) + \beta V(\tau^*) - \rho + \hat{\theta}$, which is the per-period payoff for $T = 1$, for ρ close to $\lambda^* + \hat{\theta}$ (in which case τ_1 is close to τ^*).

Let us now construct equilibrium strategies that deliver this upper bound. Let the ruler set $\{\tau_1, \lambda_1\}$ at date 1. The condition $\lambda_1 + \frac{\hat{\theta}}{1-\beta} + \frac{\beta\lambda^*}{1-\beta} = \frac{\rho}{1-\beta}$ ensures that type $\hat{\theta}$ does not want to rebel at date 1. If fewer than $F(\hat{\theta})$ convert at date 1 (an off-the-equilibrium path event), the ruler replays $\{\tau_1, \lambda_1\}$ at date 2, and so on until at least $F(\hat{\theta})$ convert and the continuation equilibrium is (the repetition of) the optimal static policy. That there cannot be a coalition of types of size greater than $1 - F(\hat{\theta})$ refusing to convert at date 1 (or later) can be seen from $-\lambda_1 + (\hat{\theta} - \tau_1) - \beta(\lambda_1 + \frac{\beta\lambda^*}{1-\beta}) < -\lambda_1 - \frac{\beta\lambda^*}{1-\beta}$, which holds when ρ is close enough to $\lambda^* + \hat{\theta}$ as λ_1 is close to λ^*.

Note that we assumed that the unconstrained optimum is on the downward-sloping side of

87. The condition $\lambda^* \leq \rho$ ensures that already converted agents do not rebel if the optimal unconstrained scheme is expected to apply forever. So, if type $\hat{\theta}$ converts at date T, rebellion is no longer a concern and Proposition 4 shows that the continuation equilibrium is indeed (the repetition of) the optimal static policy $\{\tau^*, \lambda^*\}$.

88. More generally, backloading the uniform tax in this way may not be feasible as $R(\tau_1)$ is bounded above by $R(\tau^m)$.

the Laffer curve. Suppose instead it is on the upward-sloping side ($R'(\tau^*) > 0$). Then apostasy prevents the ruler from returning to the unconstrained optimum at date 2 as $\tau_1 > \tau^*$. So the previous reasoning does not apply. ■

Proof of Corollary 1. Suppose that, in the absence of constraint on the tax system, at date 1, (a) the marginal rebel is a convert: $\lambda_1 + \hat{\theta} = \rho \leq \lambda_1 + \tau(\lambda_1)$, where $\lambda + R(\tau(\lambda)) \equiv B$; and (b) the tax system is on the downward-sloping side of the Laffer curve: $R'(\tau(\lambda)) < 0$ or equivalently $\tau(\lambda)$ is an increasing function; and (c) reintroducing the constraint on the tax system, the latter is non-binding: $\lambda_1 \leq \lambda_u$ where λ_u is the *ushr* rate. So there is no gain of removing the cap constraint at date 1. Let us assume that $\lambda_u < \rho$.

Now suppose that in the absence of both the rebellion constraint and a cap on the uniform tax, the optimum is (λ^*, τ^*) (which solves $\max\{W(\tau)\}$ and satisfies $\lambda + R(\tau) = B$). One has $\lambda_1 < \lambda^*$ and $\tau_1 < \tau^*$. If $\lambda_1 < \lambda_u < \lambda^*$, there is a strict gain at date 2 for the ruler to remove the cap on the uniform tax, while there was none at date 1. Given that at date 1 Copts with religiosity $\theta \leq \hat{\theta}$ have converted at date 1, there is no rebellion at date 2 provided that $\lambda_2 \leq \rho$. The tax reform enables the ruler to implement $\lambda_2 = \min\{\lambda^*, \rho\}$.[89] ■

89. One must check that date-1 converts indeed behave myopically. The option value of remaining Copt can be positive only if the agent remains Copt at date 2, i.e. if $\theta > \tau_2$. But $\theta \leq \hat{\theta} = \tau_1 < \tau_2$.

C Empirics

Table C.1 – **Empirical predictions of the model when on the downward-sloping side of the Laffer curve**

Shaded cell means that the result is reversed if on the upward-sloping side of Laffer curve

Outcomes / Determinants	Religiosity of tax authorities (V')	Budget (B)	Uncertainty about Muslim rule (x)	Copt religiosity (r)	Threat of rebellion†	Cap on uniform tax ($\lambda \leq \bar{\lambda}$)
Discriminatory tax (τ^*)	+	0	+	$+^{\dagger\dagger}$	−	−
Uniform tax (λ^*)	+	+	−	$-^{\dagger\dagger\dagger}$	−	−
% Converts ($F(\theta^*)$)	+	0	0	$-^{\dagger\dagger\dagger}$	−	−

Source: See text.
Notes:

† For the threat of rebellion, the effects on τ^* and $F(\theta^*)$ are reversed when on the upward-sloping side of the Laffer curve, only if the marginal rebel is a convert. The effect on λ^* is reversed only if the marginal rebel is a non-convert.

†† For extrinsic motivation; or in the case of intrinsic motivation, when f is log-concave and at the peak of the Laffer curve the ruler discriminates against the marginal member of the non-convert population.

††† When the ruler is driven solely by extrinsic motivation.

C.1 Data sources

Local-level evidence We use the following sources of data:

— Conversions: We collected village-level data on the non-presence of Coptic churches and monasteries circa 1200 are constructed from the Coptic medieval chronicle, Abul-Makarim (1200). The list of villages is from Ibn-Al-Jay'an (1477).

— Discriminatory and uniform taxes: We constructed an individual-level dataset on poll and *kharaj* tax payments from papyrological tax records in 641-1100. We employed Morimoto (1981, pp. 67-79, 85-87) for Greek papyri and the Arabic Papyrology Database for Arabic papyri (Appendix Figure C.1).[90]

— Total tax revenue: We collected village-level data on state valuation of total tax revenue (*'ibra*) per unit of taxable land from the cadastral surveys of 1375 and 1477, based on Ibn-

90. We do not employ two other sets of tax papyri. First, there are other Coptic and Greek poll tax registers and receipts in 641-800 that we do not use because they have not been digitized yet. These papyri are either from the same *kuras* as in our sample, and thus adding them will not augment the statistical power of our analysis, or from monasteries, and hence are not representative of the non-monastic population. Second, there are poll tax receipts from Nessana in Palestine, which we do not use because they do not vary within Palestine (they come from a single location).

Al-Jay'an (1477). The denominator is total area minus non-taxable area (*rizqa*, also known as *waqf*) land.

— Religious composition of tax authorities: We constructed a dummy variable at the *kura* level that takes value 1 if at least one Arab tribe settled in the *kura* between 700 and 969, based on Al-Barri (1992).

— Copt religiosity: We proxy for this variable at the village level by a dummy variable that takes value 1 if it is believed, according to Coptic traditions, that the village was visited by the Holy Family during its legendary biblical flight to Egypt. The list of villages that lie on this route is recorded in Anba-Bishoy (1999) and Gabra (2001).

— Copt income: We employ the natural logarithm of urban population circa 300, based on Wilson (2011, pp. 185-187).

— Land productivity: Wheat output per *feddan* in 1844 is from a governmental report cited in Rivlin (1961).

— Arab military presence: Byzantine military garrisons circa 600 are constructed from Maspero (1912).

— Land inequality: *Autopract* estates circa 600 are from Hardy (1931).

Egypt-level evidence

— Caliph religiosity: We constructed a dummy variable that takes value 1 if the Caliph ruling in a given year is *not* known for holding palace literary and music parties that involved drinking alcohol with his companions (*munadama*). We used Sirhan (1978) for 641-750 and Abu-Zahw (2012) for 750-847. We also employed the difference between the standardized number of religious and secular buildings built in a given year from Chaney (2013).

— Budgetary needs: The yearly number of major military battles initiated by the Caliphate against its (non-Muslim) neighboring empires is constructed from Mikaberidze (2011).

— Uncertainty about Caliphate rule and threat of rebellion: The yearly number of major military battles that were initiated by (non-Muslim) neighboring empires against the Caliphate is based on Mikaberidze (2011). The dummy variable that takes value 1 if there was a major civil war in a given year that threatened the Caliphate tenure is also based on Mikaberidze (2011). The dummy variable that takes value 1 if the Nile level in a given year fell in the top or bottom 5% of the Nile maximum levels in 641-1517 is based on Chaney (2013).

C.2 Figures and tables

This section presents additional descriptive statistics and findings.

Table I Register of Gold-Tax Assessment for "Five Fields", The 3rd Indiction (704/05 : A.H. 85/86)

Taxpayers	Location of fields	Taxes		Taxes		Total sol.	Corn tax art.
		Land sol.	Corn art.	Land sol.	Poll sol.		
Mēnas Apollōs	Belekau			½	3	3½	½
Kaumas Antheria	Sarseltōh			2½	2½	5	3
Psoios Andreas	Pkathakē Pkarou	1 ⅙	1 ⅓	1⅙	1½	2⅔	1⅓
Horsenuphios Hermaōs	Ammōniu Pankul & others Piah Alau	8½ 1½ ½	10 1½ 1	10½	4	14½	12½
Abraham Theodosios	Piah Boōn Piah Kam Hagiu Biktōr	½ 1 1	½ 1½ 1	2½	4½	7	3
Bethanias Pkaloos	Pkarou			⅓	0	⅓	⅓
Taam, Johannes Th[ ]-liaie & Eudoxia	Pkarou & Belekau			2⅓	0	2⅓	2⅓

P.Cair.Arab. 202 : List of poll-tax payers. (unknown (Egypt); 1. 1. 801 - 31. 12. 900 CE)

Inv. No.: **P.Cair.EgLib.inv. 293 recto and verso** Material: **papyrus** Height: **19 cm.** Width: **12 cm.** Language(s): **Arabic** Kind: **List, account** Edition(s): **Grohmann, P.Cair.Arab. 202** Translation(s): **Grohmann, P.Cair.Arab. 202**

سدس وثمن شنوده الفرّاش نصف وربع *** recto 1

وثمن بسنّة كرسدوره ثلثة دنانير ونصف وثلثمن *** recto 2

وسدس كيل بسنّه ثلثي وسدس ثمن *** recto 3

دينر أدّى سويرس أبلّوا ثمن دينر *** recto 4

Figure C.1 – **Photographs of papyrological individual tax payments**

Sources: Left: Morimoto (1981, p. 67): Register of "Five Fields" in *Aphrodito* in 704/05. Right: Arabic Papyrology Database: List of poll-tax payers in 801-900.

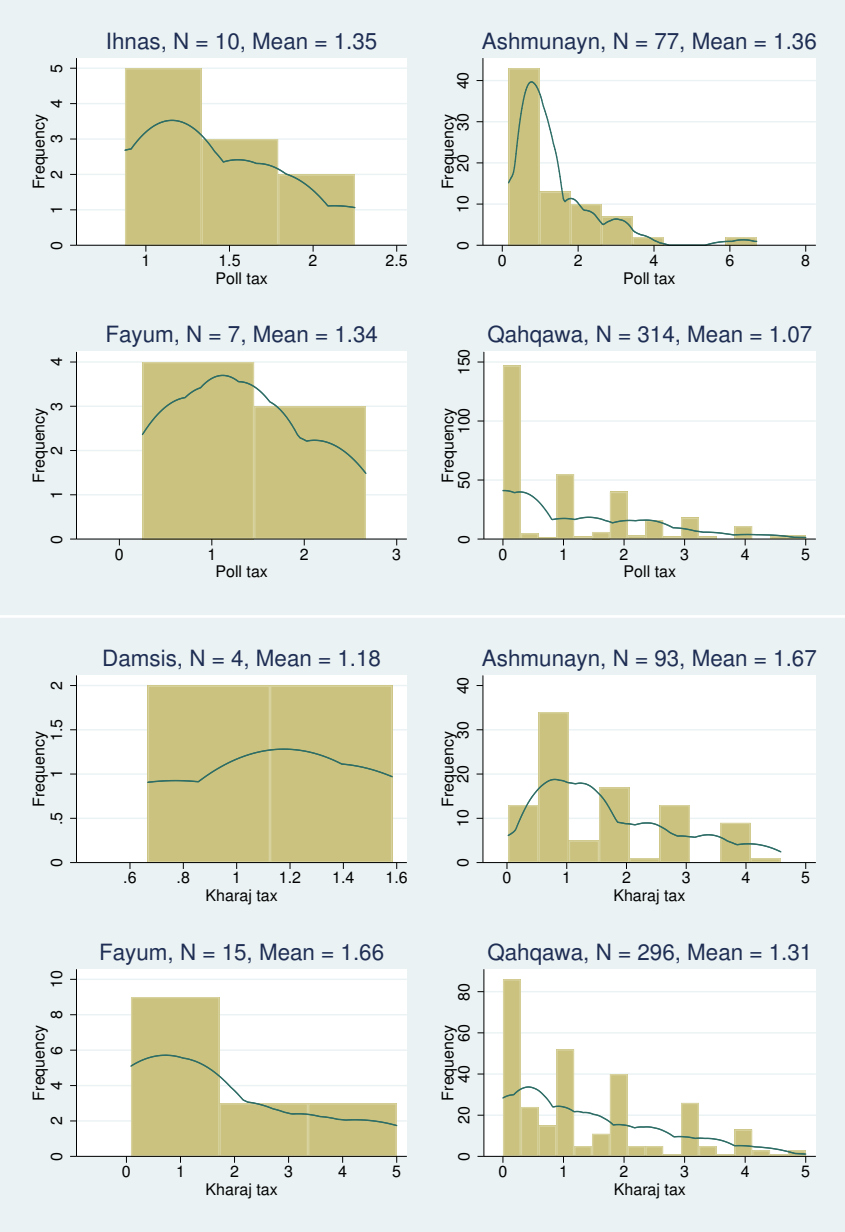

Figure C.2 – **Histogram of poll and *kharaj* tax rates by *kura* in 641-1100**

Notes:

1. Arab settlement is equal to 1 in *Ihnas*, *Ashmunayn*, and *Fayum* and equal to 0 in *Damsis* and *Qahqawa*.
2. Date ranges of poll tax payments are 701-900 in *Ihnas*, 731-1100 in *Ashmunayn*, 641-1005 in *Fayum*, and 703-733 in *Qahqawa*.
3. Date ranges of *kharaj* tax payments are 941-942 in *Damsis*, 801-1100 in *Ashmunayn*, 641-1100 in *Fayum*, and 703-733 in *Qahqawa*.

Source: Individual-level poll and *kharaj* tax payments in 641-1100 from Greek and Arabic papyri in Morimoto (1981, pp. 67-79, 85-87) and the Arabic Papyrology Database. Sample is restricted to tax payments in papyri from a known *kura*. We excluded 4 *kuras* with < 4 *kharaj* observations, and 52 outlier *kharaj* payments (> 5 dinars per person) in *Ashmunayn* and *Qahqawa*.

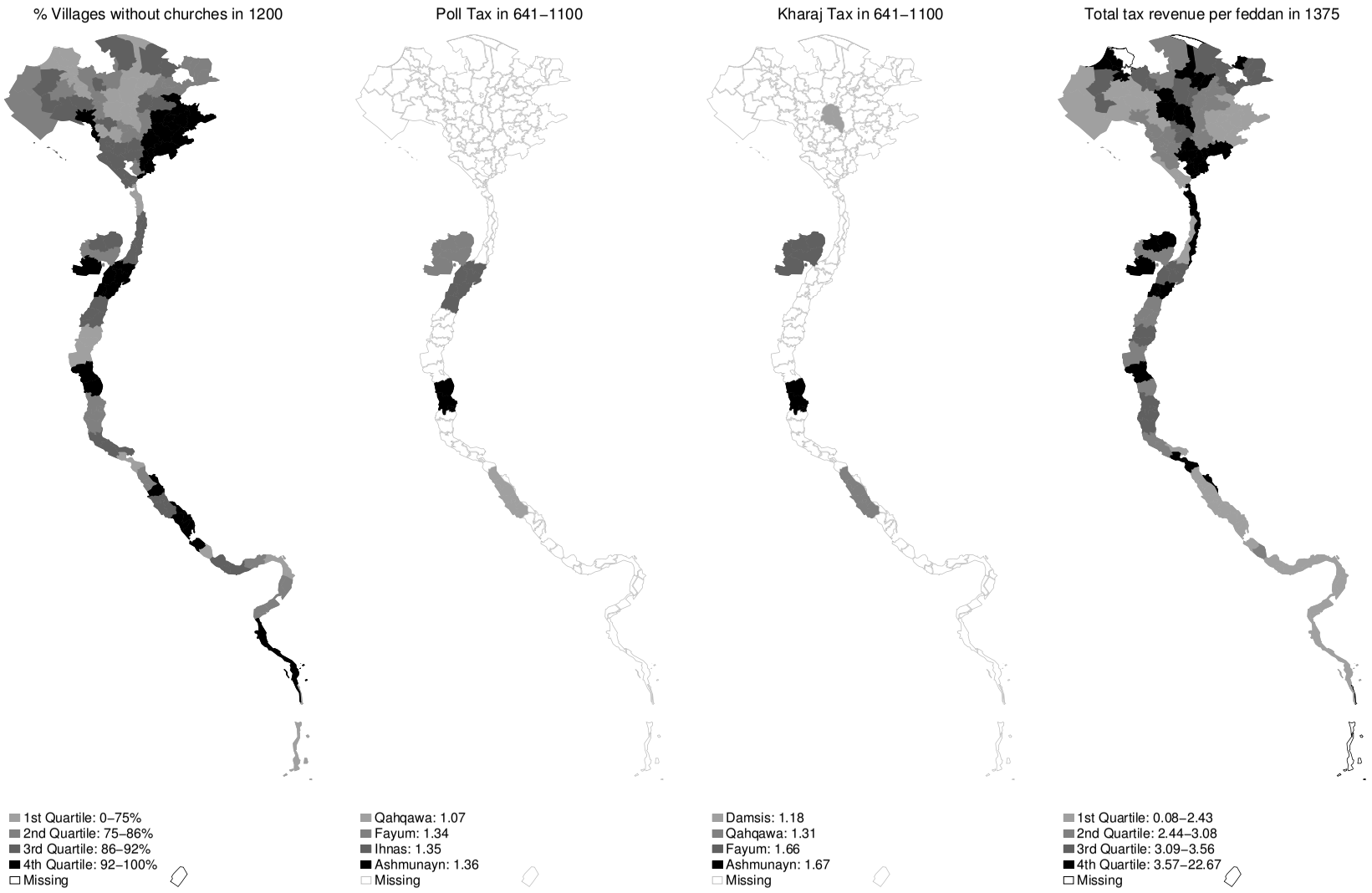

Figure C.3 – **Spatial heterogeneity in taxation and conversions**

Notes: % Villages without churches is the percentage of villages in a district which did not have any Coptic church or monastery in 1200; poll and *kharaj* taxes are the *kura*-level average tax payment in dinars per person in 641-1100; total tax revenue per *feddan* in 1375 is the district-level average total tax revenue per unit of taxable land in a district. The Nile Delta refers to the Northern triangle on the map. The Nile Valley extends covers the whole region to the south of the Delta.
Sources: Arab settlement: Al-Barri (1992); poll and *kharaj* taxes: Morimoto (1981, pp. 67-79, 85-87) and the Arabic Papyrology Database; Coptic churches and monasteries: Abul-Makarim (1200); total tax revenue: Ibn-Al-Jay'an (1477).

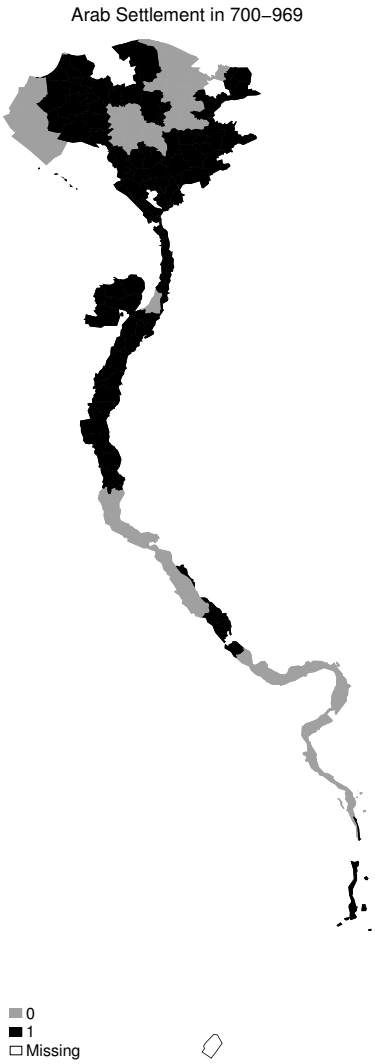

Figure C.4 – **Spatial heterogeneity in Arab settlement in 700-969**

Notes: Arab settlement =1 if at least one Arab tribe settled in a *kura* between 700 and 969. The Nile Delta refers to the Northern triangle on the map. The Nile Valley covers the whole region to the south of the Delta.
Source: *Kura*-level data on settlement of Arab tribes in Egypt in 700-969 compiled from Al-Barri (1992).

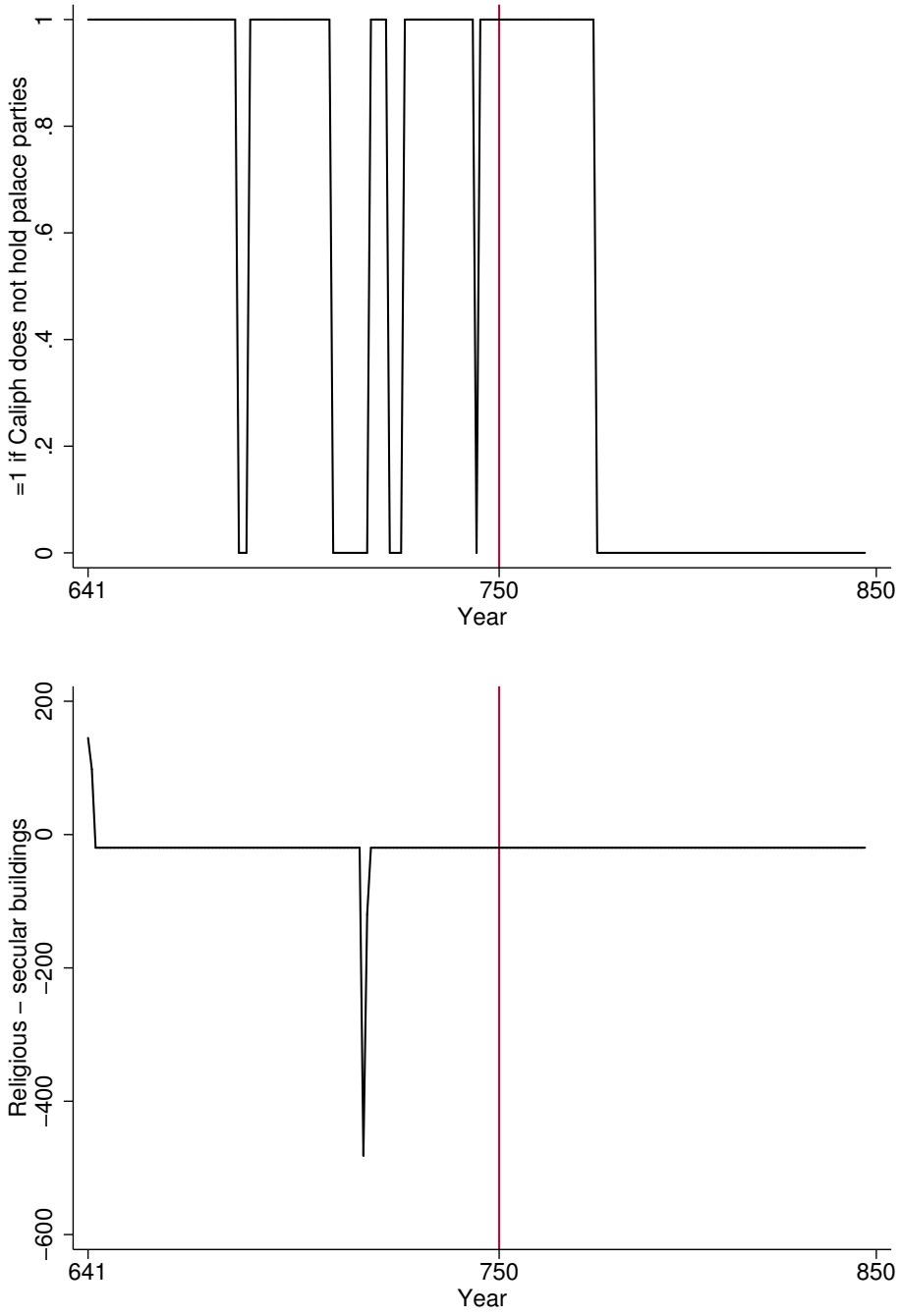

Figure C.5 – **Caliphs' religiosity in 641-847**

Sources: Top panel: 641-750: Sirhan (1978); 750-847: Abu-Zahw (2012). Bottom panel: Chaney (2013).

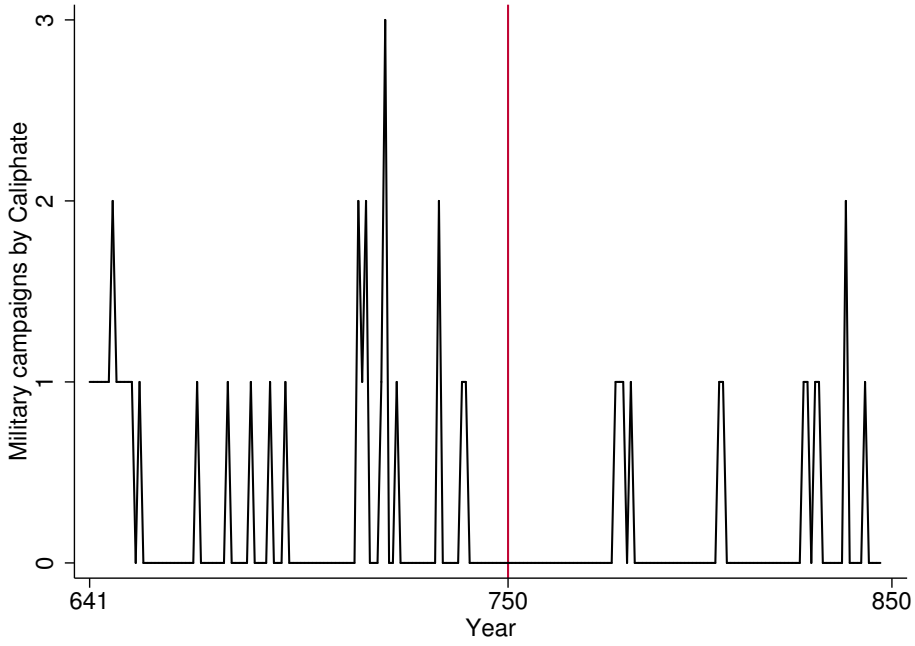

Figure C.6 – **Caliphate's budgetary needs in 641-847**

Source: Mikaberidze (2011).

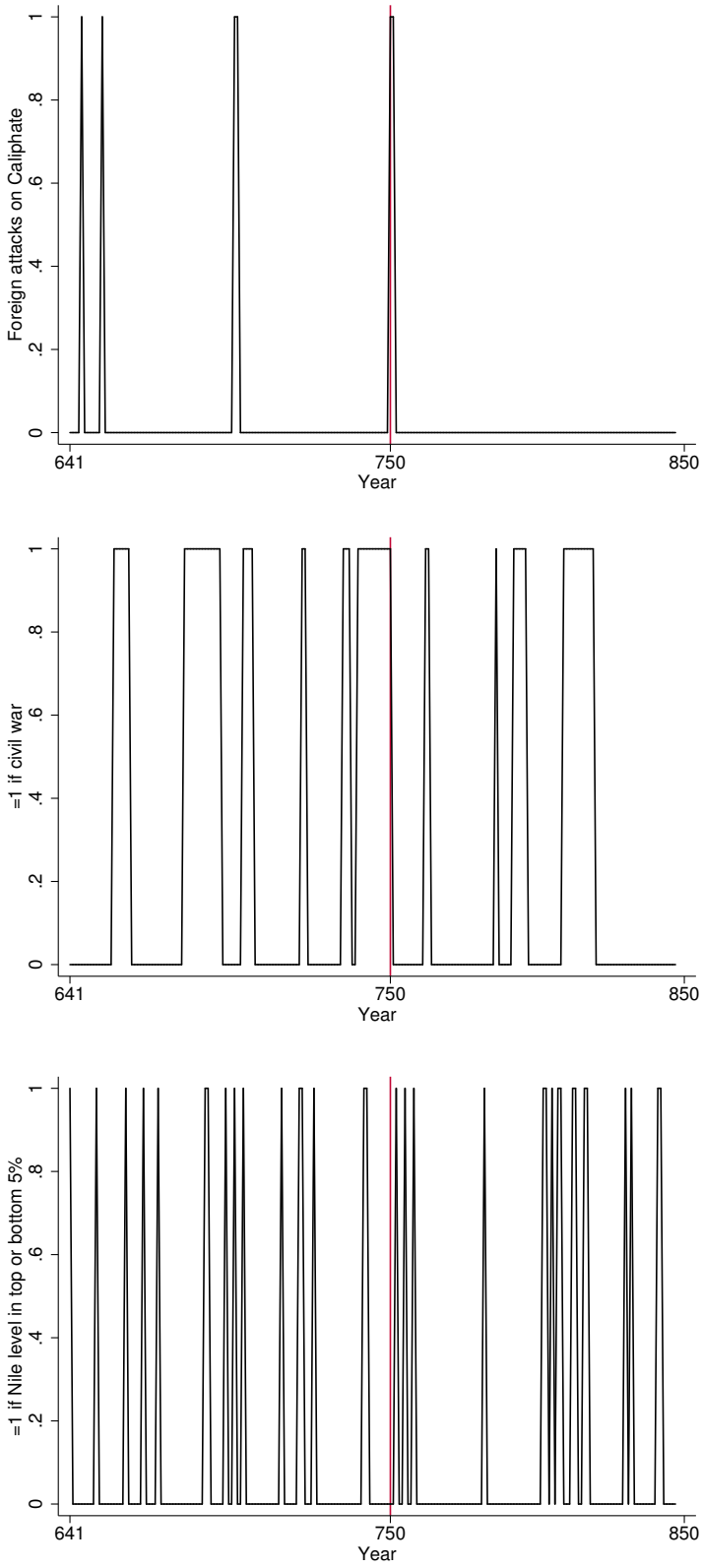

Figure C.7 – **Uncertainty about Caliphate's rule and threat of rebellion in 641-847**

Sources: Top two panels: Mikaberidze (2011). Bottom panel: Chaney (2013).

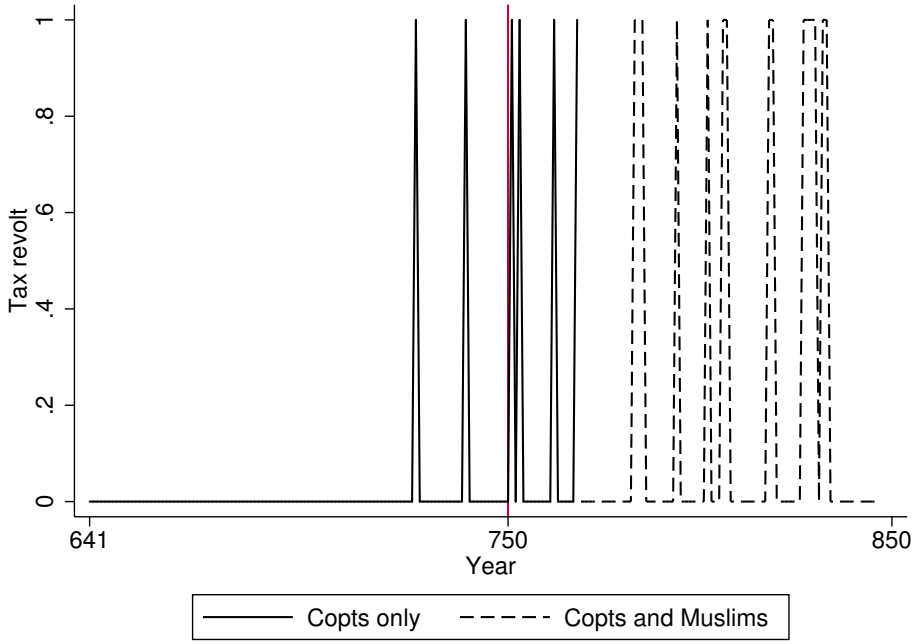

Figure C.8 – **Egypt's tax revolts in 641-847**

Source: Morimoto (1981).

Table C.2 – **Arab settlement, taxation, and conversions: Additional controls**

	Conversion			Poll tax	Kharaj tax	Tax Revenue		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
=1 if Arab settlement in *kura* in 700-969	0.089	0.089	0.105	0.287	1.283	-0.265	-0.266	-0.456
	(0.032)***	(0.032)***	(0.047)**	[0.341]	[0.389]	(0.273)	(0.275)	(0.274)+
=1 if village/*kura* on Holy Family route	-0.605	-0.626	-0.803	0.007	-0.885	0.895	0.819	1.038
	(0.079)***	(0.178)***	(0.037)***	[0.490]	[0.268]	(0.447)*	(1.150)	(1.049)
Arab settlement × Holy Family route		0.028	0.282				0.100	-0.123
		(0.198)	(0.111)**				(1.220)	(1.144)
Log (urban population) in *kura* circa 300	0.016	0.016	0.026			0.383	0.383	0.680
	(0.023)	(0.023)	(0.034)			(0.261)	(0.260)+	(0.304)**
Wheat yield per *feddan* in 1844	-0.154	-0.153	-0.087	0.171	9.550	-0.523	-0.522	-0.456
	(0.116)	(0.116)	(0.182)	[0.667]	[0.219]	(1.428)	(1.429)	(1.465)
=1 if Byzantine garrison circa 600	-0.007	-0.007	-0.047			0.287	0.287	0.261
	(0.028)	(0.028)	(0.054)			(0.243)	(0.243)	(0.233)
=1 if autopract estates in 600			-0.056					
			(0.053)					
Share of non-taxable land								22.131
								(7.635)***
Obs (villages)	1817	1817	602	408	408	1539	1539	1539
Clusters (*kuras*)	42	42	21	4	4	40	40	40
R^2	0.05	0.05	0.08	0.01	0.02	0.01	0.01	0.05
Mean dep. var.	0.84	0.84	0.84	1.14	1.40	3.45	3.45	3.45

Notes: Wheat output per *feddan* (≈ 1.038 acre) in 1844 is under the traditional basin irrigation by Nile inundation that was the norm in ancient and medieval Egypt, and not by the summer canals that introduced perennial irrigation post 1800. The sample size is identical ($N = 408$) in both the poll tax and *kharaj* tax samples in columns (3)-(4). This is by chance. They are different samples and from different locations. Robust standard errors clustered at the *kura* level are in parentheses in columns (1)-(2) and (5)-(7). *P*-values are in brackets in columns (3)-(4): These are estimated using Wild Cluster Restricted (WCR) bootstrap, with clustering at the *kura* level, Webb weights, and 999,999 replications. + p <0.15, * p <0.10, ** p <0.05, *** p <0.01. A constant is included in all regressions.
Sources: Wheat output per *feddan* is from a government report cited in Rivlin (1961). Byzantine military garrisons circa 600 are from Maspero (1912). *Autopract* estates are from Hardy (1931). Columns (1)-(2): Village-level data on Coptic churches and monasteries constructed from Abul-Makarim (1200). Columns (3)-(4): Individual-level poll and *kharaj* tax payments in 641-1100 from Greek and Arabic papyri in Morimoto (1981, pp. 67-79, 85-87) and the Arabic Papyrology Database. Sample is restricted to tax payments in papyri with a known *kura*. We excluded 4 *kuras* with < 4 *kharaj* observations, and 52 outlier *kharaj* payments (> 5 dinars) in *Ashmunayn* and *Qahqawa*. Columns (5)-(7): Village-level data on *'ibra* per taxable *feddan* and on the share of non-taxable (including *waqf*) land are from the 1375 cadastral survey in Ibn-Al-Jay'an (1477).

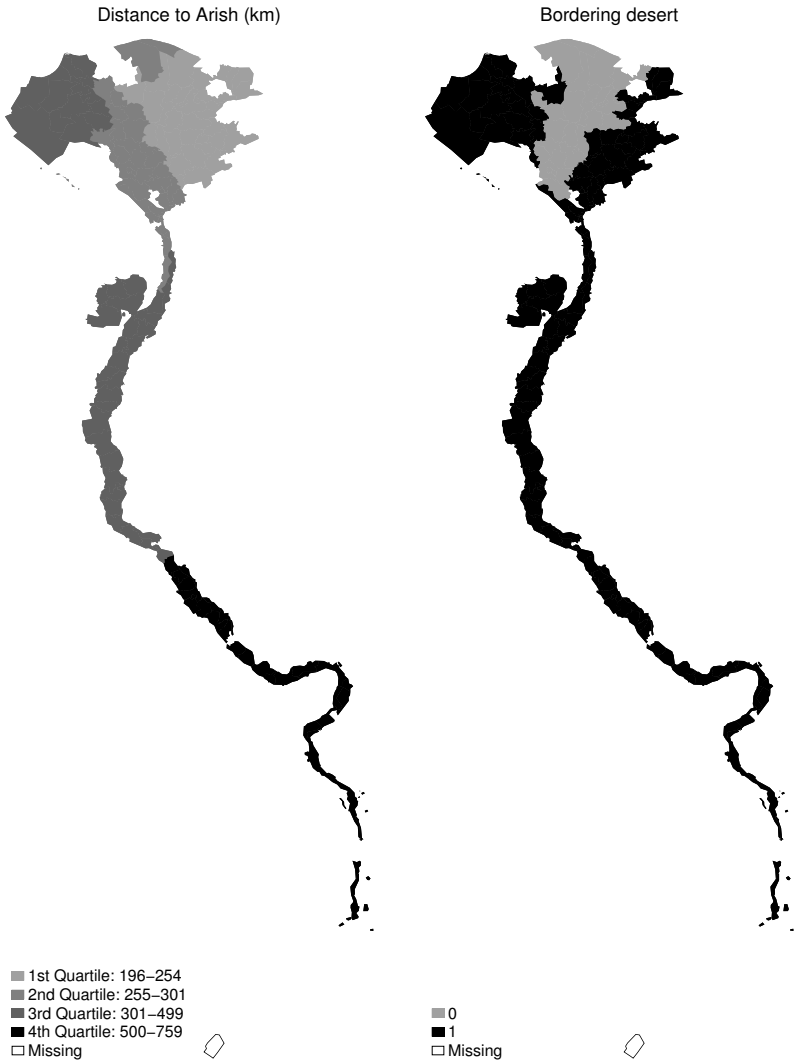

Figure C.9 – **Spatial heterogeneity in distance to *Arish* and bordering desert**

Notes: Bordering desert =1 if a *kura* is bordered by desert land.
Source: Authors calculations.

Table C.3 – **Relevance and exogeneity of distance to *Arish* and bordering desert**

	=1 if Arabs settled in *kura* in 700-969			=1 if *kura* on Holy Family route in 400			Log (urban population) in 300			=1 if Byzantine garrison in *kura* in 600		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Kura's distance to *Arish* (km)	-0.001		0.011	-0.001		0.005	0.001		-0.005	0.000		0.008
	(0.001)		(0.004)**	(0.000)**		(0.006)	(0.001)		(0.001)***	(0.001)		(0.005)
=1 if *Kura* borders desert		0.394	3.715		-0.364	1.168		0.532	-1.004		0.182	2.223
		(0.180)**	(1.020)***		(0.181)*	(1.419)		(0.152)***	(0.492)**		(0.184)	(1.211)*
Bordering desert × Dist. *Arish*			-0.012			-0.006			0.006			-0.008
			(0.004)***			(0.006)			(0.002)***			(0.005)
Observations	42	42	42	42	42	42	42	42	42	42	42	42
R^2	0.062	0.114	0.376	0.066	0.094	0.134	0.049	0.089	0.109	0.013	0.022	0.061

Notes: White-Huber robust standard errors are in parentheses. + p <0.15, * p <0.10, ** p <0.05, *** p <0.01. A constant term is included in all regressions.
Sources: Arab settlement: Al-Barri (1992); Holy Family route: Anba-Bishoy (1999) and Gabra (2001); Byzantine garrisons: Maspero (1912).

Table C.4 – **Arab settlement, taxation, and conversions: IV estimates**

	Conversions		Poll tax		*Kharaj* tax		Tax Revenue	
	(1) Second Stage	(2) First Stage	(3) Second Stage	(4) First Stage	(5) Second Stage	(6) First Stage	(7) Second Stage	(8) First Stage
=1 if Arab settlement in *kura* in 700-969	0.115		0.285		0.333		-0.398	
	(0.058)**		[0.002]***		[0.044]**		(0.376)	
=1 if village on Holy Family route	-0.599	0.056					0.874	0.074
	(0.078)***	(0.076)					(0.450)*	(0.082)
Log (urban population) in *kura* circa 300	0.011	0.090					0.460	0.111
	(0.028)	(0.043)**					(0.292)+	(0.055)**
Kura's Distance to *Arish* (km)		0.015		-0.009		-0.007		0.015
		(0.005)***		[0.124]+		[0.241]		(0.005)***
=1 if *kura* borders desert		4.836						4.889
		(1.204)***						(1.225)***
=1 if borders desert × Dist. *Arish*		-0.017						-0.017
		(0.005)***						(0.005)***
Obs (villages/individuals)	1817	1817	408	408	408	408	1539	1539
Clusters (*kuras*)	42	42	4	4	4	4	40	40
R^2	0.04		0.01		0.02		0.01	
KP Wald F-stat	16.89		8.53		3.29		16.29	
Mean dep. var.	0.84	0.75	1.14	0.230	1.40	0.265	3.45	0.73

Notes: Note that the sample size is identical ($N = 408$) in both the poll tax and *kharaj* tax samples in columns (3)-(4) and (5)-(6). This is by chance. They are different samples and from different locations. Robust standard errors clustered at the *kura* level are in parentheses in columns (1), (2), (7), and (8). P-values are in brackets in columns (3)-(6): These are estimated using Wild Cluster Efficient (WRE) for the second-stage regressions in columns (3) and (5) and Wild Cluster Restricted (WCR) bootstrap in the first stage regressions in columns (4) and (6), with clustering at the *kura* level, Webb weights, and 999 replications in columns (3) and (5), and 999,999 replications in columns (4) and (6). + p <0.15, * p <0.10, ** p <0.05, *** p <0.01. A constant is included in all regressions.
Sources: Columns (1)-(2): Village-level data on Coptic churches and monasteries constructed from Abul-Makarim (1200). Columns (3)-(6): Individual-level poll and *kharaj* tax payments in 641-1100 from Greek and Arabic papyri in Morimoto (1981, pp. 67-79, 85-87) and the Arabic Papyrology Database. Sample is restricted to tax payments in papyri with a known *kura*. We excluded 4 *kuras* with < 4 *kharaj* observations, and 52 outlier *kharaj* payments (> 5 dinars) in *Ashmunayn* and *Qahqawa*. Columns (7)-(8): Village-level data on *'ibra* per taxable *feddan* from the 1375 cadastral survey in Ibn-Al-Jay'an (1477).

Table C.5 – **Arab settlement and conversions to Islam in 641-1200 in *kuras* with tax papyri**

Dependent variable = 1 if no Coptic church or monastery in village in 1200

	Kuras with poll tax papyri					*Kuras* with *kharaj* tax papyri				
	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) IV	(6) OLS	(7) OLS	(8) OLS	(9) OLS	(10) IV
=1 if Arab settlement in *kura* in 700-969	0.152			0.278	0.327	0.224			0.345	0.252
	[0.563]			[0.216]	[0.330]	[0.054]*			[0.147]+	[0.295]
=1 if village on Holy Family route		-0.506		-0.499			-0.549		-0.629	
		[0.784]		[0.778]			[0.708]		[0.886]	
Log (urban population) in *kura* circa 300			0.044	-0.063				0.128	-0.069	
			[0.849]	[0.452]				[0.061]*	[0.816]	
Obs (villages)	196	196	196	196	196	193	193	193	193	193
Clusters (*kuras*)	4	4	4	4	4	4	4	4	4	4
R^2	0.01	0.07	0.00	0.08		0.07	0.04	0.05	0.12	
KP Wald F-stat					1.09					1.86
Mean dep. var.	0.89	0.89	0.89	0.89	0.89	0.79	0.79	0.79	0.79	0.79

Notes: P-values are in brackets. These are estimated by clustering standard errors at the *kura* level, using Wild Cluster Restricted (WCR) bootstrap for OLS regressions, and Wild Restricted Efficient (WRE) clustered bootstrap for IV regressions, with Webb weights and 999,999 replications. + p <0.15, * p <0.10, ** p <0.05, *** p <0.01. A constant is included in all regressions. The first-stage regression results in column (5) are: $\hat{settlement} = 1.883 \quad [0.060]^* - 0.002 \quad [0.491] \quad DistancetoArish$, and in column (10): $\hat{settlement} = -0.455 \quad [0.804] + 0.003 \quad [0.564] \quad DistancetoArish$.

Source: Village-level data on Coptic churches and monasteries in 1200 constructed from Abul-Makarim (1200). Sample is restricted to *kuras* with tax papyri.

Table C.6 – **Arab settlement and total tax revenue in *kuras* with tax papyri**
Dependent variable = State valuation of total tax revenue per unit of taxable land in 1375

	Kuras with poll tax papyri					*Kuras* with *kharaj* tax papyri				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
=1 if Arab settlement in *kura* in 700-969	2.289			5.732	4.968	-0.864			-2.105	-2.492
	[0.622]			[0.453]	[0.408]	[0.548]			[0.328]	[0.116]
=1 if village on Holy Family route		0.801		1.139			1.166		1.338	
		[0.587]		[0.706]			[0.667]		[0.902]	
Log (urban population) in *kura* circa 300			0.733	-1.896				-0.459	0.808	
			[0.748]	[0.664]				[0.582]	[0.825]	
Obs (villages)	180	177	180	177	180	182	180	182	180	182
Clusters (*kuras*)	4	4	4	4	4	4	4	4	4	4
R^2	0.01	0.00	0.00	0.01		0.02	0.00	0.01	0.03	
KP Wald F-stat					1.05					2.28
Mean dep. var.	4.09	4.09	4.09	4.09	4.09	3.82	3.82	3.82	3.82	3.82

Notes: P-values are in brackets. These are estimated by clustering standard errors at the *kura* level, using Wild Cluster Restricted (WCR) bootstrap for OLS regressions, and Wild Restricted Efficient (WRE) clustered bootstrap for IV regressions, with Webb weights and 999,999 replications. + p <0.15, * p <0.10, ** p <0.05, *** p <0.01. A constant is included in all regressions. The first-stage regression results in column (5) are: $\widehat{settlement} = 1.858 \quad [0.058]^* - 0.002 \quad [0.505] \quad DistancetoArish$, and in column (10): $\widehat{settlement} = -0.514 \quad [0.796] + 0.003 \quad [0.520] \quad DistancetoArish$.
Source: Village-level data on *'ibra* per *feddan* in 1375 constructed from Ibn-Al-Jay'an (1477). Sample is restricted to *kuras* with tax papyri.

Table C.7 – **Arab settlement and conversions to Islam in 641-1500**
Dependent variable = 1 if no Coptic church or monastery in village in 1500

	OLS				IV Second Stage	IV First Stage
	(1)	(2)	(3)	(4)	(5)	(6)
=1 if Arab settlement in *kura* in 700-969	0.034			0.035	0.032	
	(0.025)			(0.022)$^{+}$	(0.023)	
=1 if village on Holy Family route		-0.310		-0.309	-0.309	0.056
		(0.072)***		(0.073)***	(0.072)***	(0.076)
Log (urban population) in *kura* circa 300			-0.002	-0.004	-0.004	0.090
			(0.010)	(0.008)	(0.009)	(0.043)**
Kura's Distance to *Arish* (km)						0.015
						(0.005)***
=1 if *kura* borders desert						4.836
						(1.204)***
=1 if borders desert × Dist. *Arish*						-0.017
						(0.005)***
Obs (villages)	1817	1817	1817	1817	1817	1817
Clusters (*kuras*)	42	42	42	42	42	42
R^2	0.01	0.05	0.00	0.06		
KP Wald F-stat					16.89	
Mean dep. var.	0.97	0.97	0.97	0.97	0.97	0.75

Notes: Robust standard errors clustered at the *kura* level are in parentheses. * p <0.10, ** p <0.05, *** p <0.01. A constant is included in all regressions.
Source: Village-level data on Coptic churches and monasteries in 1500 constructed from Al-Maqrizi (1500).

Table C.8 – **Arab settlement and total tax revenue in 1477**

Dependent variable: State valuation of total tax revenue per unit of taxable land in 1477

	OLS				IV Second Stage	IV First Stage
	(1)	(2)	(3)	(4)	(5)	(6)
=1 if Arab settlement in *kura* in 700-969	-0.021			-0.089	-0.238	
	(0.267)			(0.268)	(0.333)	
=1 if village on Holy Family route		0.489		0.420	0.420	0.074
		(0.454)		(0.467)	(0.466)	(0.082)
Log (urban population) in *kura* circa 300			0.286	0.290	0.311	0.111
			(0.288)	(0.295)	(0.300)	(0.055)**
Kura's Distance to *Arish* (km)						0.015
						(0.005)***
=1 if *kura* borders desert						4.889
						(1.225)***
=1 if borders desert × Dist. *Arish*						-0.017
						(0.005)***
Obs (villages)	1543	1539	1543	1539	1539	1539
Clusters (*kuras*)	40	40	40	40	40	40
R^2	0.00	0.00	0.00	0.00		
KP Wald F-stat					16.29	
Mean dep. var.	2.97	2.97	2.97	2.97	2.97	0.73

Notes: Robust standard errors clustered at the *kura* level are in parentheses. * p <0.10, ** p <0.05, *** p <0.01. State valuation of village tax worth (*'ibra*) is in *jayshi* dinars (≈13.3/20 dinars) per *feddan* (= 1.038 acres) of taxable land. A constant is included in all regressions.
Source: Village-level data on *'ibra* per *feddan* in 1477 constructed from Ibn-Al-Jay'an (1477).

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