The Reluctant Transformation:

Modernization, Religion, and Human Capital in Nineteenth Century Egypt

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Abstract

Over the nineteenth century, Egypt embarked on one of the world's earliest state-led modernization programs in production, education, and the army. I examine the impact of this ambitious program on long-standing human capital differentials and occupational and educational segregation between Muslims, Christians, and Jews. I employ a new and unique data source, samples of the 1848 and 1868 Egyptian censuses that I digitized from the original manuscript forms, to examine this question. I find that the first wave of industrial modernization widened the religious occupational gap that was traditionally in favor of non-Muslims, but the second wave led to upward occupational mobility among *both* Muslims and Christians, although it did not alter the gap. Educational and military modernization, on the other hand, favored Muslims who benefited from these institutions almost exclusively, but the impact was too limited to induce a general catching-up effect. Overall, occupational and educational segregation was not attenuated by modernization, both because the traditional institutions in production and education were still the major routes for skill-acquisition, and because the new routes for mobility that modernization created were themselves segregated.

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I. Introduction

"*Look at this battalion… There are there Arabs and Copts, Mussulmans and Christians, that march in the same rank. I assure you that not one of them troubles himself about his comrade's religion. Equality between them is complete."*

Ismail, Khedive of Egypt (1863-79)[1]

Over the nineteenth century, Egypt, at the time an autonomous Ottoman province, embarked on one of the world's earliest state-led modernization programs in production, education, and the army, preceding the Japanese program by half a century. Even though the program failed to transform Egypt into a developed economy,[2] the creation of westernized institutions triggered a *social* transformation. In 1848, state production projects employed 8% of the adult active male population of urban Egypt, and in 1868 3%.[3] By the end of the century, the railways became the largest employer in the country (Toledano 1998, p. 261), and workers in large state transportation enterprises became the pioneers of the workers' collective action movement in the early 20th century.[4] The newly established army (which grew to be 5% of Egypt's adult active male population in 1868) later on played a pivotal role in the nationalist movement, and the graduates of the modern schools (despite serving only 1% of males 5-25 years of age in urban Egypt) were the pioneers of Egyptian "enlightenment."[5]

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[1] Charmes, Gabriel (1883), *Five Months at Cairo and in Lower Egypt*, p. 161.
[2] The average annual growth rate of real GDP per capita in Egypt was standing at a low level of 0.4% over the period (1820-70), in contrast to 1.1% in the U.S. and Western Europe, or even to 0.7% in the non-industrialized neighboring Lebanon over the same period (Pamuk 2006).
[3] Author's calculations from the Egyptian 1848 and 1868 digitized census samples (See section III).
[4] Examples include the strikes by Cairo tramways' workers in 1908 and 1911 and the railways' workers in 1908, and their role in the first workers union in Egypt in 1909 (Beinin and Lockman 1987, pp. 57-82).
[5] See K. Fahmy (1998, pp. 263-8) for an insightful discussion of the "unintended" impact of the move to create a regular army on building the national sentiments in Egypt. Heyworth-Dunne (1938, pp. 159-63, 177-80, 253-64, 269-71, 304-7, 326-9) provides biographies of the prominent graduates of the schools.

Did religious groups benefit equally from industrial, educational, and military modernization? Did modern institutions integrate traditionally occupationally-segregated religious groups as Khedive Ismail believed? Following a long medieval tradition, non-Muslims in Egypt were relatively more concentrated than Muslims in white-collar occupations such as scribes, moneychangers, and merchants (See figure 1). They also had better educational outcomes in terms of quantity and quality.[6] In another paper, I trace the origins of these religious differentials to the imposition of the Islamic poll-tax on non-Muslims upon the Islamic conquest of the then-Coptic Christian Egypt in 640 AD, which led to the widespread conversion of poor and uneducated Copts to Islam to avoid paying the tax, and to the shrinking of Copts into a minority that is wealthier and more educated, on average, than the growing Muslim majority. Traditional institutions of skill-acquisition (the guilds and the *kuttabs* or elementary religious schools) then preserved religious differentials and segregation for centuries. Noncompetitive policies in these institutions constrained access to skills and made occupations hereditary within each religious group (See section II). Modern institutions can affect religious differentials via two channels: First, the technological change embodied in state production projects creates a new demand for labor that may differ in its complementarity to skills from the traditional production sector. A large body of literature examined the impact of technological change on wage inequality via shifting the relative demand for skills (e.g. Acemoglu 2002; Goldin and Katz 1998; Atack et al. 2004; Goldin and Sokoloff 1982). This impact may vary by religious group. Second, modern institutions create new routes for skill-acquisition: job training in state production projects, education in modern public

[6] School enrollment rate in *kuttabs* among male children 5-14 years of age in 1848 Cairo was 34% for Muslims, 51% for Christians, and 80% for Jews. See section II.2 for a discussion of the quality differences between Muslim, Christian, and Jewish *kuttabs*, and section III for the data source.

schools, and military training in the army. Black and Lynch (1996) demonstrated that job training has a positive impact on productivity, and Yuchtman (2010) found a positive impact of educational modernization in 19th century China on economic outcomes. Costa and Kahn (2006) found a positive effect of military experience on integrating minorities in the labor market. The impact of these skill-acquisition routes on human capital may also differ by religious group.

I evaluate the effect of modernization on religious occupational differentials using a new and unique data source: individual-level samples of the Egyptian 1848 and 1868 censuses that I digitized from the original manuscript forms. I focus on three areas of modernization: (i) the two waves of industrial modernization in 1816-48 and 1848-68, (ii) the four public modern higher-education schools of engineering, medicine, veterinarian medicine, and translation operating from 1827 to 1854, and (iii) the conscription of non-Muslims as soldiers into the army starting from 1856 and the promotion of Egyptians into commissioned officers' ranks starting from 1854-63. I also examine whether religious occupational/educational segregation in the modern institutions (state production projects, modern schools, and the post-reforms army) was different from that in the traditional institutions. I distinguish between two hypotheses: (1) what I call *integrated modernization*, in which modernization acts as a "melting pot" reducing both religious occupational/educational segregation *and* differentials, and (2) *segregated modernization*, in which modernization fails to reduce religious segregation but the differentials can either increase or decrease.[7] The data allow me to evaluate these hypotheses because they

[7] This distinction is inspired by the modernization literature in sociology and political science (Newman 1991). "Melting pot modernization theory" predicts that the role of religion subsides as societies modernize and move to "organic" solidarity, which is based on division of labor rather than religion (Durkheim 1984, pp. 126-46). "Conflictual modernization theory" suggests to the contrary that modernization invigorates

include information on religion, occupation, school enrollment, and work establishment/school, in addition to geographic and demographic information.

I examine the impact of industrial modernization, defined as employment in a state production project, on religious occupational differentials using the traditional production sector (by industry) in each census year as a counterfactual.[8,9] I attempt to disentangle the mechanisms of this impact, technological change's relative demand for skills versus job training. To evaluate the impact of educational and military modernization on occupational outcomes by religious group, I use the variation across birth cohorts in exposure to these "treatments." Finally, I provide cross-tabulations and segregation indexes to examine religious segregation in the modern institutions. In all the analysis, I draw on historical evidence and rigorous quantitative methods to support the findings.

The economics literature has long examined the impact of ethno-religious segregation on economic performance (e.g. Alesina and La Ferrara 2005). What is less understood, however, is the possible endogeneity of segregation and how it can be altered by *deliberate* institutional changes. The paper provides perhaps the first empirical evidence on the impact of state-led modernization on the integration (or lack thereof) of minorities within the same occupations/schools/military ranks in the labor market. The paper also contributes to the literature on the impact of state-led industrial modernization or the so-called "forced industrialization" on the skill level of the labor force and how the strength of traditional labor market institutions can hamper the efforts of the state (Gerschenkron

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religious conflicts through the competition of previously segregated groups over the new economic opportunities that modernization creates (Rogowski 1985). While it is not my goal in this paper to evaluate the impact of modernization on religious conflicts, examining the impact of modernization on religious differentials and the occupational integration of religious groups has its implications for this literature.

[8] Endogeneity of religion is not a concern since my goal is to examine the *changes* in religious differentials that were caused by modernization rather than to examine the *levels* of these differentials.

[9] I use the 1848 census to evaluate the first industrial wave and the 1868 census to evaluate the second.

1962). It also has implications for the long-standing debate in sociology and political science on whether modernization increases or reduces the possibility of ethno-religious conflicts (Durkheim 1984; Rogowski 1985; Newman 1991).

The paper provides the first rigorous quantitative analysis of two of the most important and intriguing questions in Middle Eastern economic history: (i) Egypt's "failed" state-led modernization in the 19th century and its impact on guilds and other traditional institutions (Baer 1964; Owen 2002; Marsot 1984; Ghazaleh 1999; M. Fahmy 1954; K. Fahmy 1998; Heyworth-Dunne 1938), and (ii) the "privileged" position of non-Muslim minorities in the Middle East (Courbage and Fargues 1997; Tagher 1998; Issawi 1981). The digitized census samples allow me to provide not only the first quantitative evidence on these two phenomena, but also the first examination of the impact of state-led modernization on the religious differentials, a question that received less attention in the historical literature. The findings shed light on the historical reasons behind the persistence of religious differentials in Egypt, despite allegedly *early* attempts at modernization and integration of non-Muslims.

The rest of this paper is organized as follows. Section II provides a historical background. Section III describes the data. I introduce the empirical analysis and the results on industrial modernization in section IV, and on educational and military modernization in section V. Finally, section VI concludes.

II. Historical Background

II.1. Guilds and State Production Projects

At the turn of the 19th century, the Egyptian labor market was organized through the guild system (*ta'ifa*) that encompassed almost all labor force in the cities (Baer 1964, pp.

16-48). Apprenticeship, the sole route for skill-acquisition and accession to mastership, and the *jedik*, a fee required to practice a craft in a workshop, both made guild membership hereditary and thus restrained occupational mobility (Baer 1964, pp. 49-76, 107; Raymond 1973, pp. 544-51). Barriers to entry were higher in artisanal and trade (high-skill) occupations than in transport and services (low-skill) occupations, since the latter had neither a clear-cut apprenticeship (Baer 1964, p. 62) nor a *jedik* system. Apprenticeship complemented *kuttabs* as a route for acquiring skills in white-collar occupations (Heyworth-Dunne 1938, p. 87),[10] and there were significant barriers to entry into such occupations even in the government.[11] With the growing state power in the 19th century, the authority of the guilds headmen increased as they became responsible for conflict resolution between the government and guilds members (Baer 1964, pp. 77-84).

Religious segregation of guilds reflected religious occupational segregation. Figure (1) shows the occupational distribution of the adult active male population of each religious group in the traditional sector in 1848-68. Christians and Jews were relatively more concentrated in white-collar and high-skilled guilds (scribes, carpenters, merchants, jewelers, moneychangers, tailors).[12] A similar pattern of segregation existed in the late 18th and early 19th centuries. Up to the 19th century, there was no religious segregation *within* occupations, and "mixed" occupations, i.e. those that had sizeable memberships from different religions, had *single* guilds (Raymond 1973, pp. 524-6).

[10] Dor Bey, the Swiss education inspector under Ismail (1863-79), pointed out that "Coptic (Egyptian Christian) children have acquired a skill in arithmetic through practical exercises when accompanying their fathers to government offices" (Tagher 1998, p. 213).

[11] Lord Cromer, the British consul-general of Egypt (1883-1907), observed that Copts limited access to white-collar occupations, such as scribes and accountants, by making the accounting system "archaic" and "incomprehensible to anyone but themselves." They resisted all attempts at reform or simplification of the system. The duke of Harcourt, a French contemporary author, emphasized the peculiarity of the Coptic accounting system and how it allowed Copts to dominate administrative and fiscal jobs for centuries (Tagher 1998, pp. 212-3).

[12] All the statistics come from the author's calculations from the digitized census samples (See section III).

In 1816, Muhammad Ali (1805-48), the Ottoman viceroy of Egypt, launched the first wave of state industrialization by establishing the first textiles manufactory in Egypt (Owen 2002, p. 69). This was followed by a series of manufacturing projects throughout his reign that, in 1848, included textiles (66% of Egypt's modern sector employment), military industries (17%), and other industries (17%), such as printing, paper, coin making, and wood (Al-Gritli 1952, pp. 51-65; M. Fahmy 1954, pp. 21-54). 70% of these production projects were in Cairo and Alexandria,[13] and they differed from traditional workshops in both technology and size. Unlike traditional workshops, state projects employed machines that were a crude imitation (by Egyptian blacksmiths under the supervision of European skilled artisans) of the technology used in Western Europe at the time. A few manufactories used steam power to operate the machines, but the vast majority resorted to animal power. The estimated median size of the manufactory in 1848 sample is 163 workers, much larger than the size of a traditional workshop.

To fund his ambitious projects, M. Ali monopolized internal and external trade, and centralized the tax system (Owen 2002, pp. 65-6). Nonetheless, by 1868, 67% of his manufactories closed down, and employment in the surviving ones in Cairo and Alexandria dropped by 75%. Traditional accounts for the failure center around: (1) the Anglo-Turkish commercial convention (1838) which abolished monopolies and reduced tariffs in the Ottoman Empire, and (2) the London treaty (1841) which limited the size of the Egyptian army, the raison d'être of the manufactories (Owen 2002, pp. 75-6). Owen, however, suggests that there were structural causes for the failure such as the fading centralized power of the state since 1837, the unqualified personnel, the fuel and power problems, and, perhaps most importantly, the failure to create an entrepreneurial class.

[13] Author's calculations, based on the production projects observed in the 1848 census sample.

M. Ali's successors (1848-68) focused on transportation in the second wave of industrial modernization. Projects such as the railways (1853), telegraph (1854), steam navigation companies (1856 and 1863), and Alexandria tramways (1861) (Al-Hitta 1967, pp. 215-91) recruited 58% of Egypt's modern sector employment in 1868. The share of military industries remained stable at 22%, while the share of textiles fell sharply to 3%. Other industries, such as printing, tannery, and coin making recruited 17% of modern sector workers. Cairo and Alexandria were still the major centers of modernization (86% of the projects), although railways, steam navigation, and telegraph served most of the country. The technology used in these projects was presumably more sophisticated than the technology of the 1848 manufactories, but the median size of the plant dropped to 60 workers. Both internal and external debts were used to fund these projects, and the increasing debt (especially for Suez Canal which was opened in 1869) was the major reason behind Egypt's fall under British occupation in 1882. Generally, however, the transportation projects were more successful than the earlier manufactories and many of these projects survived until today.

II.2. *Kuttabs* and Modern Schools

In 1800, religious institutions were the sole providers of education through the *kuttabs* (Heyworth-Dunne 1938, pp. 2-7, 84-92). The curricula of these elementary schools were mainly religious, but there were important differences between Muslim, Coptic (Christian), and Jewish schools. Coptic schools taught arithmetic and geometry besides religious subjects, perhaps to prepare the students for their future careers in the administration,[14] a preparation that was supplemented later by apprenticeship.[15] Little

[14] Heyworth-Dunne (1938, p. 85) mentions the following passage as the earliest account on Coptic schools written by Sadlier (1693): "... the children were taught *religion, good manners, to read and write Arabic*

evidence exists on Jewish schools at the time, but it appears that Hebrew was "taught not only for religious reasons but also for practical purposes" (Heyworth-Dunne 1938, p. 92). Yet, Muslim *kuttabs* focused only on learning Arabic orthography through memorizing the Quran. 20% of the teachers in Muslim *kuttabs* in 1848 were blind, and thus were unable to teach reading and writing, unlike teachers in Coptic and Jewish *kuttabs*. Higher education was provided solely through Muslim religious institutes and was thus focused on religious preparation of the *ulama*.[16] Overall, the non-Muslim educational system was more inclined towards "useful" knowledge than the Muslim system.[17]

Public modern schools were introduced in 1816 in reverse order starting with higher schools, and then followed by preparatory schools and primary schools. Four public higher schools stand out as the most significant: medicine (1827-54), engineering (1834-54), veterinarian medicine (1827-51), and translation (1836-51).[18] Non-Muslims were *not* admitted to these schools until 1873 (Sami 1928, p. 1123),[19] and thus they presumably had no access to higher education until then (Heyworth-Dunne 1938, p. 87). Nonetheless, most of the public modern schools were closed in the 1840s and 1850s, perhaps in response to the London treaty (Heyworth-Dunne 1938, pp. 223-43, 288-301, 313-23).

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and Coptic... and were taught geometry and arithmetic because *these two sciences are very useful and necessary on account of the overflowing of the Nile, whereby the limits are lost; so that it becomes necessary for them to measure out their land, and by the benefit of the first of these sciences they compute the yearly increase.*" Italics are mine to identify the words of Sadlier (1693).

[15] See the discussion in section II.1 and footnote 11.

[16] Al-Azhar was the foremost renowned religious higher educational institution in Egypt since the tenth century. The *ulama* are the Muslim clergy.

[17] See Mokyr (2002 and 2005) on the concept of "useful" knowledge.

[18] Although the schools of medicine and engineering were reopened in 1856 and 1858 respectively, they were so frequently reopened and closed that they became generally in a bad condition until 1863, the year of accession of Ismail to power (Heyworth-Dunne 1938, pp. 320-3). Therefore, it is reasonable to conclude that the indicated periods of operation were indeed the *effective* ones until 1868.

[19] According to the 1867 law, non-Muslims were to be allowed to enter governmental *kuttabs* and primary schools (Heyworth-Dunne 1938, p. 363).

II.3. National Regular Army and Military Reforms

In 1822, M. Ali ordered the conscription of Egyptian Muslims into the army for the first time in centuries (K. Fahmy 1998, pp. 89-92). The measure was taken in order to build a regular army, following the style of Napoleon Bonaparte's revolutionary army that conquered Egypt in 1798-1801, and to replace the *Mamluk* irregular military regiments constituting mainly of slaves and mercenaries, which were inferior to European armies in organization and tactics (K. Fahmy 1998, pp. 79-84). During Egyptian military history in the nineteenth century, two military reforms are perhaps the most critical: First, in 1856, non-Muslims were conscripted as soldiers for the first time; an action that may have led to the integration of non-Muslims in the army (Tagher 1998, pp. 203-4).[20] Second, during Sa'id's reign (1854-63), Egyptians were allowed promotion to high commissioned officers' ranks, which were previously preserved for the ruling Turkish (Muslim) elite (Al-Raf'i 1987, p. 35). Non-Muslims were not officially excluded from this latter reform.[21]

III. Data

To examine the impact of state-led modernization, individual-level data with information on religion, occupation, and work establishment are required. I digitized two nationally representative samples (about 80,000 records each) of the 1848 and 1868

[20] This occurred in response to the abolition of the Islamic poll-tax on non-Muslims in 1855 (Tagher 1998, p. 204). Conscription was carried out on an arbitrary basis, by the village headmen, and not through a universal scheme (K. Fahmy 1998, pp. 97-9).

[21] Although Heyworth-Dunne (1938, p. 338) reports that the Coptic Pope's request to allow Copts to become army officers was not met until the Pope's death in 1861 when it was dropped, there are reasons to conclude that non-Muslims were not banned from becoming officers, although they may well have been subject to state discrimination. First, there is the factual evidence of observing two Coptic officers in the 1868 sample as opposed to the 1848 sample where there is none. Second, Dunn (2005, p. 25) points out that Sa'id allowed *both* Copts and (Muslim) peasants to become officers. Third, there are no theoretical grounds for banning non-Muslims from becoming officers since conscripting them was, by itself, a violation of Islamic law. Finally, Ismail (1863-79) recruited foreign non-Muslim officers widely in the army, and it is hard to believe that there was an official ban that applied only to local non-Muslims.

Egyptian censuses from the original Arabic manuscripts, which are preserved at the National Archives of Egypt, and I also constructed an oversample of non-Muslims in Cairo in both years.[22] The Egyptian censuses are perhaps the earliest individual-level census records in the Middle East to include information on *every* member in the household including females, children, and slaves. They include information on a wide range of variables including location (province, district, quarter/village, street/section, dwelling number), dwelling ownership, dwelling owner's name, dwelling type, dwelling size, name, household relationships, age, gender, ethnicity, nationality, religion, place of origin (province, district, village), legal status (free or slave), occupation (for males), school enrollment (for male children), enterprise/school (for active individuals), and infirmities. This list exceeds that of the 1850 U.S. census,[23] but the latter records literacy and real estate value in addition.

In this paper, I restrict the sample to adult males who are at least 15 years old. Four key variables in the empirical analysis require close attention: First, occupational titles were first recorded in full text in Arabic as they appeared in the manuscripts. I then manually coded the occupational titles (about 3,700 distinct titles in each census) following the five-digit *Historical International Standard Classification of Occupations* (HISCO) scheme, where I created new codes for the titles that were not found in HISCO. Based on this occupational coding, I constructed my main occupational outcome measure, *Social Status Index* (henceforth SSI), which classifies occupational titles into 12 ordered categories (from unskilled farm workers to higher managers). There are four

[22] Sampling rates are 8-10% in Cairo and Alexandria and 1% in the provinces. The oversampling of non-Muslims is at the rate of 25%. The data source and sampling strategy are described in Saleh (2011).
[23] The additional variables in the Egyptian censuses are detailed geographic location, dwelling ownership, dwelling type, religion, detailed place of origin (internal migration can be identified), and enterprise/school.

criteria used in this classification: manual vs. non-manual, supervisory vs. non-supervisory, skill level (from low to high), and primary sector vs. non-primary.[24] I also created an alternative outcome, *Occupational Group*, where I collapsed the 12 ordered categories of the SSI into: white-collar workers, skilled workers, and unskilled workers.

Second, religion is recorded for most observations in 1848 but not in 1868, where I inferred an individual's religion from his name. The main religious groups are Muslims, Christians, and Jews. The last two groups can be broken down further by denomination, when combined with ethnicity. Christian denominations include Copts (Egyptian Christians), Armenians, Levantines, and *Ruum* (Ottoman Greeks), while Jewish denominations are *Rabbanites* and *Karaites*.

Third, the industrial modernization measure (*Modern*) is an index that takes the value of one if the individual is employed in a state modern project. The census takers are generally keen on distinguishing between being employed by the state (*miri*) and working in the private sector (*barrani*). For most of the individuals employed by the state, the establishment of work is recorded in the occupation field. I constructed a list of state modern projects, by project's name, industry, and location in both 1848 and 1868, based on information from secondary historical sources (M. Fahmy 1954; Al-Gritli 1952; Sami 1928). I then combined the list with the digitized census samples in order to decide whether the individual's establishment of work is a state modern project.[25]

Finally, I created a categorical measure, "Industry," to identify the individual's industrial affiliation. The categories include textiles, transportation, military, other

[24] See data appendix and van Leeuwen and Maas (2005) for details.
[25] The criteria for the SSI, including primary sector vs. non-primary, are inferred from the occupational title *only*. Information on work establishment that is used to construct the modernization index is **not** used in constructing the SSI. Thus, a livestock worker is assigned the same SSI regardless of being employed in a given "modern" state textiles manufactory or on a "traditional" farm.

modernized industries, and non-modernized industries.[26] The latter are defined as the industries that exist *only* in the traditional sector, while the first four categories exhaust all industries in the modern sector.

Table (1) shows the descriptive statistics for the sample of adult males who are at least 15 years, including those with missing age. Around 3% (5%) in urban Egypt are "Without Occupation," 3% (3%) are out of labor force (students and retired), and 8% (12%) have missing occupational titles in 1848 (1868). In rural provinces, the percentages of unemployed and out of labor force are negligible but the percentage missing is particularly large at 27% (31%) in 1848 (1868). About half of the adult active males in urban Egypt are unskilled workers, but the percentage is much higher in the rural Egypt at more than 80%, since this category includes farmers. The religious composition is quite stable across the two years and across urban and rural provinces, with Muslims constituting the vast majority (about 90%), followed by Christians (6-7%), and Jews (1%), but the latter are mainly urban.[27] Throughout the empirical analysis (sections IV and V), the sample is restricted to active males who are at least 15 years old and who have non-missing values for all the variables in the analysis.

IV. Empirical Analysis: State Industrial Modernization

This section examines the impact of state industrial modernization, i.e. being employed in a state modern project (*Modern*), on occupational attainment and whether this impact varies by religious group. Since profit-maximization may not have been the underlying incentive behind program, the external validity of the results is restricted to

[26] An animal-driver and a scribe in the railways both belong to the "transportation" industry.
[27] The vast majority of Christians are Coptic Christians (86%). Non-Coptic Christians are concentrated in Cairo and Alexandria where they constitute 40% of Christians. Almost all Christians in rural Egypt are Copts (98%). Jews are urban, and in Cairo are either *Rabbanite* (56%), *Karaite* (29%), or unspecified.

other experiments of state industrialization. For example, state projects deviated from the free markets norm in their recruitment policies. While the 1868 wave recruited individuals who applied voluntarily for the jobs, many workers were *drafted* into the 1848 manufactories (Owen 2002, p. 76; Marsot 1984, pp. 181-5), and headmen of urban districts carried out the drafting (Ghazaleh 1999, p. 122; Sami 1928, Vol. 2, p. 374). Many workers were discontent and cases of flight were recorded (Ghazaleh 1999, pp. 122-3). Historical evidence suggests that matching skills with job requirements was the main recruitment criterion, be it by drafting or voluntary application.[28]

Conceptually, *Modern* represents the *equilibrium* in the labor markets of state modern projects. Thus, the marginal effect of industrial modernization on occupational attainment is a "combined" effect of labor supply and demand. Supply-side factors include, besides observable individual characteristics, the unobserved individual skill that may affect the decision to apply for or be assigned to a job at the state projects.[29] Demand-side factors include the technological change that dictate the job structure in the state projects, the availability of job training as an alternative route to acquire skills away from guilds and *kuttabs*, and the recruitment policies in the projects. These factors may vary by religious group *differentially* across the modern and traditional sectors. I first introduce the results on technology-skill complementarity of state industrialization and its impact on religious occupational differentials. I then attempt to disentangle the two mechanisms of modernization's impact: technological change's demand for skills versus job training. I

[28] A state order in Sami (1928) (Vol. 2, p. 279) asserts that recruits into the cotton spinning and weaving manufactories have to be of those who had some knowledge of spinning and weaving. Similar examples are found regarding recruiting turners, carpenters, and blacksmiths who were to imitate the imported European machines (Owen 2002, p. 70), railways engineers (Sami 1928, Vol. 3, p. 242), *tarboush* (hats) weavers and dyers (Vol. 3, p. 24), shipbuilding engineers (Vol. 3, p. 330), and telegraphers (Vol. 3, p. 459).

[29] Skills were constrained by the guild structure. Jews, despite having higher school enrollment than Christians in 1848 Cairo, did not work as scribes, which was a Christian-dominated guild. They instead dominated the financial jobs. I will discuss the recruitment policies of state modern projects in IV.4.

next address the threats to the empirical strategy. I finally compare religious occupational segregation in the modern and traditional sectors.

IV.1. Technology-Skill Complementarity of State Modern Projects

Did the technology employed in each industrial wave increase the relative demand for skills, compared to the traditional sector, or was it low-skill-biased? Did technology-skill complementarity vary by industry? Evidence from the U.S. suggests that the First Industrial Revolution was "de-skilling," (Goldin and Sokoloff 1982; Atack et al. 2004), but that the relative demand for skills rose with the Second Industrial Revolution (Goldin and Katz 1998). I thus estimate the following ordered categorical regressions:

(1) $Probability\ \left(SSI_{ij} = m\right) = F\left(\alpha_j + \beta Modern_{ij} + \delta X_{ij} + \varepsilon_{ij}\right)$

(2) $Probability\left(SSI_{ij} = m\right)$

$= F\left(\alpha_j + \beta\ Industry_{ij} + \gamma\ \left(Industry_{ij} \times Modern_{ij}\right) + \delta\ X_{ij} + \varepsilon_{ij}\right)$

Where the probability that the SSI of an individual *i*, residing in district *j*, takes the value *m* (*m* = 1, …, 12) is a function $F(.)$ that depends on *Modern* in (1), and on both *Industry* dummies, as defined in section III, and a full set of interactions between *Modern* and *Industry* in (2). X_i is a vector of individual characteristics: age, slave dummy, foreigner dummy, black dummy, and migrant dummy. α_j are district fixed effects to account for variation in spatial proximity to the state projects.[30] ε_{ij} is an error term. Notice that *Industry* exhausts all the industries that exist in the modern sector.

Factor changes in odds ratios are shown in table (2). Panel (A) shows that recruitment in a state modern project reduces an individual's odds of having the highest SSI value

[30] The limited number of districts in 1848 and 1868 (97 and 53 respectively) relative to the number of observations (18,146 and 18,968) mitigates the concerns about the incidental parameters problem when including district fixed effects in the ordered categorical regression.

versus the combined lower values in 1848 (compared to the odds for an individual in the traditional sector), but improves his odds in 1868. For example, being in the modern sector in 1848 reduces the probability of working as a clerk (SSI = 9) by 0.05, but increases the probability of working as an unskilled manual worker (SSI = 2) by 0.20. On the other hand, in 1868, modernization increases the first probability by 0.08, but decreases the second probability by 0.05. Thus, the technology of the 1848 wave was low-skill-biased, i.e. it increased the relative demand for low-skilled workers, while the technology of the 1868 wave was complementary to high skills. The 1848 regional estimates suggest a stronger low-skill-bias in rural provinces than in urban provinces.

Panel (B) shows that the effect of industrial modernization varies by industry; modern textiles that dominated the 1848 wave is low-skill-biased, while modern transportation that dominated the 1868 wave is high-skill-biased. For example, being in a modern textile manufactory in 1848 compared to traditional textiles increases the probability of being an unskilled manual worker by 0.55 [95% CI = (0.47, 0.63)]. But working in a modern transportation enterprise compared to traditional transportation in 1868 increases the probability of being a clerk by 0.29 [95% CI = (0.22, 0.33)].[31] The results are qualitatively similar across urban and rural provinces. The findings seem to be consistent with the evidence from industrialized countries. Goldin and Sokoloff (1982) showed that textiles made an intensive use of women and children, as unskilled workers, in the early U.S. industrialization. Also, improvements in transportation increased the relative demand for skills in the U.S. in the early 20th century (Goldin and Katz 1995).

[31] Traditional textile workers are primarily skilled, such as weavers and spinners, while traditional transportation workers are primarily unskilled, such as animal drivers and boatmen. Throughout section IV, all CIs are calculated by Delta method at the 95% confidence level, and all average marginal effects on the probability of a particular outcome are for a free, non-black, non-migrant, and non-foreigner individual.

IV.2. State Production Projects, Religion, and Occupational Differentials

Did religious groups benefit (or were hurt) *equally* by the new demand for labor that the projects created or were specific groups poised to benefit more than others? Did modernization reduce or aggravate religious occupational differentials? Did this impact vary by industry? I estimate the following equations to tackle this question:

$$(3) Probability\ (Occupational\ Attainment_{ij} = m) = F\big(\alpha_j + \beta Modern_{ij} + \gamma Christian_{ij} + \pi Jew_{ij} + \delta(Modern_{ij} \times Christian_{ij}) + \theta X_i + \varepsilon_{ij}\big)$$

$$(4)\ Probability\ \big(SSI_{ij} = m\big) = F\big(\alpha_j + \beta Christian_{ij} + \gamma Jew_{ij} + \delta MainIndustry_{ij} + \theta\big(MainIndustry_{ij} \times Christian_{ij}\big) + \varphi Modern_{ij} + \mu\big(MainIndustry_{ij} \times Modern_{ij}\big) + \pi\big(Modern_{ij} \times Christian_{ij}\big) + \tau(MainIndustry_{ij} \times Modern_{ij} \times Christian_{ij}) + \rho\, X_{ij} + \varepsilon_{ij}\big)$$

Where *Occupational Attainment* = SSI or *Occupational Group*. The probability distribution of each outcome in (3) depends, besides *Modern*, on *Christian* and *Jew*, indexes for religious affiliation, and the interaction of *Christian* and *Modern*. I do not include an interaction of *Jew* and *Modern* because of the small number of Jews in the modern sector. In (4), *MainIndustry* = textiles in 1848 and transportation in 1868

Table (3) shows the factor changes in odds ratios from the ordered logit regressions of equations (3) and (4) where SSI is the dependent variable. The odds of having the highest SSI value versus the combined lower values for a Christian or a Jew in the traditional sector are greater than for a Muslim. The findings of table (2) hold for the Muslim majority; working in the modern sector implies *downward* mobility among Muslims in 1848 but *upward* mobility in 1868. Christians in the modern sector, however, experienced *upward* mobility in *both* waves. Thus, for a Muslim in the modern sector, the

probability of working as a clerk is lower by 0.06 [CI = (-0.07, -0.05)] in 1848 but higher by 0.06 in 1868 [CI = (0.01, 0.11)], compared to a Muslim in the traditional sector. However, for Christians in the modern sector, the effects are 0.12 [CI = (0.07, 0.16)] in 1848 and 0.15 [CI = (0.09, 0.20)] in 1868. Overall, modernization widens the religious *average* SSI gap in 1848, but does not alter it in 1868 [See figure (2) for the effect of modernization on the religious differential in probability of each SSI value].[32] Moreover, the impact varies by industry; working in modern textiles in 1848 caused downward mobility among Muslims but modern transportation in 1868 improved their lot. Christians, however, enjoyed upward mobility in *both* industries in 1848 and 1868.

As an alternative specification, I use *Occupational Group* as the dependent variable in (3), and I estimate a multinomial logit regression. The rationale is to relax the *proportional odds assumption* and to allow the coefficients to vary by occupational outcome. The estimated average partial effects are in table (4). Non-Muslims' advantage in the traditional sector in 1848 and 1868 is in *both* skilled and white-collar occupations. Recruitment in the modern sector reduces a Muslim's probability of being a white-collar worker by 0.05 [CI = (-0.07, -0.03)], but increases it by 0.20 [CI = (0.14, 0.26)] in 1868, compared to a Muslim in the traditional sector. For Christians in the modern sector, the effects are 0.29 [CI = (0.16, 0.43)] in 1848 and 0.34 [CI = (0.13, 0.56)] in 1868. The religious white-collar gap is wider in the modern sector in 1848 but not in 1868.

In general, while modernization widened the Christian-Muslim occupational gap in 1848, it did not affect it in 1868. This stems from the downward mobility of Muslims in the 1848 modern textile manufactories, and their upward mobility in the 1868 modern

[32] A wider religious average SSI gap means that the ratio of Christians' odds of having the highest SSI value versus the combined lower values compared to Muslims' odds in the modern sector is larger than the corresponding ratio of Christians' to Muslims' odds in the traditional sector.

transportation enterprises. Christians, on the contrary, experienced upward mobility by employment in state modern projects in *both* industrial modernization waves and in both textiles and transportation. In the next subsection, I will examine the mechanisms that may account for these findings.

IV.3. Mechanisms of Modernization: Technological Change or Job Training?

Two mechanisms may account for the findings in tables (3) and (4): (i) *Technological Change*: In 1848, the technological change embodied in the modern sector decreases the relative demand for Muslims' skills, but increases the relative demand for Christians' skills, compared to the relative demand for skills of their coreligionists in the traditional sector. In 1868, technological change increases the relative demand for *both* Muslims' and Christians' skills. Under this mechanism, guilds and *kuttabs* still dominate the acquisition of skills, and state production projects are merely hiring workers based on their skills.[33] (ii) *Job Training*: State production projects provide job training for skill-acquisition. Training effect can be either positive or negative depending on the relative average SSI of the "training-based" jobs in the modern sector compared to that of the jobs for which there is no job training provided. According to this mechanism there is positive training effect for Christians in both 1848 and 1868. The training effect for Muslims is negative in 1848 but positive in 1868.

To examine these mechanisms, I classify occupations in the modern sector into two types: "overlapping" or "guild-based" occupations, i.e. those that exist in *both* traditional and modern sectors; and "new" or "training-based" occupations, i.e. those that exist

[33] The observation that the *three* Jews who are observed in the modern sector in the sample are all in modern banks may also be explained using the technological change and the relative demand for skills mechanism. Since skills are guild-specific, Jews did not traditionally possess a skill in administrative occupations, and their comparative advantage lied in financial occupations. Hence, it was only the technology of the modern banks that benefited Jews by increasing the relative demand for their skills.

solely in the modern sector and are thus presumably *created* by modernization.[34] In this classification, the "overlapping" occupations, which recruited 73% and 66% of modern sector employment in 1848 and 1868 respectively, proxy for the technology effect, because they were controlled by guilds in the traditional sector that provided a priori training through apprenticeships. "New" occupations, on their part, are a proxy for the training effect, because they did not possess guilds to provide training to employees and so had to resort to job training, which is supported by historical evidence.[35] I construct an index for working in a "new" occupation, "New," and I extend equation (3) to be:

$$(5) Probability(SSI_{ij} = m) = F\big(\alpha_j + \beta Modern_{ij} + \gamma Christian_{ij} + \pi Jew_{ij} + \rho\,(Modern_{ij} \times New_{ij}) + \delta(Modern_{ij} \times Christian_{ij}) + \tau(Modern_{ij} \times New_{ij} \times Christian_{ij}) + \theta X_i + \varepsilon_{ij}\big)$$

Notice that the technology effect for Muslims in the modern sector is captured by *Modern*, while the training effect for Muslims is captured by the interaction of *Modern* and *New*. For Christians, the effects are augmented by *Christian*. The factor changes in odds ratios are shown in table (5). In 1848, the technology effect for a Muslim in the modern sector reduces his odds of having the highest SSI by a factor of 0.43. The training effect reduces the odds for a Muslim in a "new" occupation of having the highest SSI by

[34] "New" occupations include, for example, telegraphers, train drivers, ticket conductors on trains and trams, factory workers, and printing workers. Almost every occupation that exists in the traditional sector has a guild, and so it is safe to assume that the "overlapping" occupations are "guild-based." A few "overlapping" occupations, such as engineers, physicians, and military officers are education-based or military-based rather than guild-based, and are thus an outcome of modernization in its broader sense. Also job training might have been provided for some of the "overlapping" occupations. I will examine the impact of modernization on professional and military occupations in section V. However, since my interest here lies in identifying the training effect of *industrial* modernization per se, I chose a rather conservative definition of "new" occupations that can be safely attributed to job training provided by these projects.

[35] Evidence includes workers in glass manufacturing (Sami 1928, Vol.2, p. 368 and 376), sugar refining (Vol. 2, p. 376), cotton spinning and weaving (Vol. 2, p. 384), silk spinning and weaving (Vol. 2, p. 421), telegraph (Vol. 3, p. 240), machine building (Vol. 3, p. 331), printing (Vol. 3, p. 659), and gun making (Vol. 2, p. 384 and Vol. 3, p. 992). An 1866 state order (Vol. 3, p. 652) introduced telegraph as one of the subjects to be taught to students in public schools to satisfy the need for telegraphers in the railways.

an additional factor of 0.07 compared to a Muslim in an "overlapping" occupation in the modern sector. For Christians the two effects operate in opposite directions but the technology effect dominates; there is a positive technology effect of 2.85 (0.43*6.63), but a negative additional training effect of 0.004 (0.07*0.05). In 1868, the technology effect for both Muslims and Christians is positive but is *stronger* for the latter; it increases a Muslim's (Christian's) odds of having the highest SSI by a factor of 1.91 (5.39). The additional training effect is insignificant for Muslims but is negative for Christians.

The results of table (3) are thus mainly explained by technological change. Christians, who traditionally had a skill advantage over Muslims, gained more from state industrialization that increased the relative demand for their skills in both 1848 and 1868. Muslims were hurt in 1848 because of the low-skill-bias of the textiles technology, but benefited in 1868 because of the high-skill-bias of the transportation technology. The effect of job training in the new occupations, although perhaps more open to individuals than guild-based occupations, was either negative or insignificant because the average SSI of the "training-based" occupations was lower than (not different from) that of the "guild-based" occupations in the modern sector.

IV.4. Examining the Validity of the Empirical Strategy

Does the traditional sector in each census year represent a valid counterfactual that captures what the religious occupational differentials would have been like in the *absence* of state-led modernization? This is violated if state modern projects generate general equilibrium effects, such as crowding-out of private producers via competition in the output markets.[36] To examine this possibility, I first observe that the religious

[36] Forced crowding-out through drafting of private producers into state projects is also possible and has been documented in Owen (2002, p. 69) especially in the case of textile workers.

occupational segregation in the traditional sector is similar to what has been documented in the late 18th and early 19th century, i.e. before modernization (Raymond 1973, pp. 524-6). Second, the employment share of the modern sector is 8% and 3% of adult active male population in Cairo and Alexandria in 1848 and 1868 respectively. The percentages are even lower in the other provinces at 2% and 0.3%.[37] These numbers indicate a significant modern sector which is not, however, large enough to generate general equilibrium effects. This observation is confirmed by estimating the following panel equation at the district-level:

$$(6) ThreatIndustry_{jt} = \alpha_j + \beta_{1868} + \gamma Projects_{jt} + \varepsilon_{ij}$$

ThreatIndustry is the percentage of active adult males in the traditional sector in the district who work in a "threatened" industry; i.e. an industry for which a state project has been established. *Projects* is the supply of state projects in the "threatened" industry in the district. α_j is district fixed effects, and β_{1868} is 1868 year fixed effect. I estimate equation (6) for each "threatened" industry separately, and I conduct the analysis at the district-level to have a meaningful output market. The results are shown in table (6). In all three industries: textiles, transportation, and military, the coefficient on *Projects* is either insignificant or positive, thus implying no crowding-out effects.

But are there significant differences in the religious *bias* of the recruitment policies across modern and traditional sectors that may drive the results? I compare the religious composition *within* the "overlapping" or "guild-based" occupations across traditional and modern sectors. My rationale is that if the religious bias of recruitment policies differed

[37] Marsot (1984, p. 181) cites a much higher employment at 20-25% of adult males who are at least 15 years old in 1833. If her estimates are accurate, employment must have fallen sharply in the 1840s, and what one observes in 1848 is already a low point in the employment of modern projects. This might be in line with the general decline of state-led modernization in response to the London treaty of 1841.

across the two sectors, one should observe different religious composition of the "overlapping" occupations, on average. In 1848, the average percentage of Christians in the "overlapping" occupations in the traditional and modern sectors is 8% and 6% respectively. In 1868, the percentages are almost identical across the two sectors (7%).[38] In figure (3), I show the percentage of Christians in the large (>= 9 workers in each sector) "overlapping" occupations in both sectors. These occupations constitute 55% (53%) of modern sector employment in 1848 (1868). Overall, the religious composition of these occupations is very similar across the two sectors, thus suggesting no significant difference in the religious bias of recruitment policies.[39]

IV.5. State Production Projects and Religious Occupational Segregation

Were state modern projects more integrated within occupations across religious groups than the traditional guilds? I measure occupational segregation by two segregation indexes, dissimilarity and isolation. Dissimilarity index measures the share of the Christian population that would need to change occupation so that religious groups become evenly distributed across occupations within the sector (traditional or modern). Isolation index, on the other hand, measures the percentage of Christians in the occupation practiced by the average Christian (Cutler and Glaeser 1997).

[38] The z-statistic for test of equality of proportions across sectors is 0.005 and -0.003 in 1848 and 1868 respectively. The number of "overlapping" occupations in 1848 and 1868 is 44 and 43 respectively, and is equal, by construction, across traditional and modern sectors. The computed average percentage of Christians in each sector is the average of the percentages of Christians over "overlapping" occupations in that sector, weighted by the occupation size. The occupational percentage of Christians used in calculating this average is computed from the systematic sample only.

[39] The religious bias of recruitment policies in the "training-based" occupations may have been different from that in the traditional sector. Evidence cited in Heyworth-Dunne (1938, p. 338) suggests that the government did not hire Copts as printing workers (!). However, the analysis in subsection IV.3 shows that the main findings are driven by technology mechanism which is in turn affected by the recruitment policies in the "guild-based" occupations only.

Table (7) shows the occupational segregation indexes for the traditional and modern sectors in 1848 and 1868, and for each of the "old," "overlapping," and "new" occupations, where "old" occupations are those that exist in the traditional sector *only*. I find that occupational segregation is not attenuated by modernization, and that the work force in state modern projects was equally segregated as the work force in the traditional sector. Interestingly, occupational segregation is not restricted to "guild-based" occupations and is equally large in the "training-based" occupations.

The result seems to be consistent with considerable historical evidence that suggests that recruitment policies of the modern sector generally preserved the (religiously-segregated) guild structure. The 1823 account books of the largest textile manufactory in Egypt in 1848 classified workers by guilds (Ghazaleh 1999, p. 131). Ghazaleh (1999, pp. 122-3) cites several events in which the government resorted to the guilds headmen in order to solve problems with workers in the state projects. Baer (1964, p. 94) states explicitly that Muhammad Ali used guilds to supply workers for his manufactories. Along the same lines, an 1876 document in Amin (1928, p. 1304) elaborates the role of the guilds headmen in resolving conflicts between the state and workers in a modern industrial institution, Alexandria port. Baer (1964, p. 108) makes a similar point when mentioning that the steam navigation companies demanded the opening up of the labor market to get rid of the control of the pilots' guild over the supply of workers.

V. Empirical Analysis: Educational and Military Modernization

V.1. Educational Modernization

Having examined the impact of state industrialization, I now turn to educational modernization. I first evaluate the impact of four public modern schools of higher

education: engineering, medicine, veterinarian medicine, and translation that operated over the period (1827-54), and that did not admit non-Muslims until 1873, on religious differentials in occupational attainment. I then examine whether modern schools, both public and private (at all educational levels), that grew since the first half of the 19th century, acted as an integrating device for religious minorities, or they were rather equally segregated as the traditional educational scheme.

With regard to the first question, I estimate the following linear probability regression:

$$(7) Professional_{ij} = \alpha_j + \beta_t + \gamma Nonmuslim_{ij} + \delta\, Tcohort_{ij} + \pi\, Ycohort_{ij} + \theta\left(Nonmuslim_{ij} \times Tcohort_{ij}\right) + \tau\left(Nonmuslim_{ij} \times Ycohort_{ij}\right) + \rho\, Z_{ij} + \varepsilon_{ij}$$

In this regression, *Professional* is an index for working in a professional occupation (engineer, physician, pharmacist, veterinarian, medical assistant, nurse, translator, or interpreter). β_t is an 1868 census year dummy. *Nonmuslim* is an index for being non-Muslim. *Tcohort* is an index for the "treated" cohort (1812-34) that was poised to benefit from the public modern schools operating in 1827-54.[40] *Ycohort* is an index for the younger untreated cohort (1834-47) that witnessed the closure of the schools by the time it was in higher-education age. The base cohort is the older untreated cohort (1778-1812) that was too old to enter these schools when they were opened. Identifying the effect of modern schools (and whether it varies by religion) comes from differences in the availability of the four schools across cohorts of birth. *Z* is a vector of individual-level characteristics including slave index, foreigner index, black index, migrant index, and the interactions of the foreigner index with cohort of birth. I restrict the sample to active males who are 21-70 years old in each census year, and I pool the two census years

[40] I assume that students enter these schools for a period of five years, from age 15 to 20, which is consistent with the admission system in these schools (Sami 1928, Vol. 3(3), p. 1123).

together to obtain a reasonable sample size in each birth cohort in the professional occupations. Finally, I estimate the regression for the full sample, but when I restrict it to the urban areas, where the four schools operated, the results are not affected.

Table (8), column (1), shows the results. The coefficients should be interpreted as the lower bound of the true effects of the four schools. Graduates of these schools may have worked in other professional occupations which are not directly related to the fields they specialized in.[41] Also, in a society with a very low human capital, providing education to these pioneering students is expected to have high returns and to create knowledge spillovers. I find that Muslims in the "treated" cohort are more likely to work in a professional occupation by 0.4 percentage point than their coreligionists in the old cohort. Non-Muslims in the old cohort are not statistically different from Muslims (although the effect is positive at 0.3 percentage point), and the religious "professional" gap in the treated cohort is smaller, but statistically not different from, the gap in the old cohort. I find that the young "untreated" cohort is insignificantly different from the old "untreated" cohort, thus lending support to the hypothesis that it is the four schools, rather than general trend effects, that explain the upward mobility of Muslims towards professional occupations in the treated cohort. Historical evidence lends support to this finding.[42]

The finding comes as no surprise given the institutional ban on non-Muslims from entering these schools. They had to resort to local guilds training, or training outside Egypt, in order to enter these high-profile occupations. 75% of non-Muslims in professional occupations in the sample are foreigners, compared to 0.6% among

[41] Biographies of prominent graduates of these schools confirm this possibility. Many of these graduates worked as managers of governmental departments and state production projects, judges, and lawyers (Heyworth-Dunne, 1938, pp. 159-63, 177-80, 253-64, 269-71, 304-7, 326-9).

[42] Heyworth-Dunne (1938, p. 433) mentions that "the training of translators has practically ceased with the closing of the establishment… and the government services had to fall back on Syrians or foreigners."

Muslims. Thus, it is possible to conclude that the four schools provided upward mobility routes for local Muslims to replace foreign non-Muslims in professional occupations.

Table (9) shows the religious composition of students in religious and modern schools at both the pre-higher and higher-education levels in 1848 and 1868.[43] First, modern schools were equally religiously segregated as the religious schools, with Muslims going to public schools and non-Muslims to private ones. This segregation pattern persisted until mid-20th century. Second, although modern schooling generally expanded between 1848 and 1868, the growth was faster among non-Muslims. 40% of non-Muslim students went to modern schools in 1868, as opposed to only 4% of Muslim students.

V.2. Military Modernization

Promoting Egyptians to high commissioned officers' ranks and conscripting non-Muslims in the army under Sa'id (1854-63) were two major reforms in the military and social history of Egypt. In this subsection I examine whether the promotion reform benefited both Muslims and non-Muslims equally, and whether the army integrated non-Muslims at all military ranks in 1868, as a result of the reforms, as Khedive Ismail claimed. In particular, I estimate the following linear probability equation:

$$(8) CommOfficer_{ij} = \alpha_j + \beta_t + \gamma Nonmuslim_{ij} + \delta Mcohort_{ij} + \theta\left(Nonmuslim_{ij} \times Mcohort_{ij}\right) + \rho\, Z_{ij} + \varepsilon_{ij}$$

CommOfficer is an index for being a commissioned officer. *Mcohort* is an index for the "treated" cohort (1838-47) that was poised to benefit from the promotion reform.[44] The base cohort in the regression is the older cohort that was born in 1778-1838. The

[43] Sample consists of males currently enrolled in schools in 1848 and 1868 with non-missing religion. Low enrollment in public schools is consistent with the evidence on the closures of public schools after 1841.

[44] Since I could not find a specific date for the first reform, I assume it took place in the middle of Sa'id's reign, i.e. in 1858/59. I assume that the promotion to commissioned officer's rank occurs at 20 years old which is the average age of graduation from military schools.

results are shown in table (8), column (2). Two caveats in the regression are the missing age for 32% of the commissioned officers in the sample,[45] and the extremely small number of non-Muslim officers (only 2 officers). Non-Muslims in the old cohort are less likely to be officers than Muslims. Muslims in the treated cohort are more likely to be commissioned officers than their coreligionists in the old cohort, and the gap is even wider in this cohort in favor of Muslims. Foreigners in the old cohort are more likely to be officers than locals (since Turks dominated the commissioned officers' body before the reform). The foreigner-local gap is not affected by the reform, however.

Because of the small number of non-Muslims in the army and the scarcity of information on the covariates for the military personnel, I evaluate whether both reforms led to the integration of non-Muslims in the army by comparing the religious and nationality composition of the Egyptian army in the sample across 1848 and 1868 in Table (10). The army is overwhelmingly Muslim in both 1848 and 1868, but there is a rise in the share of non-Muslims in the total military personnel from 1% to 3% (still below their population share of 7%) between the two years, perhaps as a result of the conscription reform. Although Egyptian non-Muslims had access to commissioned officers' ranks by 1868 because of the promotion reform, their representation in the army remained mainly at the soldier level. Egyptian Muslims, on the other hand, improved their lot vis-à-vis the Turkish officers from 40% of the officers' body in 1848 to 69% in 1868. Thus, it appears that the officers' promotion reform benefited mainly Egyptian Muslims, while the non-Muslims' conscription reform increased their access to the army as soldiers in 1868. Contrary to what Khedive Ismail believed, their representation in the

[45] Military personnel were usually not enumerated in the 1848 and 1868 censuses as they were to be enumerated in an "undiscovered" military census. Their census returns thus only include name, location, occupation, and nationality. See Saleh (2011) for more details.

army was still below their national share, thus suggesting they were not fully integrated yet, especially at the commissioned officers' ranks.

VI. Conclusion

State-led modernization in 19th century Egypt was perhaps *the* most significant institutional intervention in the Middle East since the Ottoman Conquest in the 16th century. The state's intense modernization programs in production, education, and the army, strongly shook the inherited medieval institutions that preserved deeply-rooted inequalities, most importantly between religious groups. Using samples that I digitized of the 1848 and 1868 Egyptian census manuscripts, the earliest individual-level data source in the Middle East, the paper sheds entirely new lights onto two major and highly controversial questions in the Middle Eastern economic history literature. It provides the first rigorous quantitative evidence on the magnitude of the human capital gap between Muslims and non-Muslims in Egypt, on the nature of the technologies used in Egypt's long-debated industrial modernization program in its two waves, and on the impact of industrial, educational, and military modernization on the religious gap.

I found that the first wave of industrial modernization in 1816-48 increased the religious human capital gap. Its technology increased the relative demand for low skills (primarily in textiles), affected Muslims adversely but benefited Christians who experienced upward mobility because their administrative skills were highly demanded by the manufactories. The second wave in 1848-68 did not alter the gap. Its technology that was complementary to high skills (primarily in transportation), led to upward mobility among *both* Muslims and Christians. In contrast, educational and military modernization benefited Muslims more than non-Muslims, and increased their upward

mobility to high-profile jobs, such as physicians, engineers, translators, and high-ranked commissioned officers in the face of foreign non-Muslims (in professional occupations) and the Turkish Muslim elite (in military officers' ranks). Nevertheless, the impact of these reforms was limited to a tiny fraction of the Egyptian Muslim population and thus did not lead to a general catching-up effect with non-Muslims. In all three modern institutions, state industrial establishments, modern schools, and the army, religious segregation was not attenuated both because the traditional skill-acquisition institutions, guilds and *kuttabs*, remained dominant, and because the new channels for mobility (job training, modern education, military training), that were created by modernization, were themselves segregated.

The findings of the paper have implications for several literatures including those on state-led modernization, technological change and labor market inequality, and ethno-religious segregation. The failure of the first wave of industrial modernization in Egypt (1816-48) in raising the human capital of the Muslim population may suggest that a successful state-led modernization program should establish skill-acquisition institutions rather than *pure* production institutions. Focusing on state production projects that still rely on traditional skill-acquisition institutions makes modernization largely *superficial*. My findings also suggest that technological change alters the relative demand for skills but that this effect may vary across social groups. The effect on each group depends on the matching between the group's traditionally-dominated skills and the specific skills that the modern technology demands. Finally, my findings also imply that ethno-religious occupational segregation can be altered by a deliberate program if the program provides

alternative routes for skill-acquisition through job training, educational, and military modernization that can effectively replace the traditional gap-preserving institutions.

Convergence in educational and labor market outcomes between religious groups in Egypt may have had to await the second major (and highly controversial) state-led modernization program under Nasser (1952-70). I show in another paper that the educational modernization aspect in Nasser's program, that made a complete transformation of *kuttabs* to public modern schools, was more successful in closing the religious gap by the end of the 20th century. In an ongoing research, I am also investigating whether 19th century state industrialization that did not attenuate religious *occupational* segregation, reduced religious *residential* segregation through creating more integrated working-class neighbourhoods around the state production projects. I am exploring this possibility using GIS techniques to map the 1848 and 1868 individual census records and the state projects in Cairo and Alexandria.

References

Acemoglu, Daron (2002), "Technical Change, Inequality, and the Labor Market," *Journal of Economic Literature*, Vol. 40 (1), pp. 7-72.

Alesina, Alberto and E. La Ferrara (2005), "Ethnic Diversity and Economic Performance," *Journal of Economic Literature*, Vol. 43(3), pp. 762-800.

Al-Gritli, Ali (1952), *Tarikh al-sina'a fi Misr fil nisf al-awwal min al-qarn al tasi' 'ashar* (History of Industry in Egypt in the First Half of the Nineteenth Century), Dar El-Ma'aref, Cairo.

Al-Hitta, Ahmed A. (1967), *Tarikh Misr al-iqtisadi fil qarn al tasi' 'ashar* (Economic History of Egypt in the Nineteenth Century), Al-Masry Publishing, Cairo.

Al-Raf'i, Abdel-Rahman (1987), '*Asr Ismail* (The Era of Ismail), Vol. 1, Dar El-Ma'aref, Cairo.

Atack, Jeremy, F. Bateman, and R. Margo (2004), "Skill Intensity and Rising Wage Dispersion in Nineteenth-Century American Manufacturing," *Journal of Economic History*, Vol. 64 (1), pp. 172-192.

Baer, Gabriel (1964), *Egyptian Guilds in Modern Times*, Israel Oriental Society, Jerusalem.

Beinin, Joel and Z. Lockman (1987), *Workers on the Nile: Nationalism, Communism, Islam, and the Egyptian Working Class, 1882-1954*, Princeton University Press, Princeton, NJ.

Black, Sandra E. and L. M. Lynch (1996), "Human-Capital Investments and Productivity," *American Economic Review*, Vol. 86 (2), pp. 263-7.

Charmes, Gabriel (1883), *Five Months at Cairo and in Lower Egypt*, William Conn (Translator), Richard Bentley & Son, London.

Costa, Dora and M. Kahn (2006), "Forging a New Identity: The Costs and Benefits of Diversity in Civil War Combat Units for Black Slaves and Freemen," *Journal of Economic History*, Vol. 66(4), pp. 936-62.

Courbage, Youssef and Philippe Fargues (1997), *Christians and Jews under Islam*; Mabro, Judy (translator), I. B. Tauris Publishers, London- New York.

Cutler, David and Edward Glaeser (1997), "Are Ghettos Good or Bad?" *Quarterly Journal of Economics*, Vol. 112(3), pp. 827-72.

Durkheim, Emile (1984), *The Division of Labor in Society*, Translated by: W. D. Halls, Free Press, New York.

Fahmy, Khaled (1998), *All the Pasha's Men: Mehmed Ali, his Army, and the Making of Modern Egypt*, Cambridge University Press, Cambridge.

Fahmy, Moustafa (1954), *La Revolution de l'Industrie en Egypte et Ses Consequences Sociales au 19^{e} Siecle (1800-1850)*, E. J. Brill, Leiden, Netherlands.

Gerschenkron, Alexander (1962), *Economic Backwardness in Historical Perspective: A Book of Essays*, Harvard University Press, Cambridge, MA.

Ghazaleh, Pascale (1999), *Masters of the Trade: Crafts and Craftspeople in Cairo, 1750-1850*, The American University in Cairo Press, Cairo, Egypt.

Goldin, Claudia and Kenneth Sokoloff (1982), "Women, Children, and Industrialization in the Early Republic: Evidence from the Manufacturing Censuses," *Journal of Economic History*, Vol. 42 (4), pp. 741-774.

Goldin, Claudia and Lawrence F. Katz (1995), "The Decline of Non-Competing Groups: Changes in the Premium to Education, 1890 to 1940," NBER Working Paper SEeries, Working Paper No. 5202.

_____ (1998), "The Origins of Technology-Skill Complementarity," *Quarterly Journal of Economics*, Vol. 113 (3), pp. 693-732.

Heyworth-Dunne, J. (1938), *An Introduction to the History of Education in Modern Egypt*, Luzac & Co., UK.

Issawi, Charles (1981), "The Transformation of the Position of the Millets in the Nineteenth Century," In *The Arab World's Legacy* by Charles Issawi, The Darwin Press, Princeton.

Marsot, Afaf L. A. (1984), *Egypt in the Reign of Muhammad Ali*, Cambridge University Press, UK.

Mokyr, Joel (2002), *The Gifts of Athena: Historical Origins of the Knowledge Economy*, Princeton University Press, Princeton, NJ.

_____ (2005), "The Intellectual Origins of Modern Economic Growth," *Journal of Economic History*, Vol. 65(2), pp. 285-351.

Newman, Saul (1991), "Does Modernization Breed Ethnic Political Conflict?" *World Politics*, Vol. 43(3), pp. 451-78.

Owen, Roger (2002), *The Middle East in the World Economy 1800-1914*, I. B. Tauris & Co Ltd, UK.

Pamuk, Sevket (2006), "Estimating Economic Growth in the Middle East since 1820," *Journal of Economic History*, Vol. 66(3), pp. 809-28.

Raymond, André (1973), *Artisans et Commerçants au Caire au XVIIIe Siècle*, Two volumes, Institut Français de Damas.

Rogowski, Ronald (1985), "Causes and Varieties of Nationalism: A Rationalist Account," In *New Nationalisms of the Developed West*, Edited by: E. A. Tiryakian and R. Rogowski, Allen & Unwi, Boston, pp. 87-108.

Saleh, Mohamed (2011), "A Pre-modern Middle Eastern Population Brought to Light: The Digitization of the 1848 and 1868 Egyptian Individual-Level Census Records," *Unpublished Manuscript*.

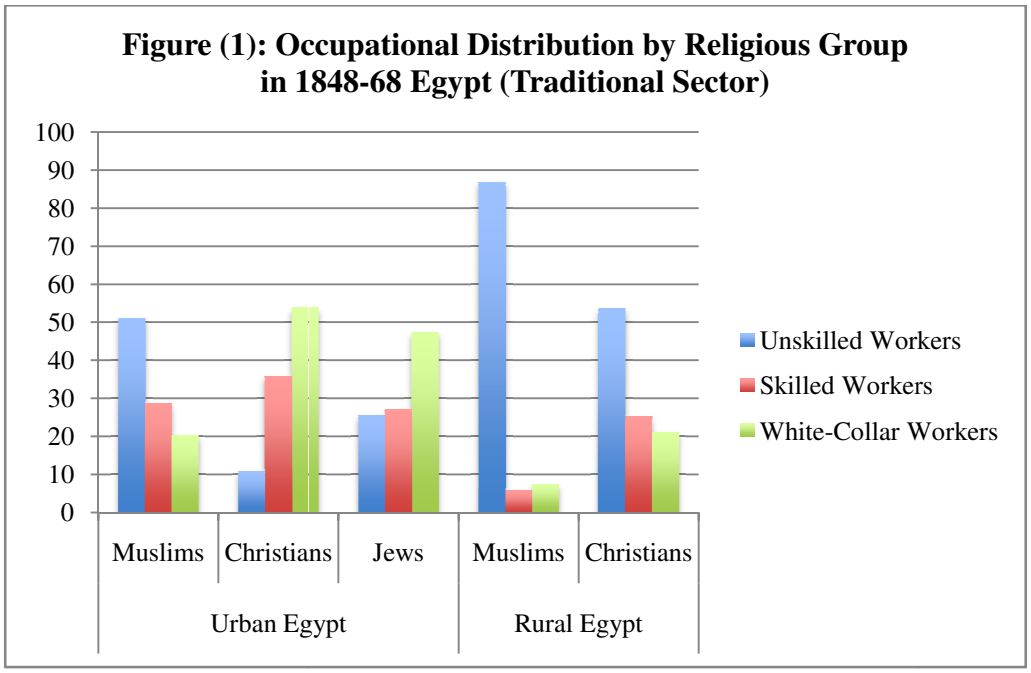
Sami, Amin (1928), *Taqwim Al-Neel* (Chronicles of the Nile), Three volumes, Dar Al-Kutub, Cairo.

Tagher, Jacques (1998), *Christians in Muslim Egypt: A Historical Study of the Relations between Copts and Muslims from 640 to 1922*, Oros Verlage, Altenberge.

Toledano, Ehud (1998), "Social and Economic Change in the Long Nineteenth Century," In *Cambridge History of Egypt*, Vol. 2, Edited by: M. W. Daly, Cambridge University Press.

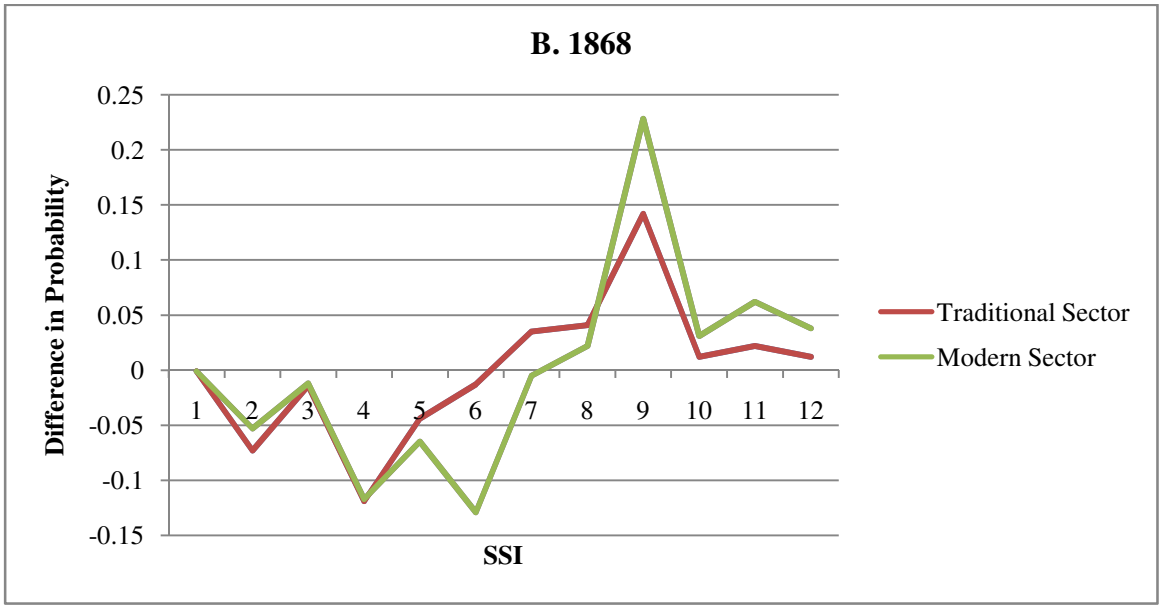
van Leeuwen, Marco H.D. and Ineke Maas (2005), "A Short Note on HISCLASS," In *History of Work Information System*, http://historyofwork.iisg.nl/

Yuchtman, Noam (2010), "Teaching to the Tests: An Economic Analysis of Traditional and Modern Education in Late Imperial and Republican China," *Unpublished manuscript*.



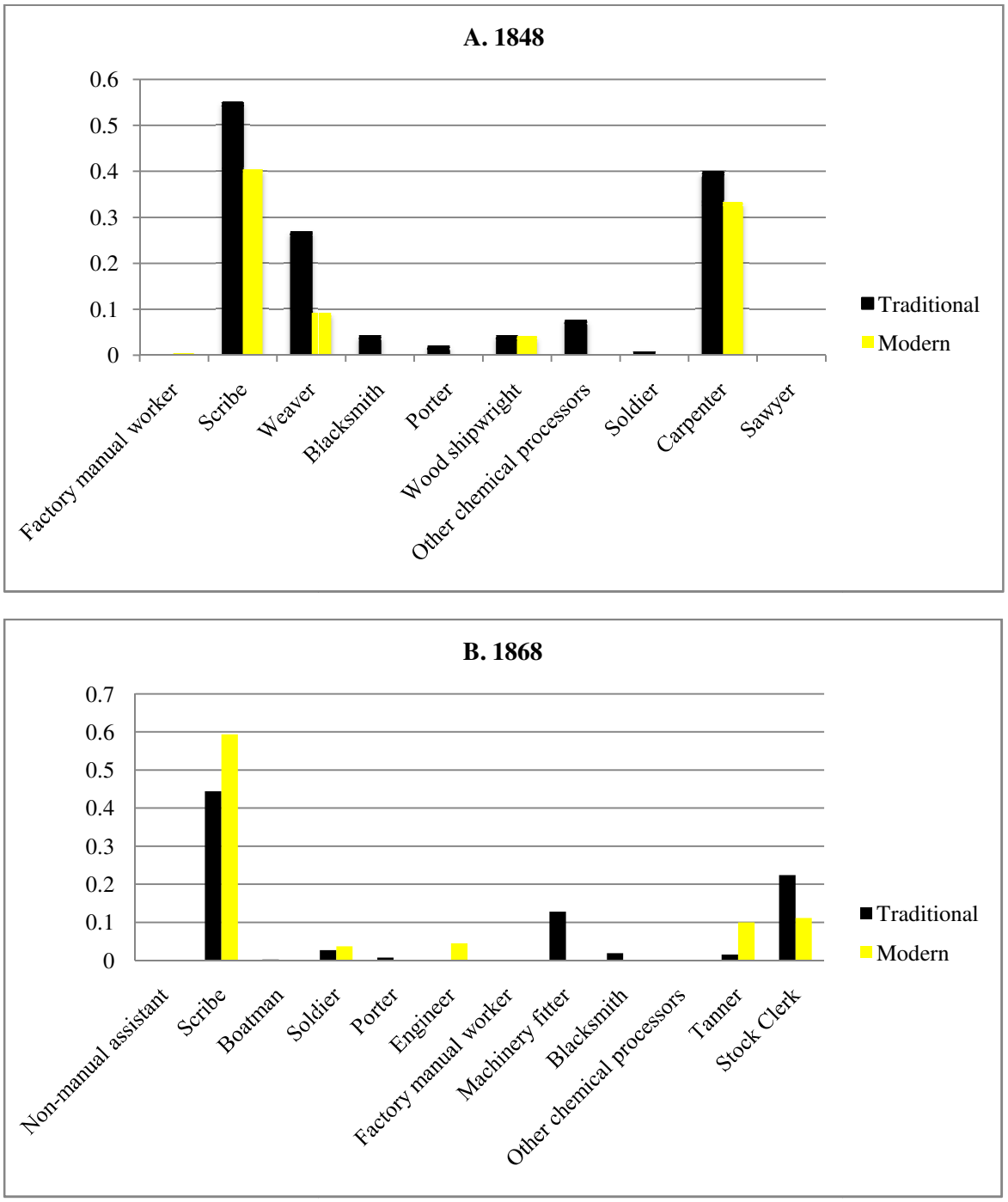
Sample is restricted to males employed in the traditional production sector who are at least 15 years old, including those with missing age. Statistics are based on the systematic sample only, and are weighted to account for the different sampling rates across the provinces. Each column represents the share of the occupational category within the relevant religious group. Urban Egypt is defined as Cairo and Alexandria, while rural Egypt includes all the other provinces.

Figure (2): Industrial Modernization and Christian-Muslim SSI Gap
(Religious Differences in Ordered Logit Predicted Probabilities for Each SSI Value)



Christian-Muslim differences in predicted probabilities of SSI values in each sector are based on the estimates of the ordered logit regressions of table (3), columns (1) and (3). Predicted probabilities are calculated for a free, non-black, non-foreigner, and non-migrant individual, while all the other regressors are set at their mean values. See data appendix for definitions of SSI values. The predicted probabilities of the 12 SSI values for a Muslim in the traditional sector in 1848 are 0.01, 0.1, 0.02, 0.13, 0.36, 0.20, 0.05, 0.04, 0.07, 0.01, 0.01, and 0.00. In 1868, they are 0.00, 0.11, 0.02, 0.22, 0.12, 0.27, 0.08, 0.05, 0.11, 0.01, 0.01, and 0.01. All differences in predicted probabilities are statistically significant at the 5% level in 1848. In 1868, they are all significant except at SSI=6 in the traditional sector and at SSI=7 in the modern sector. All the difference-in-differences estimates are statistically significant at the 5% level in both years, where the standard errors are estimated using the delta method.

Figure (3): Percentages of Christians in the Large "Overlapping" Occupations in Traditional and Modern Sectors



Sample is restricted to males who are employed in the "overlapping" occupations in the traditional and modern sectors, and are at least 15 years old, including those with missing age. Statistics are based on the systematic sample only. A large occupation is an occupation with at least 9 workers in each of the traditional and modern sectors. Occupations are ordered in the figure by the occupation's size in the modern sector, from the largest to the smallest.

Table (1): Descriptive Statistics

	1848		1868	
	Cairo and Alexandria	Other Provinces	Cairo and Alexandria	Other Provinces
Employment Status	N=11,324	N=12,457	N=19,110	N=5,878
Employed (%)	86.11	72.57	80.20	68.36
Unemployed (%)	3.26	0.37	4.51	0.41
Out of labor force (%)	2.83	0.04	3.00	0.43
Missing (%)	7.80	27.02	12.29	30.76
Occupational Attainment	N=9,792	N=9,040	N=15,286	N=4,021
White-collar worker (%)	21.96	7.73	23.69	9.80
Skilled worker (%)	27.80	6.73	29.55	8.26
Unskilled worker (%)	50.24	85.54	46.76	81.94
Social status index (Mean)	5.43	5.01	5.67	5.21
Modernization	N=9,792	N=9,040	N=15,286	N=5,878
Employed in the modern sector (%)	7.55	1.75	3.33	0.32
Military personnel (%)	4.15	1.50	2.31	6.53
Professional occupation (%)	0.90	0.00	0.85	0.00
Religion	N=11,324	N=12,457	N=19,110	N=5,878
Muslim (%)	89.90	92.65	86.44	89.79
Christian (%)	7.14	6.34	6.06	6.74
Jew (%)	1.16	0.03	1.01	0.00
Non-Muslim (unspecified) (%)	0.31	0.02	3.43	0.00
Missing (%)	1.07	0.96	3.07	3.47
Demographic				
Age (Mean)	37.46 (N=10,593)	40.45 (N=12,294)	35.51 (N=17,071)	38.18 (N=5,858)
Slave or emancipated slave (%)	1.56 (N=11,316)	1.33 (N=12,454)	1.42 (N=19,024)	1.97 (N=5,742)
Outside government's control (%)	10.99 (N=11,018)	1.13 (N=12,419)	12.26 (N=19,004)	0.68 (N=5,864)
Abyssinian, black, or Nubian (%)	3.35 (N=10,794)	0.12 (N=12,336)	5.56 (N=17,852)	2.94 (N=5,846)
Migrant (%)	58.36 (N=9,948)	6.23 (N=12,286)	35.26 (N=18,369)	3.67 (N=5,644)

Sample is restricted to adult males who are at least 15 years old, including those with missing age. Sample size varies from one variable to another to reflect the missing values for each variable. Sample weights are used to adjust for the different sampling rates across provinces. Descriptives are based on systematic sample only. See data appendix for definitions of variables.

Table 2: Testing for Technology-Skill Complementarity in State Modern Projects

Ordered Logit Regression- Dependent Variable: Social Status Index

	1848			1868	
	All Egypt	**Cairo and Alexandria**	**Other Provinces**	**All Egypt**	**Cairo and Alexandria**
Panel A: Overall Technology-Skill Complementarity					
Modern	0.254***	0.356***	0.083***	2.021***	1.994***
	(-5.28)	(-4.60)	(-7.04)	(3.94)	(4.26)
District fixed effects	Yes	Yes	Yes	Yes	Yes
Pseudo R-squared	0.044	0.043	0.040	0.029	0.03
Panel B: Technology-Skill Complementarity by Industry					
Textiles × Modern	0.018***	0.039***	0.006***	0.072**	0.089***
	(-15.14)	(-9.02)	(-12.63)	(-2.53)	(-2.61)
Transportation × Modern	2.063	2.537	3.064	24.948***	16.865***
	(0.49)	(0.45)	(0.63)	(14.45)	(12.63)
Military × Modern	0.950	1.154	0.722	0.590	0.974
	(-0.20)	(0.60)	(-0.32)	(-1.35)	(-0.13)
Other Modernized Industries × Modern	0.265**	0.401**	0.028***	0.755	0.749
	(-2.46)	(-2.15)	(-2.86)	(-0.65)	(-0.71)
Textiles	2.041***	0.922	7.562***	1.403***	1.234**
	(5.51)	(-0.46)	(24.65)	(3.94)	(2.11)
Transportation	0.081***	0.168***	0.006***	0.132***	0.183***
	(-14.11)	(0.033)	(-16.35)	(-16.81)	(-14.32)
Military	1.663***	0.920	7.284***	1.127	1.003
	(3.96)	(-0.73)	(13.23)	(1.34)	(0.04)
Other Modernized Industries	0.761***	0.609***	2.622***	0.738***	0.679***
	(-2.73)	(-5.33)	(2.99)	(-4.08)	(-5.28)
District fixed effects	Yes	Yes	Yes	Yes	Yes
Pseudo R-squared	0.073	0.067	0.093	0.051	0.051
# Districts	97	15	82	53	19
# Villages/Urban quarters	859	194	665	616	250
# Observations	18,146	9,315	8,831	18,968	15,133

Odds ratios are reported. Z-values are between parentheses. Robust standard errors are clustered at the village/urban quarter level. Sample is restricted to employed males who are at least 15 years old with non-missing values for all variables included in the regression. I do not run the regression for the other provinces in 1868 because the number of workers in the modern sector in the sample is very small (13 workers). Controls in each regression are: age, foreigner dummy, slave dummy, migrant dummy, and black dummy. * indicates significance at 10% level, ** indicates significance at 5% level, and *** indicates significance at 1% level.

Table 3: Impact of Industrial Modernization on Inter-religious Occupational Differentials- Ordered Logit Model

Dependent Variable: Social Status Index- Factor Changes in Odds Ratios are Reported

	1848		1868	
Christian	2.833*** (8.28)	2.992*** (7.79)	3.137*** (10.48)	2.889*** (10.38)
Jew	1.268 (0.76)	1.303 (0.86)	1.594*** (2.62)	1.459** (2.10)
Modern	0.183*** (-6.93)	0.987 (-0.05)	1.742*** (2.67)	0.477*** (-2.52)
Christian × Modern	12.703*** (8.60)	2.393** (2.55)	1.602 (1.42)	6.248*** (3.43)
Textiles × Modern		0.020*** (-10.29)		
Textiles × Modern × Christian		51.432*** (6.67)		
Textiles		2.575*** (9.23)		
Textiles × Christian		0.388*** (-3.87)		
Transportation × Modern				45.476*** (10.03)
Transportation × Modern × Christian				0.190** (-2.23)
Transportation				0.141*** (-16.85)
Transportation × Christian				0.740 (-0.78)
District fixed effects	Yes	Yes	Yes	Yes
Pseudo R-squared	0.053	0.059	0.033	0.053
# Observations	18,039	18,039	18,526	18,526

Factor changes in odds ratios are reported. Robust Z-values, clustered at the village/urban quarter level, are in parentheses. Sample is restricted to active males who are at least 15 years old with non-missing values for all variables included in the regression. Additional controls in each regression are: age, foreigner dummy, slave dummy, migrant dummy, and black dummy. * indicates significance at 10% level, ** indicates significance at 5% level, and *** indicates significance at 1% level.

Table 4: Impact of Industrial Modernization on Inter-religious Occupational Differentials- Multinomial Logit Model

Dependent Variable: Occupational Group- Partial Derivatives are Reported

	(1) Outcome: Unskilled Worker	(2) Outcome: Skilled Worker	(3) Outcome: White-Collar Worker
Panel A: 1848			
Christian	-0.387*** (0.031)	0.107*** (0.023)	0.276*** (0.032)
Jew	-0.111** (0.058)	0.023 (0.014)	0.088 (0.058)
Modern	0.052 (0.021)	0.002 (0.014)	-0.054*** (0.012)
Christian × Modern	-0.361 (0.131)	-0.012 (0.028)	0.371*** (0.115)
District fixed effects	Yes	Yes	Yes
Predicted Probability of Outcome	0.806	0.076	0.113
Pseudo R-squared	0.190	0.190	0.190
# Observations	18,039	18,039	18,039
Panel B: 1868			
Christian	-0.436*** (0.026)	0.141*** (0.025)	0.295*** (0.033)
Jew	-0.175*** (0.047)	0.014 (0.062)	0.161** (0.067)
Modern	-0.214*** (0.039)	-0.007 (0.027)	0.222*** (0.035)
Christian × Modern	-0.092 (0.154)	-0.024 (0.080)	0.115 (0.136)
District fixed effects	Yes	Yes	Yes
Predicted Probability of Outcome	0.600	0.202	0.198
Pseudo R-squared	0.130	0.130	0.130
# Observations	18,526	18,526	18,526

All columns in each year are from the same multinomial logit regression. Partial derivatives are reported. Standard errors, calculated by the delta method, are in parentheses, where the original robust standard errors are clustered at the village/urban quarter level. Sample is restricted to employed males who are at least 15 years old with non-missing values for all variables included in the regression. Additional controls in each regression are: age, foreigner dummy, slave dummy, migrant dummy, and black dummy. * indicates significance at 10% level, ** indicates significance at 5% level, and *** indicates significance at 1% level.

Table 5: Mechanisms of Industrial Modernization: Technology or Job Training?

Ordered Logit Regression- Dependent Variable: Social Status Index

	1848	1868
Christian	2.855*** (8.20)	3.134*** (10.44)
Jew	1.241 (0.68)	1.589** (2.60)
Modern	0.429*** (-3.09)	1.913 (2.92)
Modern × New Occupation	0.070*** (-8.39)	0.757 (-0.70)
Christian × Modern	6.629*** (6.27)	2.816*** (3.46)
Christian × Modern × New Occupation	0.055*** (-7.54)	0.180*** (-3.29)
District fixed effects	Yes	Yes
Pseudo R-squared	0.056	0.033
# Observations	18,039	18,526

Odds ratios are reported. Z-values are between parentheses. Robust standard errors are clustered at the village/urban quarter level. Sample is restricted to employed males who are at least 15 years old with non-missing values for all variables included in the regression. Additional controls in each regression are: age, foreigner dummy, slave dummy, migrant dummy, and black dummy. * indicates significance at 10% level, ** indicates significance at 5% level, and *** indicates significance at 1% level.

Table (6): Crowding-out Effects of State Industrialization

Fixed Effects Panel Regression- Dependent Variable: Percentage in a Threatened Industry

	Textiles	**Transportation**	**Military**
Projects	-0.004 (0.010)	-0.008 (0.042)	0.028** (0.012)
1868 Effect	-0.004 (0.005)	0.021 (0.023)	-0.002 (0.003)
Constant	0.024 (0.003)	0.044 (0.012)	0.004 (0.002)
R-squared (Overall)	0.003	0.005	0.256
# Districts	150	150	150

Standard errors are in parentheses. Percentage in a threatened industry is calculated out of the employed adult male population who are at least 15 years old in the traditional sector in the district. Systematic sample only is used in the calculation. * indicates significance at 10% level, ** indicates significance at 5% level, and *** indicates significance at 1% level.

Table (7): Occupational Segregation in Traditional and Modern Sectors

	Traditional			Modern		
	Old	Overlapping	Overall	Overlapping	New	Overall
1848						
Dissimilarity	0.423	0.756	0.525	0.749	0.06	0.635
Isolation	0.932	0.919	0.928	0.948	0.969	0.953
# Occupations	180	44	224	44	4	48
1868						
Dissimilarity	0.433	0.664	0.528	0.82	0.721	0.786
Isolation	0.946	0.93	0.939	0.928	0.919	0.925
# Occupations	162	43	205	43	15	58

"Old" occupations are the occupations that exist only in the traditional sector. "Overlapping" and "New" occupations are defined as in the text. Only systematic sample of employed adult males who are at least 15 years old with non-missing religion is used in the calculations, and dataset is collapsed at the occupation-level.

Table (8): Educational and Military Reforms and Religious Human Capital Differentials

(Linear Probability Regression)

	(1) Dependent Variable = Professional Index	(2) Dependent Variable = Commissioned Officer Index
Non-Muslim	0.003 (0.002)	-0.009*** (0.002)
Born in 1812-34	0.004*** (0.001)	
Born in 1834-47	-0.000 (0.001)	
Born in 1838-47		0.005** (0.002)
Non-Muslim × Born in 1812-34	-0.006 (0.004)	
Non-Muslim × Born in 1834-47	0.001 (0.006)	
Non-Muslim × Born in 1838-47		-0.008* (0.004)
Black	-0.004 (0.004)	-0.006*** (0.002)
Slave	0.004 (0.010)	-0.004** (0.002)
Foreigner	0.009 (0.011)	0.016*** (0.005)
Foreigner × Born in 1812-34	-0.014 (0.009)	
Foreigner × Born in 1834-47	-0.014 (0.011)	
Foreigner × Born in 1838-47		-0.000 (0.010)
Migrant	0.005** (0.003)	0.004** (0.002)
1868 Index	0.003 (0.002)	0.005*** (0.001)
Constant	0.002 (0.001)	-0.000 (0.001)
Adjusted R-squared	0.012	0.01
District fixed effects	Yes	Yes
# Observations	29,572	29,572

Robust standard errors that are clustered at the village/urban quarter level are between parentheses. Sample is restricted to employed males who are 21-70 years old in each census year with non-missing values for all the variables included in the regressions. The two census samples are pooled together. * indicates significance at 10% level, ** indicates significance at 5% level, and *** indicates significance at 1% level.

Table (9): Religious Composition of Religious and Modern Schools in 1848 and 1868

	Religious Schools				Modern Schools			
	Muslim Schools		Non-Muslim Schools		Public Schools		Private Schools	
School Sector/Level	**Muslim Students**	**Non-Muslim Students**	**Muslim Students**	**Non-Muslim Students**	**Muslim Students**	**Non-Muslim Students**	**Muslim Students**	**Non-Muslim Students**
1848								
Pre-Higher Education	692	0	0	280	6	0	0	0
Higher Education	111	0	0	0	7	0	0	0
Total	803	0	0	280	13	0	0	0
1868								
Pre-Higher Education	1,561	0	0	115	42	0	6	76
Higher Education	266	0	0	1	23	0	0	0
Total	1,827	0	0	116	65	0	6	76

Sample is restricted to male students who are currently enrolled in schools in the 1848 and 1868 censuses with non-missing religion. School sector and level for modern schools are inferred from school names which are usually recorded in the census records, combined with information on schools from Heyworth-Dunne (1938).

Table (10): The Composition of the Egyptian Regular Army by Religion and Nationality in 1848 and 1868

	Muslim Military Personnel				Non-Muslim Military Personnel			
	Egyptians	**Foreigners**	**Nationality Unknown**	**Total**	**Egyptians**	**Foreigners**	**Nationality Unknown**	**Total**
1848								
Soldier	310	22	68	400	3	0	0	3
Non-Commissioned Officer	23	10	3	36	1	0	0	1
Commissioned Officer	24	16	20	60	0	0	0	0
Total	357	48	91	496	4	0	0	4
1868								
Soldier	396	8	0	404	13	1	0	14
Non-Commissioned Officer	11	1	1	13	0	0	0	0
Commissioned Officer	97	40	4	141	2	0	0	2
Total	504	49	5	558	15	1	0	16

Sample is restricted to military personnel who are 21-70 years old with non-missing religion, but including those with missing age. There are 27 (7) military personnel in the sample with missing religion in 1848 (1868). Their occupational distribution in 1848 (1868) is as follows: 20 (3) soldiers, 1 (0) non-commissioned officer, and 6 (4) commissioned officers.

Data Appendix

1. Coding Occupational Titles in the Egyptian 1848 and 1868 Census Records and Constructing the Social Status Index (SSI)

The 1848 and 1868 Egyptian individual- level census records provide the earliest comprehensive lists of occupational titles in Egypt and perhaps in the Middle East at large. An important phase of the digitization project of the Egyptian census records (Saleh 2011) consists of the coding of the occupational titles, to make it usable in quantitative analysis. To this end, in the data entry phase of the digitization project, occupational titles were first entered in full text in Arabic exactly as they appeared in the census manuscripts. In the post- data entry phase, I coded the occupational titles in the digitized samples manually according to Historical International Standard Classification of Occupations (HISCO). The HISCO coding of the Egyptian occupational titles will be made available on the web with free access to all, through the website of History of Work Information System (http://historyofwork.iisg.nl/). In this section, I document the process of the manual coding of the occupational titles and the construction of the Social Status Index (SSI). In particular, I point out the challenges and difficulties of coding the Egyptian historical occupational titles, and the decisions that I had to make in the manual coding process. It has to be emphasized, however, that any occupational coding is by its very nature arbitrary, and thus that this manual coding is merely *one possible* coding scheme out of many possible schemes. Yet, an important advantage of the current coding scheme is that it follows the HISCO system, and will hence make the future harmonization of the Egyptian census records with the North Atlantic Population Project

(NAPP) historical census records from North Atlantic populations relatively straightforward.

In the absence of an Egyptian dictionary of occupational titles in the 19th century, I had to rely on the available historical sources on guilds and occupations in 19th century Egypt (Baer 1964; Raymond 1973; Ghazaleh 1999), besides common sense, and historians' advice[46] in understanding the Egyptian occupational titles. This was followed by finding the closest English (or French) translation of the Egyptian occupational title, and then assigning to it the HISCO code of the corresponding English-language title. HISCO scheme provides a brief description of the tasks of each occupational code. In this regard, the HISCO coding phase can be considered as a first step towards building a dictionary of occupational titles for 19th century Egypt. Finally, I created new codes for the occupational titles for which I did not find a close English or French counterpart (Table 2), based on my understanding of the HISCO major (and minor) group the title falls under. For the few titles that I could not understand, I coded them using the five-digit scheme with the first two digits being "xx", followed by three-digit serial number. Fortunately, the individuals with unknown occupations represented less than 1% of the population with recorded occupational titles in 1848 and 1868. These observations are not included in the empirical analysis and they are treated as having "missing" occupational titles.

Although the coding process is in principle a straightforward one, several challenges and difficulties arose, which I summarize as follows:

[46] I am particularly indebted to Emad Hilal at the National Archives of Egypt (NAE) for his help in this respect.

1. Difficulty of distinguishing production from commercial activity in some occupational titles: The problem mainly arises because of the peculiarity of the Arabic language, where the occupational title is merely *relating* the individual to the product he is producing/selling. For example, strictly speaking, the title "*hariry*" merely relates the individual to the "silk" product and could possibly mean that the individual is *manufacturing* silk or is rather merely *selling* silk. This causes confusion on the proper classification of the occupational title in the HISCO scheme. Nevertheless, according to Raymond (1973, 1:213), many of these occupational titles in fact involved *both* manufacturing and trade activities, where the artisan was actually selling his products. Hence, I chose to classify the occupational title as a "production" title if it was possible to produce the product in a workshop in the geographical location of the individual. For example, the title "*tabban*" which relates the individual to the "hay" product does not involve a production activity since the title existed only in the cities where making hay was not feasible, and hence I coded it as a sales occupation.

2. Omitted occupational titles where the establishment of work or employer is mentioned: In a few cases, the census scribe does not mention the occupational title of the individual and merely mentioned the work establishment or the employer of the individual. In most of these cases, however, it is possible to infer the occupational title from the information mentioned on the establishment of work. For example, an individual may be recorded as (working) in a specific military battalion, which implies that he is a "soldier". Also, an individual might be mentioned as (working) in a government manufactory or a workshop, where I infer that the individual is a "factory worker." This also applies to most of the students in the modern public schools, the religious elementary schools *kuttabs*, and the

higher religious institutes such as Al-Azhar, where the word "student" is not mentioned explicitly, and only the educational establishment is mentioned.

3. Primary and secondary jobs: In a few cases, there is more than one occupational title mentioned for the individual because the individual has two jobs. In these cases, I always coded the first mentioned occupational title unless one occupational title is a specialization (or a further explanation) within the other "general" occupation. Hence, for example an individual who is recorded as a "farmer and guard" is coded as farmer. But, specialized military personnel, such as a lieutenant engineer, were classified according to their specialization (engineer), *regardless* of the order of the occupational titles.

4. Change in occupation or in labor force participation status: In a few cases, the individual has recently changed jobs (or has recently become unemployed) and both the past and present jobs are recorded (with an indication of the timing). In these cases, I always take the *present* occupation unless the current status is "unemployed," where I take the *past* occupational title instead. This is motivated by my interest in the occupation the individual is *generally* working in rather than in his exact status at the time of the census.

5. Vague occupational titles: For some occupational titles, I used other information to determine the exact meaning of the title. For example, the title *tabe'* (follower) is coded based on the individual's legal status. Free followers are coded as domestic servants, but slave followers are coded as slaves. Another vague title is *khaddam* (servant), which could possibly mean a free domestic servant, a slave servant, or a free employee employed by the "master/employer." In all these cases, I have to combine other information on the household relationships, and legal status in order to classify the title

into one of these categories. For all the vague occupational titles, I *created* occupational codes to explicitly code them such as: *khaddam* (employee), *mustakhdim* (employee), *shaghaal* (manual worker), *mo'awen* (assistant- nonmanual), *mosa'ed* (assistant-manual).

Constructing the Social Status Index (SSI)

Based on the HISCO coding of occupational titles, I assigned values for social status standing of each occupational code following the HISCLASS measure described in van Leeuwen and Maas (2005). HISCLASS is based on classifying occupational titles according to four dimensions: manual versus non-manual, skill level, supervisory versus non-supervisory role, and primary versus non-primary sector. The authors use the 1965 Dictionary of Occupational Titles (DOT) of the USA in order to define and to classify the HISCO occupational titles/codes along the aforementioned dimensions. Table (A.1) shows the dimensions of HISCLASS with the modification that I made by extending the HISCLASS value of (6) to include unskilled non-manual workers. Three notes are in order: First, the information used in the HISCO coding or in HISCLASS is the information on occupational title *only*. The information on establishment of work is not used in the coding except in the very few cases when the occupational title is itself missing. Second, for the new occupational codes that I created and thus do *not* exist in the HISCO scheme, I had to assign values for HISCLASS. Table (A.2) shows the decisions that I made in this regard, which are based on my understanding of the nature and skill content of these occupational titles (either from direct knowledge and/or from the aforementioned historical sources). Third, for the occupational titles that exist in the HISCO scheme, I used the original HISCLASS values that are available through the

website of History of Work Information System (http://historyofwork.iisg.nl/). In order to construct the Social Status Index (SSI), and to account for the fact that occupations in nineteenth century Egypt may have had quite *different* social class standing from the occupations in 1965 USA, as reflected in the DOT, I revised the original HISCLASS values, that are based on van Leeuwen and Maas (2005). Throughout the paper, this revised measure is the one that I am using in all the empirical analysis, the SSI. As a robustness check, however, I used the original HISCLASS measure that is purely based on the U.S. classification, to replicate all the results. The results are not altered. Moreover, the correlation coefficient between the original HISCLASS and the constructed Social Status Index is 0.87.

2. Constructing the Modernization Index

I constructed the (industrial) modernization index (*Modern*) that takes the value of one if the individual is employed in a state modern production project. Fortunately, the census takers are usually keen on distinguishing between the individuals who are employed by the state (*miri*) and those who are working in the private or "outside" sector (*barrani*). The reason for this interest on part of the census takers lies, perhaps, in the growing central power of the state over the 19th century. For most of the individuals employed by the government, the name of the establishment of work was recorded in the occupation field. I constructed a dataset of state "modern" projects, by project's name, industry, and location, among other information on dates of construction and closure, number of machines, and number of workers, in both 1848 and 1868, based on information from both secondary historical sources (M. Fahmy 1954; Al-Gritli 1952; Sami 1928) and the

digitized census samples. I then combined the list with the individual census records in order to construct the individual-level modernization measure.[47]

Perhaps, an example is helpful in illustrating the procedure of creating both the *Social Status Index* and the *Modern* indices. Suppose an individual is recorded in Cairo's census manuscripts as a "carpenter in *Bulaq*'s arsenal." I first enter this information in full in Arabic, and I then code the occupational title *independently* from the establishment of work. On the one hand, I manually code the occupational title "carpenter" according to the HISCO scheme with the code "95410" which corresponds to "Carpenter, general." Following HISCLASS, I assign the value "6" to this title on the ladder of the SSI which corresponds to "medium-skilled non-supervisory manual workers in the non-primary sector." On the other hand, based on the secondary dataset of state modern production projects that I constructed, I know that Bulaq's arsenal is one of the state production projects in the military industries. Hence, this individual takes one in the modernization index. Importantly, if the individual is recorded as a carpenter *only*; i.e. employed in the traditional sector, then he would have been assigned the *same* occupational code and the same SSI as the carpenter in the modern sector.

3. Constructing the Industrial Affiliation Variable

I constructed a categorical variable named *Industry* that classifies the individual into one of five industries: Textiles, transportation, military, other modernized industries, and non-modernized industries. The first four categories exhaust all the industries in the modern sector, while the last category includes all the industries for which there is no state

[47] *Modern* is independent from the *Social Status Index* (SSI). The criteria for the SSI, including primary sector vs. non-primary, are inferred from the occupational title *only*. Information on work establishment that is used to construct the modernization index is not used in constructing the SSI. Thus, a livestock worker in a textiles manufactory is given the same SSI value as a livestock worker on a farm, although the former is working in the modern sector while the latter is in the traditional sector.

modern project operating based on the dataset of state modern projects that I constructed. The individuals for which the establishment of work is known (including all the individuals in the modern sector) are classified based on the industrial affiliation of the establishment they are working at regardless of their occupational title. The industry of the individuals for which only the occupational title is known is inferred from their title. For example, a weaver and a merchant of cloth in the traditional sector with no further information mentioned are classified into the "textiles" industry. A scribe in a textiles manufactory is classified in the "textiles" industry too. An animal-driver in the traditional sector and a scribe in the railways in the modern sector both belong to the "transportation" industry.

4. Other Variables in the Empirical Analysis

1. Religion: This is recorded directly in the 1848 census manuscripts either in front of the individual record itself or in the tabulation that follows each street or village section. In 1868, it is mostly unrecorded, but it is still straightforward to infer it from the names. Religion in Egypt is an inherited characteristic that is decided by birth and not by choice. It is the same as race in the U.S.

2. Age: This is recorded in years as of the next birthday. Individuals who are not enumerated often have missing age (Saleh 2011).

3. Slave: This is a dummy variable that takes the value of one if the individual is a slave or an emancipated slave.

4. Black: This is a dummy variable that takes the value of one if the individual is Sudanese, Nubian, or Abyssinian.

5. Foreigner: This is a dummy variable that takes the value of one if the individual is recorded as “Outside government’s control” or is of “Protégé” status.

6. Migrant: This is a dummy variable that takes the value of one if the individual is recorded as born outside the province of residence.

Table (A.1) : Dimensions of HISCLASS

Manual/ Non-manual	Skill	Supervision	Sector	Class labels	HISCLASS
Non-manual	Higher skilled	Yes	Other	Higher managers	12
			Primary		
		No	Other	Higher professionals	11
			Primary		
	Medium skilled	Yes	Other	Lower managers	10
			Primary		
		No	Other	Lower professionals, clerical and sales personnel	9
			Primary		
	Lower skilled	Yes	Other		
			Primary		
		No	Other	Lower clerical and sales personnel	8
			Primary		
	Unskilled	Yes	Other		
			Primary		
		No	Other	Unskilled non-manual workers	7
			Primary		
Manual	Higher skilled	Yes	Other		
			Primary		
		No	Other		
			Primary		
	Medium skilled	Yes	Other	Foremen	7
			Primary		
		No	Other	Medium-skilled workers	6
			Primary	Farmers and fishermen	5
	Lower skilled	Yes	Other		
			Primary		
		No	Other	Lower-skilled workers	4
			Primary	Lower-skilled farm workers	3
	Unskilled	Yes	Other		
			Primary		
		No	Other	Unskilled workers	2
			Primary	Unskilled farm workers	1

Source : van Leeuwen and Maas (2005). I made two modifications on their scheme. First, I added the category "unskilled non-manual workers" with the corresponding value "7" which is the same as that of "foremen." Second, I reversed the values of the HISCLASS index, when constructing the SSI, so that higher values indicate higher social status.

Table (A.2): Occupational Titles in the Egyptian Census Records that Do Not Exist in HISCO Scheme and Their Assigned HISCO Codes and HISCLASS Values

Code	Occupational title and description	Definitional notes	HISCLASS	Source
-11	Student or apprentice		Out of labor force	
-10	Student in a public or military school		Out of labor force	
-8	Child		Out of labor force	
-6	Student in Al-Azhar or other higher education religious institute (*mugawir*)		Out of labor force	
-5	Unemployed; without occupation		Out of labor force	
-2	Student in a religious elementary school (*kuttab*)		Out of labor force	
-1	Retired		Out of labor force	
12510	Legal representative (*Wakeel*)		4	
12610	Petition Writer (*'Ardh'algi*)		6	
13600	*Fiqi* (*Kuttab* teacher and/or general religious worker)		6	
13800	Higher Religious Institutes Teachers		2	
17155	Singers of poems praising the Prophet		11	
21250	*Waqf* manager		3	
31010	Governmental scribe		4	
33115	Banker		4	
36050	Ticket conductor on trains and trams (*kumsari*)		5	
39910	Private scribe		4	
49040	Traders in slaves (*gallab* and *yasirji*)		5	
49050	Broker (*simsar*)		5	
53260	Coffee and tea waiter (*qahwaji*)	Serves tea and coffee in an oriental coffee shop	9	
54070	Slave		11	
54075	Eunuch; Head of female slaves		11	
54080	Emancipated slave		11	
55250	Water tanks filler in public buildings (*malla'*)		9	
58410	Headmen (*sheikhs*) of villages and urban quarters		3	

59300	General-purpose assistant or servant (*khaddam*)	May serve in domestic households or in businesses or in public establishments. Chosen if product or industry cannot be inferred.	5	
59400	*Shader* makers and organizers (*shawadri*)		9	
59500	Shoe Polishers (*bouyaji*)		9	
59910	Water porters (*saqqa*)		9	
62130	Farm Slaves		12	
65000	Nomads, Bedouins, dwellers (*'orbaan*)		12	
94400	Weighters and measurers, specialization unknown		7	
95980	Railways construction workers		11	
99940	Beggar		11	
99950	Assistant, unspecified manual work (*Mosa'ed*)	Chosen if product or industry cannot be inferred.	11	
99960	Assistant, unspecified non-manual work (*Mo'awen*)	Choose if product or industry cannot be inferred	5	
99970	Employee, unspecified (*Mostakhdim*)		5	
99980	Laborer or manual worker (*Shaghaal*)		11	

Note: I reversed the HISCLASS values when constructing the SSI.