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Does Industrialization Affect Segregation? Evidence from Nineteenth-Century Cairo

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Abstract

We investigate the impact of state industrialization on residential segregation between Muslims and non-Muslims in nineteenth-century Cairo using individual-level census samples from 1848 and 1868. We measure local segregation by a simple inter-group isolation index, where Muslims' (non-Muslims') isolation is measured by the share of Muslim (non-Muslim) households in the *local environment* of each location. We find that relative to locations that did not witness changes in industrialization, the opening of Cairo railway station in 1856 differentially increased Muslims' isolation from non-Muslims (conversely, decreased non-Muslims' isolation) in its proximity and that the closures of textiles firms in 1848-1868 differentially decreased it. The results are arguably driven by a labor market mechanism, whereby state firms crowded in unskilled jobs that attracted greater net inflows of rural immigrants and unskilled workers who were predominantly Muslims.

Keywords: local segregation; industrialization; Middle East; railways; slums
JEL Codes: N35; R23

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> "Over the past thirty years Europe's influence has transformed Cairo. Now we are civilized"
>
> Ismail, Khedive of Egypt (1863-1879) (Raymond, 1993, p. 309).

The question of whether residential segregation between ethno-religious groups increases with the onset of industrialization is an old question in social sciences, dating back to, at least, Friedrich Engels. Engels (1845) vividly described the working-class slums, often predominantly Irish, that emerged with industrialization in English cities where "hundreds and thousands of alleys and courts lined with houses too bad for anyone to live in." Later on, a more pronounced hypothesis was put forward by the "Chicago School of Sociology" in the 1920s (Park and Burgess, 1925; Wirth, 1928) (See Gilliland and Olson, 2010; Gilliland et al., 2011, for recent reviews). Early Chicago sociologists hypothesized that intensified immigration to cities that results from industrialization may increase segregation in the short run as immigrants choose to reside in their ethnic/religious enclaves but that segregation would eventually subside as immigrants assimilate into the city's native population (Park and Burgess, 1925). However, in the face of this somehow appealing argument, empirical research on nineteenth-century U.S. and British cities found a mixed evidence. Indeed, one set of studies contended that the industrial revolution triggered segregation by social class, which was often correlated with ethno-religious segregation (U.S.: Pratt, 1911; Hershberg et al., 1979; Greenberg, 1981) (Britain: Dennis, 1986). Nonetheless, another set of studies suggested that cities were already ethno-religiously segregated before the industrial revolution and that the increased social-class segregation that occurred with industrialization in fact mitigated ethno-religious segregation (U.S.: Zunz, 1982). In contrast to these two sets of studies, a third group of scholars argued that early industrial cities in the nineteenth century exhibited very low levels of segregation (U.S.: Warner, 1968) (Britain: Ward, 1975, 1980).

Understanding the impact of industrialization on segregation is not only a matter of historical concern though. The rapid industrialization and urbanization that characterized the recent histories of many developing countries often created ethno-religious enclaves of poor and unskilled rural immigrants who were cramped in marginalized slums in large cities. Examples of this sort abound. Segregation by caste and/or religion is quite prevalent in many Indian cities and has increased with industrialization (Mehta, 1969; Vithayathil and Singh, 2012). A large body of literature documented the same phenomenon in Sub-Saharan Africa, the Middle East, Asia, and Latin America (see Massey, 2016, for a recent review).

This article revisits the question using evidence from an early program of state industrialization in nineteenth-century Egypt, an autonomous Ottoman province at the time. Following a long medieval tradition, native non-Muslim minorities who constituted 7 percent of the population of nineteenth-century Cairo, Egypt's capital and largest city, were clustered in certain neighborhoods in the city.[1] The spatial distribution of religious groups in Cairo persisted for centuries (Dridi, 2014, 2015). Yet, a structural break in Cairo's urban history occurred as Egypt embarked under Muhammad Ali Pasha (1805-1848) and his successors on one of the region's earliest state industrialization programs that employed 8 percent of Cairo's population in 1848 and 3 percent in 1868.[2] Between 1816 and 1848, the program concentrated mostly on textiles, but the failure of the first wave led Ali's successors in 1848-1882 to switch their efforts to transportation (mainly, railways) (Saleh, 2015). Even though the program did not transform Egypt into an industrialized economy, it had long-lasting effects on its urban populace. For one, industrialization created the nucleus of an urban working

[1]There was significant segregation *within* non-Muslims, between Coptic Christians, non-Coptic Christians (Armenians, Levantines, Greeks), and Rabbinic and Karaite Jews.

[2]This is the percentage out of Cairo's employed male population that is at least 15 years old based on the authors' calculations from the 1848 and 1868 population census samples. See the data section for details.

class whose role in Egypt's labor movement was pivotal starting from the late nineteenth century. For another, many state firms from the second wave, most notably, the railways, persisted until today. The objective of this article is hence to examine how these industrialization waves affected residential segregation between Muslims and non-Muslims at both the city level and in neighborhoods that were most affected by industrialization.

There are a few distinguishing features of the current study compared to the previous literature. First, to begin with, the previous literature is largely descriptive because of the gradual co-evolution of industrialization and segregation, which makes it difficult to identify the direction of causality. By contrast, Egypt's industrialization in the nineteenth century was a centralized and well-identified state decision which is relatively easier to examine. Second, most of the literature on historical or even contemporary segregation relies on geographic information at an aggregate geographic level (e.g. census tract in the U.S.) that only allows measuring segregation at an even more aggregate level (e.g. the city level). But, with aggregate measures of segregation, it is arguably challenging to examine the effects of industrialization since these are often pronounced at only finer geographic levels. To the contrary, the current study relies on individual-level geo-referenced data that allow us to measure segregation at the local level. Third, the historical literature mostly focuses on North America and Western Europe presumably due to the difficulty of obtaining historical data from developing countries. It is not clear though if the historical experiences of North American and Western European cities are generalizable to developing countries. For example, perhaps unlike many newer cities in the Americas, Middle Eastern cities were often highly segregated long before industrialization, and Cairo is an example of this type of cities.

Conceptually, industrialization could impact segregation between ethno-religious groups via several mechanisms. In the absence of legal restrictions

on residential choice, individuals may choose where to live based on (1) the commuting cost to their workplace, (2) amenities in the local neighborhood, (3) the relocation costs (including cost of housing), and (4) a preference for living close to one's own group. Industrialization may directly alter the first two factors. On the one hand, industrial firms create a new demand for labor that may attract workers to live in their proximity in order to save on commuting cost. This could be either directly via employing people to work in the firm, or indirectly via crowding in, or crowding out, private businesses in their proximity. For example, textiles firms may crowd out private spinners and weavers. On the other hand, industrialization may affect the level of amenities via externalities. For example, some firms are noisy or harmful for public health. The two effects may vary by religious group because of inter-group differences in occupations/skills and preferences for amenities. Furthermore, the two effects may be enhanced, or rather mitigated, by the third and fourth factors, relocation costs and taste for segregation, depending for example on the initial supply of vacant land and the initial group composition in the neighborhood where the firm is located. For example, holding else constant, a firm that is located in a neighborhood with a larger area of vacant land may be more attractive for immigrants. And a firm in a purely Muslim neighborhood may attract other Muslims but may have less of an impact on non-Muslims, who may prefer instead to reside close to their co-religionists.

In order to examine this question, we employ a novel data source, individual-level population census samples from 1848 and 1868 that were recently digitized from the original manuscripts at the National Archives of Egypt (Saleh, 2013). These are two of the earliest censuses from any non-Western country to include information on every household member including females, children, and slaves. More important for the purpose of this article, the census samples include the street address of each household,

which allows us to geocode the samples at the street level. The censuses also report religion, occupation, and if an individual works in a state firm, among other demographic information. We then merge the samples, aggregated to the household level, with a dataset on locations of the large state firms that existed in each of 1848 and 1868, geocoded at the street level, that we constructed from the census samples and historical sources.[3]

We first document that Cairo was highly segregated in both 1848 and 1868 and that the city-level segregation remained almost unchanged during that period, suggesting that the change in state industrialization in 1848-1868 had little of an effect on the overall segregation in the city. According to the dissimilarity index, 79-82 percent of Cairo's population had to move in order to have an equal share of non-Muslims in every neighborhood. According to the isolation index, the average Muslim household had 96-97 percent Muslims in her neighborhood. Those figures are remarkably high at early stages of industrialization and are in fact on par with the U.S. figures at the *peak* of segregation in 1970 (Cutler et al., 1999).

We then examine if state industrialization impacted segregation at a finer geographic level. We measure local segregation by a simple *inter-group* isolation index, where Muslims' (non-Muslims') isolation is measured by the share of Muslim (non-Muslim) households in the *local environment* of each location. This captures how likely it is for households at a given location to interact with their own religious group within their immediate neighborhood. The index is symmetric across Muslims and non-Muslims: an increase in Muslims' isolation from non-Muslims implies a decrease in non-Muslims' isolation from Muslims and vice versa. Put differently, our index is a measure of *group-specific* isolation and *not* overall segregation. Because we do not observe the same households in 1848 and 1868, we con-

[3]We focus on segregation *between* religious groups because the share of mixed-religion households is less than one percent in each census. Those are almost all households with servants or slaves of a different religion rather than mixed-religion marriages.

struct a panel dataset of *locations* that are observed in both years. We exploit the cross-location variation in the *change* in the instance of state industrialization between 1848 and 1868 that occurred within a 500-meters radius from each location. In this specification, the treatment group consists of two types of locations: (1) those that did not have in their proximity any large state firms in 1848 but witnessed the opening of at least one large firm by 1868 (locations close to Cairo railway station), and (2) those that had at least one large state firm in 1848 but witnessed the closures of all these firms by 1868 (locations close to two large textiles firms). The control group, on the other hand, consists of locations that did not witness changes in the instance of industrialization during that period. Those are of two types: (3) those that had in their proximity at least one large firm in both 1848 and 1868, and (4) locations that did not have any large firms in either 1848 or 1868. While this specification allows us to control for time-invariant characteristics of locations, it relies on the assumption that there are no other location-specific time-varying characteristics that are correlated with both industrialization and segregation. We include a set of controls in order to capture some of the location-specific changes in 1848-1868. However, we are unable to completely rule out this concern.

We find that the opening of the railway station had the largest impact on segregation as it *differentially* increased Muslims' isolation from non-Muslims in its proximity by 11-16 percentage points compared to the control group. In a similar vein, the closures of textiles firms *differentially* decreased Muslims' isolation in its proximity by 2-5 percentage points. Because of the symmetry of the isolation index, the opposite effects hold with respect to non-Muslims' isolation. These effects are driven by differential movements of Muslim and non-Muslim households, where the railway station attracted greater net inflows of Muslims while the closures of textiles firms generated greater net Muslim outflows. We conduct a number of

robustness checks including re-defining the control group to include only locations that did not have any firms in their proximity in either 1848 or 1868, restricting the sample to locations within one kilometer from the firm, and correcting standard errors for spatial correlation.

We examine the population movements that may be driving these findings in more depth. We first estimate the impact of openings/closures of state firms on changes in the number of households headed by state firm workers, rural immigrants, foreigners, unskilled workers, artisans, white-collar workers, and inhabitants of low-status dwellings. We then examine the correlation between each of these changes and our measure of isolation. The results suggest that the railway station attracted in its proximity greater net inflows of rural immigrants and unskilled workers, and that the closures of textiles firms generated greater net outflows of both groups. As Muslims were over-represented among these two groups, the net effect in the case of the railway station was a differential increase in the number of Muslims and, hence, in Muslims' isolation (symmetrically, a decrease in non-Muslims' isolation), and the opposite effects in the case of textiles firms. We argue that these findings are supportive of a labor market mechanism whereby state firms crowd in unskilled jobs that are more attractive to rural immigrants and unskilled workers. For example, the railways station crowded in drivers of animal-drawn vehicles; unskilled workers who were predominantly Muslims. However, both the direct labor market effect of state firms on attracting people to work in the firm and their effect on amenities may partially account for the findings.

Finally, we document that the housing market responded to industrialization. Low-status dwellings differentially increased close to the railway station and decreased close to the textiles closures. And dwellings with undefined property rights differentially increased around the station. This indicates that both industries created "slums" in their proximity.

The rest of the article is organized as follows. Section 1 reviews the literature. Section 2 provides a historical background. Section 3 describes the data. Section 4 documents the city-level segregation. We introduce the empirical analysis in section 5. Section 6 concludes.

1 Related Literature

The article contributes to several literatures besides the aforementioned literature on industrialization and segregation. First, there is a vast literature on the causes of segregation (see Royuela and Vargas, 2010; Boustan, 2011, for recent reviews). One line of this literature examines the role of preferences and the "tipping effect" of preferences in driving segregation, both theoretically (Schelling, 1971; Pancs and Vriend, 2007), and empirically (Bayer et al., 2007; Card et al., 2008). Another line of this literature examines how public policies and neighborhood characteristics may affect segregation (Ananat and Washington, 2009; Ananat, 2011; Boustan, 2011; Bayer and McMillan, 2012; Banzhaf and Walsh, 2013). A third line of the literature, the so-called the "spatial mismatch hypothesis," examines the impact of closure or relocation of firms on segregation (Kain, 1968, 1992; Hellerstein et al., 2008; Boustan and Margo, 2009). Our article is related to the three lines of literature as it examines the impact on segregation of the openings and closures of state firms, an example of public policies that alter characteristics of neighborhoods. Unlike Ananat (2011) who examined the impact of railways *networks* on segregation, we examine the impact of railways *stations* at the initial stage of introducing railways into the city and before a railways network is developed.

Second, the article is related to the evaluation of "place-based policies" literature. Many public policies in deprived neighborhoods are based on public investments, the provision of fiscal stimuli to encourage firm reloca-

tion, and the relocation of public-sector jobs to these neighborhoods. There is a large body of literature that evaluates the impact of these policies on local employment (Boarnet and Bogart, 1996; Neumark and Kolko, 2010; Gobillon et al., 2012; Faggio, 2014). Although these policies are rarely designed to (directly) affect socio-economic or ethno-religious diversity in these neighborhoods, one may expect an indirect effect on these outcomes.

Third, the article is related to the old and vast literature on the measurement of segregation that dates back to Duncan and Duncan (1955), Massey and Denton (1988), and, more recently, Reardon and O'Sullivan (2004), Echenique and Fryer (2007), Reardon et al. (2008), Johnston et al. (2011), Mele (2013), and Östh et al. (2015). We draw on this literature in measuring spatial segregation at a fine geographic level.

Fourth, the article is related to the recently growing historical geography literature that employs geocoded historical data (DeBats and Lethbridge, 2005; Gilliland and Olson, 2010; Gilliland et al., 2011).

Finally, the paper contributes to Egyptian urban history. An old medieval tradition described Cairo's urban space including the spatial distribution of its churches and synagogues (Al-Maqrizi, 2002; Mubarak, 1887). The modern literature on the subject often draws on these narratives (Raymond, 1973, 1993; Dridi, 2014, 2015). On the other hand, there is a large body of literature on Egypt's state industrialization in the nineteenth century (Al-Gritli, 1952; Fahmy, 1954; Al-Hitta, 1967; Marsot, 1984; Owen, 2002; Saleh, 2015). The article is the first to link these two literatures.

2 Historical Background

Nineteenth-century Cairo was spatially segregated between Muslims and non-Muslims (7 percent of the population in both 1848 and 1868). Coptic Christians, who constituted 65 percent of the non-Muslim population

of Cairo, were spatially concentrated in certain neighborhoods in the city, and the same was true for non-Coptic Christians (20 percent) and Jews (15 percent). Cairo's segregation was not a nineteenth-century phenomenon though as it has been documented in the early Islamic period (641-969) and in the Mamluk period (1250-1517) (Dridi, 2014, 2015). Perhaps among the factors that contributed to this persistence is the occupational segregation between religious groups, as non-Muslims were traditionally over-represented among white-collar workers (scribes, tax collectors, brokers, and money changers) and artisans (carpenters, tailors, and jewellers) (Saleh, 2015). Specifically, since markets and workshops were likely segregated by guild or occupation, and as most people lived close to their workplace, the residential segregation between religious groups persisted.

In 1816, Muhammad Ali Pasha, the autonomous Ottoman viceroy in 1805-1848, established the first textiles firm in *al-Khurunfish* quarter in the northeast of Cairo. That was followed by a series of firms in textiles (66 percent of employment in state firms), military (17 percent), and other industries including paper and printing (17 percent). Most firms were located in Cairo and Alexandria. In 1848, state firms employed 8 percent of Cairo's employed adult male population and had a median size of 163 workers, which was much larger than the typical artisanal workshop.

Nevertheless, the first wave of industrialization failed because of many reasons including the lack of skilled labor, the crude technology, the chronic fuel shortage, the upper limit imposed in 1841 on the army size (the raison d'être of the industrialization program), and the Anglo-Turkish Tariff Convention in 1838 that dissolved state monopolies. Regardless of the underlying causes though, many state firms, especially those in textiles, closed down between 1848 and 1868.

The failure of the first wave triggered Ali's successors to switch their efforts to transportation in the second wave in 1848-1882. That was partially

motivated by Europe's interest in developing trade routes in the Ottoman Empire. In 1854, the first railways line between Cairo and Alexandria was established. Cairo railway station was then opened in 1856 in the north-western edge of the city which is closer to Alexandria. Other transportation projects followed including the telegraph (1854) and steam navigation (1856 and 1863). The pace of the public projects accelerated under the ambitious Khedive Ismail Pasha, Ali's grandson, who ruled from 1863 to 1879, and who expanded on the railways, telegraph, and steam navigation networks. As a result of these developments, state firms employed 3 percent of Cairo's employed adult male population in 1868, less than half of their employment share in 1848, but 58 percent of state firm workers were now employed in transportation, 22 percent in military, 17 percent in other industries, and only 3 percent in textiles. Despite its smaller size, the second wave was more successful than the first in that it used a more sophisticated technology and many of its projects survived until today.

Apart from industrialization, Ali's successors (Ismail in particular) initiated an ambitious modernization project of Cairo that is illustrated in Figure 1. According to Raymond (1993, pp. 304-315), among the projects that took place between 1848 and 1868 were the construction of new streets between the Citadel and *al-Azbakiya* Garden from 1845 until the reign of Ismail, the establishment of military barracks in *Qasr al-Nil* between 1848 and 1863, the construction of the *al-Ismailiya* Canal in 1864-1866 that provided water to the Suez Canal project, the provision of gas lighting in streets in 1865 (the firm was located in *Bulaq*), and the provision of clean water in 1867 (the project was closer to Old Cairo suburb in the southwest but remained limited to a tiny population as of 1891). However, many of Ismail's most known projects, such as the construction of Cairo Downtown neighborhood in the west, occurred after 1868.[4] Despite these policies, the

[4]The western expansion of Cairo was formalized in a law in 1868. However, only

1848 and 1868 census samples suggest that the housing structure remained relatively stable at the city level.[5]

3 Data

Examining the impact of industrialization on segregation between religious groups in nineteenth-century Cairo requires having information on the location of state firms along with the religious composition of neighborhoods at a fine geographic level. We employ a novel data source for this purpose, the 1848 and 1868 individual-level population census samples. These nationally-representative samples were digitized from the original Arabic manuscripts at the National Archives of Egypt at an 8-percent sampling rate in Cairo in each year (Saleh, 2013). The samples include information on religion, street address (street name and dwelling number), occupation, workplace (for workers in state firms), nationality, place of origin, dwelling type (e.g. house, hut, courtyard), and type of property rights on dwellings (e.g. private property, religious endowment or *waqf*).

We restrict our analysis to Cairo, where we employed the street address information to geo-locate each household in 1848 and 1868 using street names in current digital maps and information on locations of nineteenth-century Cairo's streets in Mubarak (1887). The success rate of the geocoding process is 81 percent in 1848 and 87 percent in 1868.[6]

13 percent of the expansion comprised residential structures in 1874 implying that it was still mostly uninhabited then (Raymond, 1993, pp. 310-312). This is confirmed by comparing the western expansion in Figure 1 to the 1868 population census in Figure 2 which indicates that the western area was barely inhabited in 1868. Among Ismail's other post-1868 projects are the construction of Cairo Opera House in 1869, the construction of *Qasr al-Nil* bridge in 1869, and the renovation of *al-Azbakiya* garden in 1872.

[5]The share of residential and unspecified types of dwellings remained stable between 1848 and 1868 at around 76-77 percent, the share of low-status dwellings (courtyards, huts, rooms, mills, stables, bathhouses) was around 12-13 percent, whereas that of multiple-household dwellings (tenement houses, market buildings) was 9 percent.

[6]The success rate in Alexandria, the second largest city, was too low (33 percent) to include it in the analysis. This is likely due to the massive expansion of Alexandria

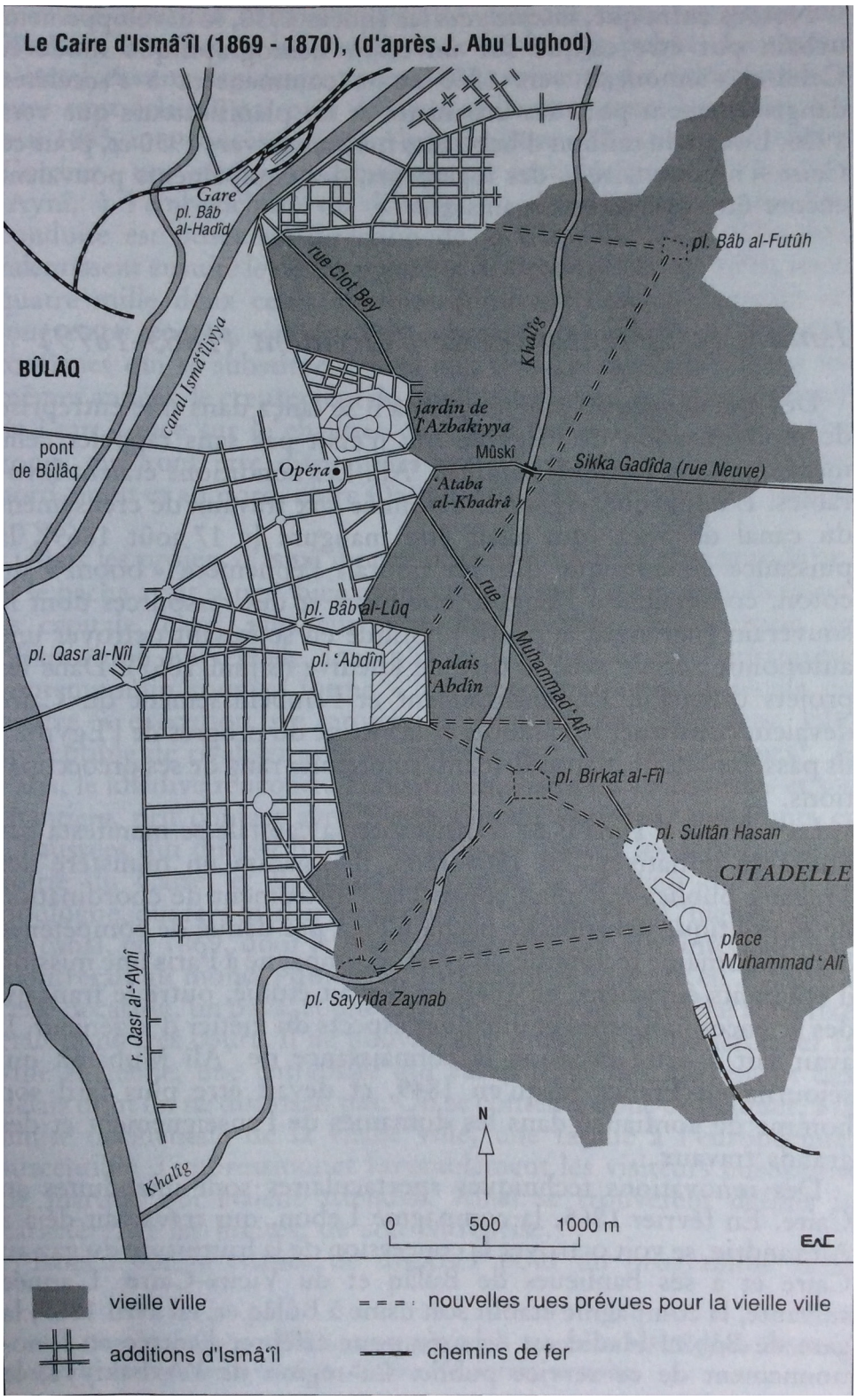

Figure 1: Ismail's Expansion of Western Cairo in 1869-1870

Source: Raymond (1993, p. 307).

We combine the census samples with a dataset on locations of the large state firms in Cairo in 1848 and 1868 which we constructed as follows. We first used the information on workplace in the census samples that is available for all workers employed by the state. This allowed us to compile a comprehensive list of state firms that existed in Cairo in 1848 and 1868 and to estimate the employment size of each firm in each year. Second, we checked our list against the information on state firms provided by Sami (1928), Al-Gritli (1952), and Fahmy (1954). Third, we restricted the list to state firms that had at least 10 workers in the sample in either 1848 or 1868 which corresponds to about 125 workers in the population (sampling rate = 8%). Finally, we geo-located the state firms using (a) information on location mentioned in the name of the state firm, (b) historical information on locations of firms in the aforementioned sources, and (c) historical maps of Cairo that sporadically mapped certain firms. The dataset is shown in Table A.1 in section (A) of the online appendix.

In order to visualize the data, we plot the geo-referenced streets of the census samples and the large state firms in each of 1848 and 1868 in Figure 2. Cairo was divided into a main section and two suburbs, *Bulaq* and Old Cairo, that are located close to the Nile in the northwest and southwest ends respectively. Non-Muslim minorities (Coptic Christians, non-Coptic Christians, and Jews) were clustered in certain neighborhoods in Cairo and their distribution remained largely stable between 1848 and 1868. In 1848, state textiles firms were in *Bulaq*, *al-Khurunfish* quarter in the northeast of Cairo, and *al-Sayyida Zaynab* quarter in the southwest of main Cairo. Military firms were concentrated in *Bulaq* and close to the citadel in the south. Two paper and printing firms were opened in *Bulaq*. By contrast, in 1868, *al-Khurunfish* and *al-Sayyida Zaynab* textiles firms closed down, although the two *Bulaq* firms survived. Military, paper,

since 1848 which altered street names.

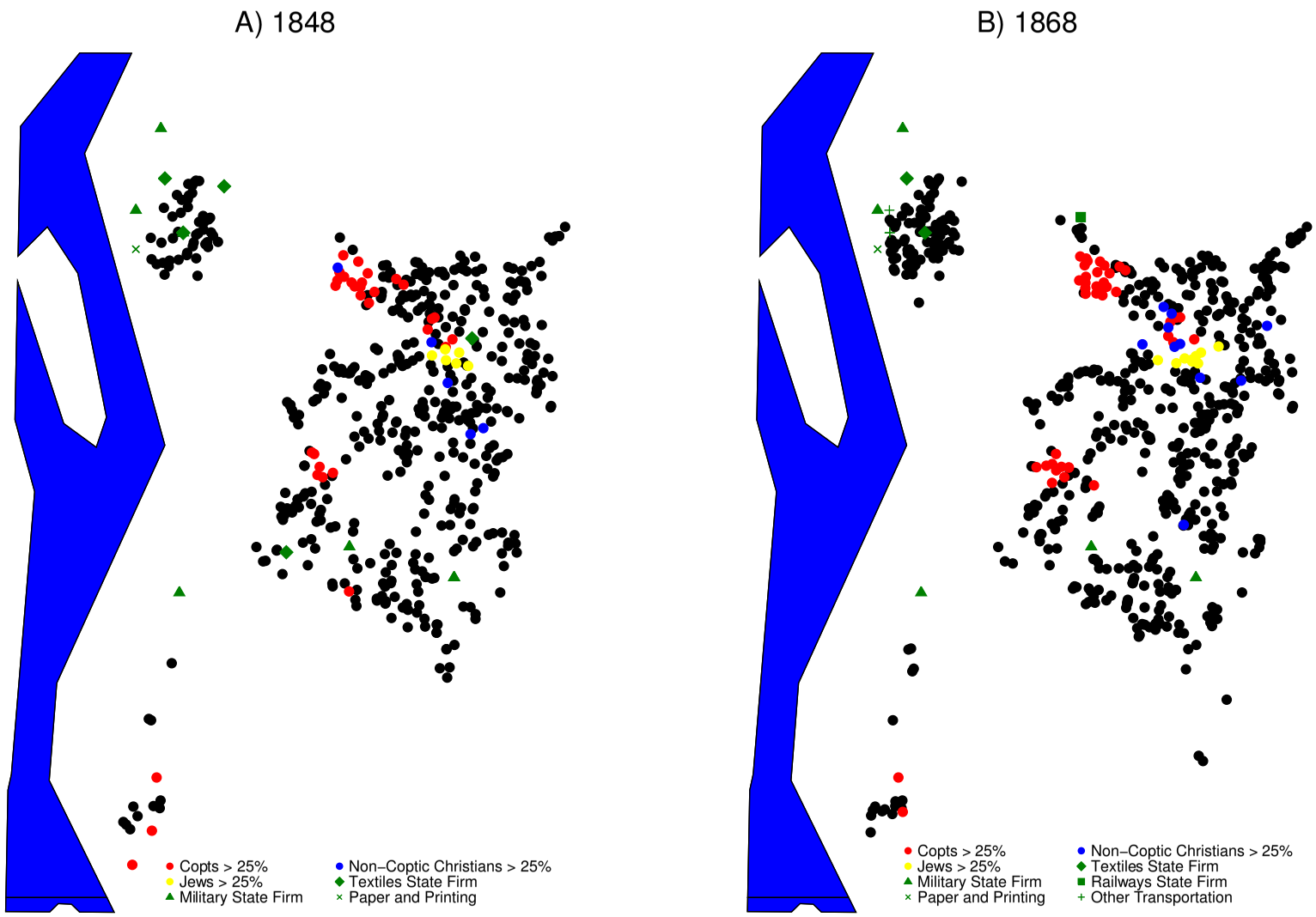

Figure 2: Locations of Cairo's Streets, Non-Muslim Neighborhoods, and Large State Firms in 1848 and 1868

Source: Cairo's 1848 and 1868 samples of locations, which are based on the geocoded population census samples aggregated to the household level and matched with information on locations of large state firms.

and printing firms mostly survived despite two military closures. A few transportation firms were opened: Cairo railway station in the northwest and other transportation firms in *Bulaq* that comprised two steam ship stations and a telegraph station.

4 City-Level Segregation in 1848 and 1868

Did the openings and closures of state firms between 1848 and 1868 affect the city-level residential segregation between Muslims and non-Muslims in Cairo? In this section, we document the evolution of the city-level segregation using both the standard "aspatial" indexes of segregation, the dissimilarity and isolation indexes, and the more recent "spatial" measures.

4.1 Measures of Segregation

Two standard measures of segregation that are widely used in the literature are the dissimilarity and isolation indexes, which are computed as follows:

$$Dissimilarity_t = \frac{1}{2}\sum_{j=1}^{n}\left|\frac{Muslim_{j,t}}{MuslimTotal_t} - \frac{NonMuslim_{j,t}}{NonMuslimTotal_t}\right| \quad (1)$$

$$Isolation_{Muslim,t} = \sum_{j=1}^{n}\frac{Muslim_{j,t}}{MuslimTotal_t} \times \frac{Muslim_{j,t}}{PopTotal_{j,t}} \quad (2)$$

$$Isolation_{NonMuslim,t} = \sum_{j=1}^{n}\frac{NonMuslim_{j,t}}{NonMuslimTotal_t} \times \frac{NonMuslim_{j,t}}{PopTotal_{j,t}} \quad (3)$$

where $Muslim$, $NonMuslim$ and $PopTotal$ are the numbers of Muslim households, non-Muslim households, and the total number of households respectively in location j in year t. $MuslimTotal$ and $NonMuslimTotal$ are the total number of Muslim and non-Muslim households respectively in the city. The dissimilarity index gives the percentage of households who

must move in order to obtain an equal share of non-Muslim households across all neighborhoods. The isolation index for Muslims (non-Muslims), on the other hand, gives the percentage of Muslim (non-Muslim) households in the neighborhood of the average Muslim (non-Muslim) household. Both indexes vary between 0 and 1 with 1 indicating perfect segregation.

Despite their simplicity, the measures suffer from a few caveats (Massey and Denton, 1988; Wong et al., 2007). First, they are sensitive to scale; they generally increase when measured at a smaller scale. Second, they are sensitive to the administrative boundaries that are used in defining neighborhoods, making it difficult to compare segregation across cities or in the same city over time. This is especially problematic in Cairo where the administrative boundaries of quarters (administrative units that are larger than streets but smaller than districts) changed between 1848 and 1868. In order to address these concerns, and to be able to compare segregation in Cairo in 1848 and 1868, we first computed segregation using streets and districts (the units that are relatively stable across the two years). We then created "artificial neighborhoods" that are invariant over time and therefore permit a more meaningful comparison.[7] We provide more details on the creation of artificial neighborhoods in section (B) of the online appendix.

A third and related caveat of the aspatial segregation indexes, as noted by Reardon and O'Sullivan (2004), is that they do not take into account the proximity between neighborhoods. For example, a non-Muslim population that is concentrated in two neighborhoods would be differently segregated if the neighborhoods are, or are not, contiguous. Thus, in order to obtain a spatial view of segregation in the city, we computed the spatial versions of the dissimilarity and isolation indexes as suggested by Reardon and O'Sullivan (2004). The computation proceeds in two steps. We first

[7] A small number of "artificial neighborhoods" are populated in only one of the two years and so we dropped those neighborhoods when we computed the indexes.

count the number of households of Muslims, non-Muslims, and the total population in the *local environment* of (i.e. a circle around) each artificial neighborhood. We then use these population figures in calculating the dissimilarity and isolation indexes. We refer the reader to section (B) of the online appendix for further details on the computation of these indexes.

4.2 Findings

The results on the city-level segregation in Cairo in 1848 and 1868 are shown in Table 1. All measures of segregation suggest that Cairo was a highly segregated city in both 1848 and 1868 and that segregation remained almost unchanged during that period. According to the dissimilarity index measured across artificial neighborhoods, 79-82 percent of the population had to move in order to have an equal share of non-Muslim households in every neighborhood. In line with previous studies on segregation, we find that the dissimilarity index drops when it is measured across districts (which are larger than streets). The isolation index for Muslims indicates that the typical Muslim household lived in a street with 98 percent Muslims. The spatial measures of segregation show similar results.

These findings are probably not surprising because, at their peak, state firms recruited only 8 percent of Cairo's employed adult male population, which is perhaps too small to alter the overall segregation in the city. Indeed, the city-level population shares of non-Muslims and of foreigners remained both stable at 7 and 7-8 percent respectively, again suggesting that industrialization had little of an effect on the overall religious and ethnic composition of the city between 1848 and 1868. This does not say though that all city-level statistics remained unchanged. For example, it appears that the population share of unskilled workers dropped from 43 to 38 percent, with a corresponding increase in the share of artisans and white-collar workers. More strikingly, the population share of rural immigrants

dropped between 1848 and 1868 from 25 to 10 percent. Together, these trends suggest a slowdown of unskilled jobs and of rural immigration into Cairo that perhaps coincided with the de-industrialization in 1848-1868.

Table 1: Segregation in Cairo in 1848 and 1868

Year	Neighborhoods	N	Dissimilarity (Aspatial)	Isolation (Aspatial)	Diss (300m)	Iso (300m)	Diss (500m)	Iso (500m)
1848	Street	499	0.9098	0.9823	-	-	-	-
1868	Street	632	0.8682	0.9786	-	-	-	-
1848	District	10	0.4871	0.9354	-	-	-	-
1868	District	10	0.4796	0.9383	-	-	-	-
1848	AN (1)	110	0.8249	0.9666	0.7783	0.96	0.678	0.9518
1868	AN (1)	110	0.8156	0.9686	0.7636	0.963	0.691	0.9521
1848	AN (2)	90	0.7918	0.9560	0.7116	0.9519	0.6289	0.9461
1868	AN (2)	90	0.7990	0.9636	0.7468	0.9598	0.6646	0.9541

Source: The 1848 and 1868 geocoded household-level census samples of Cairo.
Notes: AN (1) refers to artificial neighborhoods that are populated in both 1848 and 1868, where Cairo is divided into 25*25 grid cells, whereas AN (2) refers to populated artificial neighborhoods in 20*20 grid cells.

5 Empirical Analysis

Having documented that the city-level residential segregation between Muslims and non-Muslims in Cairo changed little between 1848 and 1868, we now proceed to the central question of this article, whether industrialization affected segregation at a finer geographic level. In this section, we first describe our empirical strategy. Second, we introduce the findings. Third, we discuss a number of robustness checks that we conducted. Finally, we explore some of the mechanisms that may account for the findings.

5.1 Empirical Strategy

5.1.1 Measuring Local Segregation

Our outcome of interest is the residential segregation between Muslims and non-Muslims defined at the neighborhood level. Inspired by Reardon and

O'Sullivan (2004), we suggest using a segregation index that captures at each location j the *spatial* egocentric isolation of a household of a given religious group from members of the other group:

$$Isolation_j = \tilde{PopGroupShare}_j = \frac{\sum_{q \in S} PopGroup_q}{\sum_{q \in S} PopTotal_q} \tag{4}$$

where $PopGroupShare$ is the population share of Muslim (non-Muslim) households, $PopGroup$ is the number of Muslim (non-Muslim) households, and $PopTotal$ is the total number of households. Specifically, the isolation of Muslims (non-Muslims) is calculated by the proportion of Muslim (non-Muslim) households within a neighborhood S around location j, where S is a circle with a given radius (300 and 500 meters).[8] Intuitively, the index measures how likely it is for a household at a certain location to interact with members of her own religious group within her local neighborhood.

We calculate the index separately for Muslim and non-Muslim households. The index is symmetric across both groups since the proportion of non-Muslims at any location is the complement of that of Muslims. Its value ranges from zero to one. A value close to zero for Muslims' (non-Muslims') isolation indicates that a Muslim (non-Muslim) household residing in that location mostly interacts with non-Muslim (Muslim) households (i.e. less inter-group isolation), whereas a value close to one for Muslims' (non-Muslims') isolation indicates that the location is almost entirely populated by Muslim (non-Muslim) households (i.e. more inter-group isolation). Since the index for a given religious group at a certain location is equal to zero if there are no households of that group at that location, which is misleading, we restrict the analysis of isolation of Muslims (non-Muslims) to locations where we observe at least one Muslim (non-Muslim) household.

[8] A radius that is less than 300 meters is highly sensitive to small changes in segregation in the immediate neighborhood of each household.

5.1.2 Cross-Sectional Strategy

We start the empirical analysis by documenting the cross-sectional correlation between state industrialization and the residential segregation across Muslim and non-Muslim households in 1848 and 1868. Specifically, we estimate the following OLS regression (we estimate separate regressions for Muslim and non-Muslim households in each of 1848 and 1868):

$$\begin{aligned} Isolation_j = \; & \tilde{\beta}_0 + \tilde{\beta}_1 Textiles_j + \tilde{\beta}_2 Military_j + \tilde{\beta}_3 Printing_j \\ & + \tilde{\beta}_4 Railways_j + \tilde{\beta}_5 SteamTele_j + \; X_j \tilde{\Gamma} + \tilde{u}_j \end{aligned} \tag{5}$$

where $Isolation_j$ is the egocentric isolation index for Muslim and non-Muslim households in the local neighborhood S of location j. We restrict the sample in 1848 (1868) to locations of streets that are observed in 1848 (1868). We further restrict the sample for examining the isolation of Muslim (non-Muslim) households in a given year to locations where we observe at least one Muslim (non-Muslim) household in that year.

In this specification, $Textiles_j$, $Military_j$, $Printing_j$, $Railways_j$, and $SteamTele_j$ are indicator variables that take the value of one if there is, within a 500-meters radius from location j, at least one large state firm in the indicated industry: textiles, military, printing and paper, railway station, and steam ships and telegraph stations respectively. Notice that railway, steam ships, and telegraph stations are observed in 1868 only. X_j is a vector of control variables that includes (1) distance to the Nile, (2) distance to the city center (average longitude and latitude), (3) distance to the Citadel (where the viceroy resided), (4) distance to *al-Azbakiya* garden (opened in 1837), (5) an indicator variable that takes the value of one if a location is in *Bulaq* suburb, (6) an indicator variable that takes the value of one if a location is in Old Cairo suburb, and (7) distance to *al-Ismailiya*

canal that was constructed in 1864-1866 (Raymond, 1993, p. 309) (observed in 1868 only). The intuition behind adding these controls is that the location of a state firm could be correlated with other characteristics of the neighborhood. As we discussed in the historical background section, apart from *al-Azbakiya* garden and *al-Ismailiya* canal that we directly control for, most of the public projects in 1848 and 1868 were located in *Bulaq*, Old Cairo, or close to the Citadel, and hence the set of controls arguably captures most of the public policies that affected Cairo during that period. $\tilde{u_j}$ is an error term clustered at the quarter level which is defined based on the administrative boundaries of the 1848 census.

5.1.3 Panel Strategy

It is difficult to interpret the coefficients on state firms in the *naive* cross-sectional regression above because the locations of those firms are likely correlated with other characteristics of neighborhoods, both time-invariant and time-variant, that could be driving segregation and that are not captured by the current set of controls.

In order to improve on this strategy, we constructed a *panel* of locations that are observed in both 1848 and 1868. This allows us to exploit the *change* in industrialization at a given location over time, while controlling for time-invariant characteristics of locations that may be correlated with both industrialization and segregation. For a location j to be included in our panel sample, it must meet three conditions. First, a location has to be the coordinates of a street observed in either 1848 or 1868. Since the number of possible locations (i.e. longitude and latitude) is infinite, this condition limits our sample to the observed streets.[9] Second, we must observe at least one household residing in the local neighborhood S of location

[9]Implicitly, this assigns greater weights to locations with more streets, i.e. where we have more households in the population census samples.

j in *both* 1848 and 1868, where S is defined to be a circle with a radius of 300 or 500 meters around that location. Applying this condition results in a panel data set of locations whose number is increasing in the radius of the local neighborhood that we employ. Third, as in the cross-sectional analysis, we further restrict our sample for examining the isolation of a particular religious group to locations where we observe at least one household of that group in the local neighborhood of location j in *both* years. The three conditions result in final sample sizes for the isolation of Muslim households of 918 and 921 locations for the 300-meters and the 500-meters radii respectively. The corresponding sample sizes for the isolation of non-Muslim households are 505 and 747. Notice that the sample of locations with at least one Muslim household includes (almost) the entire city (there is only one location without any Muslims), but that the sample of locations with at least one non-Muslim household is a restricted sample that is of interest because it is limited to Cairo's mixed-religion neighborhoods.[10]

In this setup, we define our dependent variable as the *change* in the inter-group isolation index for Muslim and non-Muslim households in the local neighborhood of location j. With respect to our main regressor, the change in state industrialization between 1848 and 1868, we focus on changes at the *extensive* margin because of the difficulty of measuring the *intensity* of industrialization. In this respect, there are four types of locations in our panel sample: (1) locations that had no large state firms in their close proximity in 1848 but witnessed the opening of at least one large state firm between 1848 and 1868, (2) locations that had at least one large state firm in 1848 but witnessed the closure of all those firms by

[10]We excluded households that are located at exactly location j from the definition of S in equation 4. This is because for almost all locations, we observe households at the exact location j in only one year but not the other. So in order to ensure the consistency of the index across the two years, we chose to compute it using households who live in the local neighborhood of each location, but not at the location itself. Technically, this exclusion modifies S to include only households that lie within a radius that is greater than 5 meters but that is smaller than 300 or 500 meters.

1868, (3) locations that had at least one large state firm in both 1848 and 1868, and (4) locations that had no large state firms in either 1848 or 1868. We think of types (1) and (2) as the "treated" locations, which witnessed changes in the *instance* of state industrialization, and of types (3) and (4) as the "control" locations that did not witness changes in the instance of industrialization.

The four types of locations are mapped in Figure 3 while the list of large state firms is provided in Table A.1. Panel (C) compares, across 1848 and 1868, locations that had in their proximity no state firms and those that had at least one state firm. The comparison reveals that locations of type (1) (red on the map) are those that were were close to the opening of Cairo railway station whereas locations of type (2) (green on the map) are those that were close to the closures of *al-Khurunfish* and *al-Sayyida Zaynab* textile firms. Notice that we are not able to examine the impact of all the other large state firms because their opening/closure did not generate in their close proximity a change in the *instance* of industrialization.

Having constructed a panel of locations, we then estimate the following OLS regression. As before, we estimate separate regressions for the isolation of Muslim and non-Muslim households:

$$\begin{aligned} \Delta Isolation_j = \quad & \beta_0 + \beta_1 TextilesClosure_j + \beta_2 RailwaysOpening_j \\ & + Z_j\Gamma + u_j \end{aligned} \tag{6}$$

where $\Delta Isolation_j$ is the *change* between 1848 and 1868 in the egocentric isolation index measured in the local neighborhood of location j. The variable $TextilesClosure$ is an indicator variable that takes the value of one if all textiles state firms within a 500-meters radius from the location closed down between 1848 and 1868 (type 2 locations). $RailwaysOpening$ is an indicator variable that takes the value of one if Cairo railway station that opened in 1856 lies within a 500-meters radius from the location (type

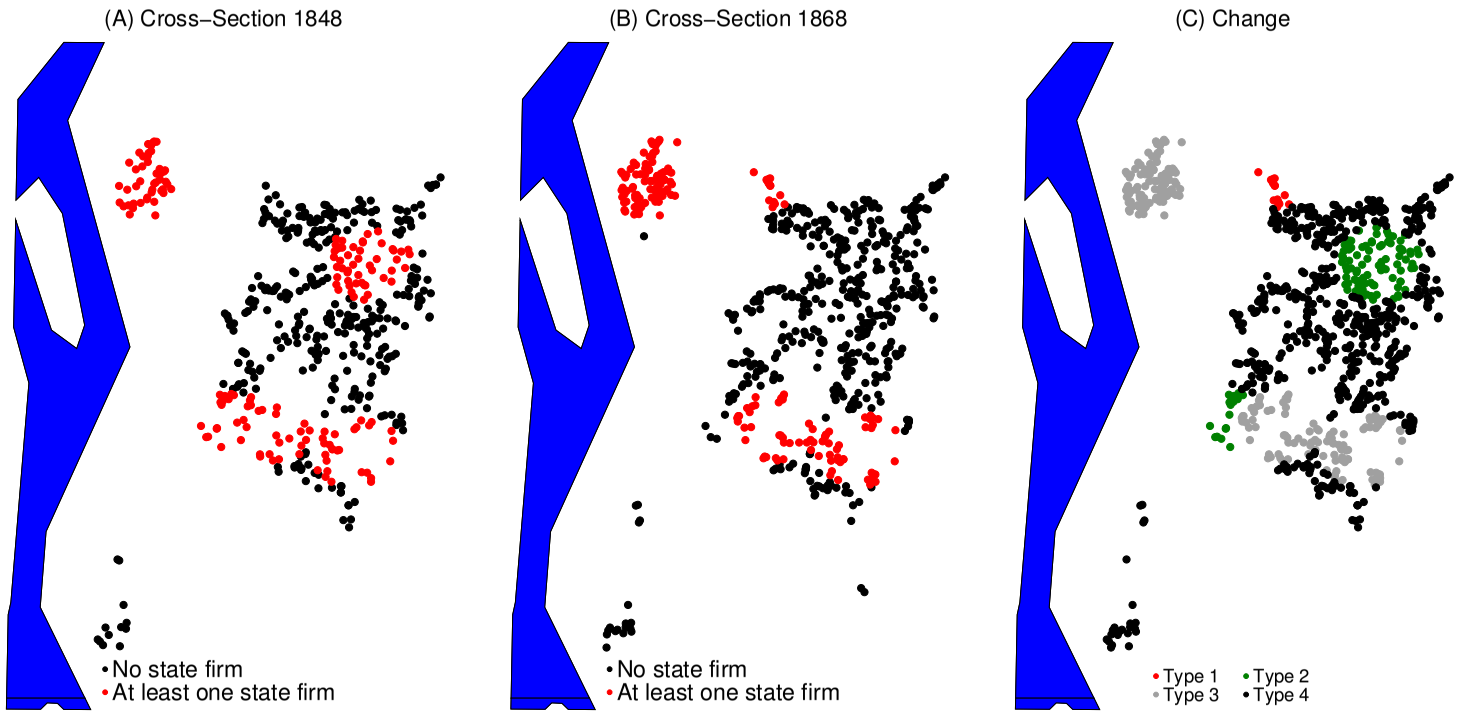

Figure 3: Treated and Control Locations - 300m Radius

Source: Cairo's 1848 and 1868 samples of locations, which are based on the 1848 and 1868 geocoded population census samples aggregated to the household level and matched with information on locations of large state firms and other geographic information.
Notes: The maps are limited to locations with at least one Muslim household.

1 locations). The "control group" in this specification consists of locations of types (3) and (4) (grey and black on the map) that did not witness changes in the instance of industrialization between 1848 and 1868. Z_j is a vector that includes the same set of controls as in X_j in equation (5) with two additional variables: the initial value of the isolation index in 1848 and the initial number of households in 1848.[11] Finally, u_j is an error term, which we assume to be clustered at the quarter level measured according the 1848 census administrative division.

The impact of the openings and closures of state firms on segregation is captured by the coefficients β_1 and β_2. Since we exploit the change in industrialization between 1848 and 1868, the identification assumption here is that, conditional on controls, there are no other location-specific changes in 1848-1868 that are correlated with both industrialization and segregation. While we are unable to rule out that this assumption may be violated, we are relatively confident in our specification. Basically, the historical evidence that we discussed in the historical background section suggests that the set of controls that we include in our regressions likely captures the most important location-specific public projects that took place in Cairo during that period.[12]

5.1.4 Descriptive Statistics

Table 2 introduces the summary statistics of the main variables in the empirical analysis using the 300-meters radius in constructing the panel sample. Consistent with the city-level segregation findings, the cross-location average isolation index for each of Muslims and non-Muslims changed little between 1848 and 1868. The typical Muslim household has 91-92 percent

[11] Controlling for the initial value of the isolation index in equation (6) is similar to estimating the equation using the *level* of isolation in 1868 as the dependent variable.

[12] Other city-level changes that are not location-specific are controlled for by our panel strategy. These include, for example, changes in social norms on segregation and aggregate changes in income.

Table 2: Summary Statistics - 300-Meters Radius

	Locations with at Least One Muslim Household			Locations with at Least One Non-Muslim Household		
	1848	1868	Change	1848	1868	Change
Isolation index	0.92 (0.16)	0.91 (0.17)	-0.00 (0.05)	0.14 (0.19)	0.12 (0.18)	-0.00 (0.07)
Number of Muslims	126.54 (53.78)	179.64 (91.34)	53.30 (64.06)	134.14 (59.09)	191.99 (96.18)	56.02 (75.23)
Number of non-Muslims	11.51 (20.48)	14.93 (26.90)	5.11 (10.58)	19.11 (23.49)	19.96 (29.45)	5.11 (10.58)
State Industrialization - Cross-sectional:						
=1 if a textile state firm in 500m radius	0.24 (0.43)	0.14 (0.35)	. (.)	0.32 (0.47)	0.16 (0.37)	. (.)
=1 if a military state firm in 500m radius	0.19 (0.39)	0.16 (0.37)	. (.)	0.17 (0.37)	0.15 (0.36)	. (.)
=1 if railways station in 500m radius	. (.)	0.02 (0.15)	. (.)	. (.)	0.03 (0.17)	. (.)
=1 if other transportation state firm in 500m radius	. (.)	0.11 (0.31)	. (.)	. (.)	0.14 (0.35)	. (.)
=1 if paper and printing state firm in 500m radius	0.03 (0.17)	0.06 (0.24)	. (.)	0.04 (0.20)	0.08 (0.27)	. (.)
State Industrialization - Panel:						
=1 if all textile state firms closed in 500m radius	. (.)	. (.)	0.12 (0.33)	. (.)	. (.)	0.15 (0.36)
=1 if railways station opened in 500m radius	. (.)	. (.)	0.02 (0.13)	. (.)	. (.)	0.03 (0.16)
Controls:						
= 1 if located in Bulaq suburb	0.09 (0.29)	0.14 (0.35)	0.12 (0.32)	0.14 (0.35)	0.16 (0.37)	0.16 (0.37)
= 1 if located in Old Cairo suburb	0.02 (0.15)	0.03 (0.16)	0.03 (0.16)	0.03 (0.18)	0.03 (0.18)	0.04 (0.20)
distance to Nile	2.39 (0.91)	2.30 (1.00)	2.36 (0.95)	2.16 (0.90)	2.22 (1.02)	2.11 (0.96)
distance to city center	1.41 (0.82)	1.53 (0.84)	1.47 (0.82)	1.41 (0.89)	1.49 (0.85)	1.44 (0.92)
distance to the citadel	2.28 (1.11)	2.43 (1.21)	2.34 (1.17)	2.55 (1.10)	2.57 (1.17)	2.63 (1.13)
distance to Azbakiyaa garden	1.61 (0.92)	1.68 (0.90)	1.64 (0.90)	1.47 (0.99)	1.55 (0.89)	1.47 (0.99)
distance to the canal (1868 only)	1.92 (0.94)	1.86 (0.98)	1.89 (0.96)	1.74 (0.93)	1.73 (0.93)	1.71 (0.95)
Number of households in 1848	138.04 (54.67)	135.29 (54.35)	137.09 (53.73)	153.25 (56.70)	144.02 (53.70)	152.79 (56.95)
Observations	495	628	918	298	470	505

Source: Cairo's 1848 and 1868 samples of locations that are observed in either 1848, 1868, or both. The "1848" and "1868" columns are from samples of locations that are observed in each of 1848 and 1868 respectively, whereas the "Change" column is from the panel sample of locations. The first three columns use the sample restricted to locations with at least one Muslim household, whereas the last three columns use the sample restricted to locations with at least one non-Muslim household.
Notes: Means reported. Standard deviations are in parentheses. Isolation index in the first three columns is computed for Muslim households while in the last three columns is for non-Muslim households.

Muslims in her local neighborhood, while the average non-Muslim household is surrounded by 12-14 percent non-Muslims. With respect to state industrialization, while 24-32 percent of locations in 1848 had at least one large textiles state firm within 500 meters, the percentage dropped to 14-16 percent in 1868, as many firms closed down. Military firms were more stable though with the numbers being 17-19 and 15-16 percent in 1848 and 1868 respectively. Similarly, paper and printing firms were quite stable affecting 3-4 and 6-8 percent of all locations in 1848 and 1868 respectively. Only 2-3 percent of locations in 1868 were close to the railway station, whereas 11-14 percent of locations were close to the other transportation firms (steam ships and telegraph stations).

5.2 Results

5.2.1 Cross-Sectional Results

The results of estimating equation (5) are shown in Table 3. In 1848, Muslim households who live nearby a large textiles firm are less isolated from non-Muslims than their co-religionists who do not live in close proximity to any state firm, and the opposite is true for non-Muslim households. These results may be partially driven by *al-Khurunfish* textiles firm that was located near a non-Muslim enclave in the northeast of Cairo (see Figure 2). By contrast, Muslim (non-Muslim) households residing around military state firms exhibit higher (lower) isolation levels compared to their co-religionists in non-industrialized neighborhoods. This is likely due to the fact that most military firms were either in *Bulaq* or close to the Citadel, both were predominantly Muslim neighborhoods. Finally, Muslim and non-Muslim households who live close to paper and printing firms do not exhibit different levels of isolation compared to households in the control group.

In 1868, the correlation between living in close proximity to textiles firms and inter-group isolation has been reversed for Muslims as the textiles firms that survived in 1868 were located in *Bulaq*, a predominantly Muslim neighborhood (see Figure 2).[13] The correlation with military firms, although still positive for Muslims, is now statistically insignificant. Since Cairo railway station was located near a non-Muslim enclave, Muslim households who live close to the station are less isolated than their co-religionists in non-industrialized locations, and the opposite result holds among non-Muslim households. The inter-group isolation of households living close to the other transportation firms (steam ships and telegraph stations) and to the paper and printing firms, all located in *Bulaq*, is not

[13] We are not able though to estimate the coefficient on textiles firms in the restricted sample of locations that had at least one non-Muslim household because it is perfectly correlated with one of the controls, the *Bulaq* indicator variable.

Table 3: Industrialization and Segregation: Cross-Sectional Results

(a) 1848

	Isolation of Muslim housholds		Isolation of non-Muslim housholds	
	(1)	(2)	(3)	(4)
	300 meters	500 meters	300 meters	500 meters
=1 if textile state firm (500m radius)	-0.083**	-0.040**	0.101**	0.039*
	(0.041)	(0.020)	(0.051)	(0.021)
=1 if military state firm (500m radius)	0.047**	0.027**	-0.033	-0.028**
	(0.023)	(0.010)	(0.042)	(0.013)
=1 if paper and printing (500m radius)	-0.002	-0.000	-0.009	0.002
	(0.010)	(0.007)	(0.015)	(0.008)
Controls	Yes	Yes	Yes	Yes
Clusters	134	135	96	122
Locations	495	496	298	408
R2	0.347	0.490	0.361	0.486

(b) 1868

	Isolation of Muslim housholds		Isolation of non-Muslim housholds	
	(1)	(2)	(3)	(4)
	300 meters	500 meters	300 meters	500 meters
=1 if textile state firm (500m radius)	0.052**	0.044**		
	(0.024)	(0.014)		
=1 if military state firm (500m radius)	0.019	0.010	-0.023	-0.010
	(0.016)	(0.012)	(0.022)	(0.012)
=1 if railways station (500m radius)	-0.064	-0.185***	0.032	0.176***
	(0.077)	(0.036)	(0.082)	(0.036)
=1 if other transportation (500m radius)	-0.003	-0.001	-0.014	0.001
	(0.008)	(0.007)	(0.009)	(0.008)
=1 if paper and printing (500m radius)	-0.005	-0.002	0.000	0.001
	(0.005)	(0.004)	(0.008)	(0.004)
Controls	Yes	Yes	Yes	Yes
Clusters	130	130	110	127
Locations	628	629	470	594
R2	0.409	0.672	0.405	0.676

Source: Cairo's samples of locations that are observed in each of 1848 and 1868 and defined using the 300 and 500 meters radii. Those are based on the 1848 and 1868 geocoded population census samples of Cairo aggregated to the household level and matched with information on locations of large state firms and other controls.
Notes: $*p < 0.1, **p < 0.05, ***p < 0.01$. Standard errors clustered at the quarter level according to the 1848-census boundaries are in parentheses.

statistically different from the isolation of households in the control group.

5.2.2 Panel Results

We now move on to the central findings of the article. Table 4 shows the estimation results of equation (6) which examines whether the *change* in inter-group isolation in a given location between 1848 and 1868 is altered by the openings or closures of state firms that are located in close proximity to that location. Panel (4a) indicates that Muslim (non-Muslim) households residing at a location that witnessed in its proximity the closure of all tex-

tiles firms between 1848 and 1868 experienced a greater decrease (increase) in their inter-group isolation compared to their co-religionists in locations that did not witness changes in industrialization (the control group). In terms of magnitude, the closure of all textiles firms is correlated with a differential decrease (increase) of 2-5 (3-9) percentage points in the level of inter-group isolation among Muslim (non-Muslim) households. This is a large magnitude if we consider that the average change in isolation in 1848-1868 across all locations is zero (see Table 2). In a similar vein, the opening of the railway station had an even greater effect on inter-group isolation. Whereas Muslim households who lived close to the station witnessed a greater increase in their isolation by 11-16 percentage points compared to the control group, non-Muslims experienced a greater decrease in isolation by 9-15 percentage points compared to the control group.

We then explore if the effects of industrialization on isolation are reflected in population movements. Specifically, we examine if the opening or closure of state firms triggered in their close proximity differential changes in (a) the number of Muslim households and/or (b) the number of non-Muslim households, relative to locations in the control group. Conceptually, holding the initial number of Muslim and non-Muslim households in 1848 constant across locations, the change in Muslims' isolation index between 1848 and 1868 is positively (negatively) correlated with the change in the number of Muslim (non-Muslim) households. The opposite holds for the isolation of non-Muslims. We thus re-estimate equation (6) using the change in the number of Muslim households and the change in the number of non-Muslim households as our dependent variables. We estimate separate sets of regressions for (a) locations with at least one Muslim household where the isolation of Muslims is defined, and (b) locations with at least one non-Muslim household where the isolation of non-Muslims is defined.

The results of this exercise are shown in panels (4b) and (4c). The find-

Table 4: Industrialization and Segregation: Panel Results

(a) Change in Isolation

	Δ Isolation of Muslim households		Δ Isolation of non-Muslim households	
	(1)	(2)	(3)	(4)
	300 meters	500 meters	300 meters	500 meters
=1 if all textile state firms closed (500m radius)	-0.054***	-0.022**	0.089***	0.030***
	(0.015)	(0.007)	(0.021)	(0.007)
=1 if railways station opened (500m radius)	0.112***	0.159***	-0.089***	-0.147***
	(0.022)	(0.036)	(0.022)	(0.036)
Constant	-0.023	-0.051	0.168***	0.165***
	(0.049)	(0.061)	(0.049)	(0.026)
Controls	Yes	Yes	Yes	Yes
Clusters	137	138	94	125
Locations	918	921	505	747
R2	0.283	0.459	0.414	0.512

(b) Population Changes - Locations with at Least One Muslim Household

	Δ Number of Muslim households		Δ Number of non-Muslim households	
	(1)	(2)	(3)	(4)
	300 meters	500 meters	300 meters	500 meters
=1 if all textile state firms closed (500m radius)	-5.767	-18.443	1.593	12.566***
	(13.513)	(19.785)	(1.327)	(2.755)
=1 if railways station opened (500m radius)	44.532**	114.210*	-0.038	-21.576***
	(16.923)	(63.391)	(1.932)	(5.275)
Constant	68.907	-94.551	48.410***	117.750***
	(61.078)	(138.055)	(5.617)	(12.709)
Controls	Yes	Yes	Yes	Yes
Clusters	137	138	137	138
Locations	918	921	918	921
R2	0.402	0.578	0.497	0.517

(c) Population Changes - Locations with at Least One Non-Muslim Household

	Δ Number of Muslim households		Δ Number of non-Muslim households	
	(1)	(2)	(3)	(4)
	300 meters	500 meters	300 meters	500 meters
=1 if all textile state firms closed (500m radius)	-36.597**	-31.398*	2.858	14.033***
	(14.505)	(17.525)	(2.170)	(2.763)
=1 if railways station opened (500m radius)	2.176	35.573	-2.066	-24.701***
	(19.738)	(53.201)	(2.340)	(5.188)
Constant	-6.668	-172.248**	16.945*	25.260**
	(69.663)	(82.652)	(9.124)	(9.325)
Controls	Yes	Yes	Yes	Yes
Clusters	94	125	94	125
Locations	505	747	505	747
R2	0.631	0.687	0.495	0.527

Source: Cairo's panel sample of locations that are observed in both 1848 and 1868 and defined using the 300 and 500 meters radii. Those are based on the 1848 and 1868 geocoded population census samples of Cairo aggregated to the household level and matched with information on locations of large state firms and other controls.
Notes: $*p < 0.1, **p < 0.05, ***p < 0.01$. Standard errors clustered at the quarter level defined according to the administrative division of the 1848 census are in parentheses.

ings reveal that the effects of the closures of textiles firms on isolation are attributable to a differential decrease in the number of Muslim households nearby the closures and by a lesser magnitude to a differential increase in the number of non-Muslim households, although the results are not always statistically significant. Similarly, the effect of the opening of the railway station on isolation is primarily driven by a differential increase in the number of Muslim households nearby the railway station and secondarily by a differential decrease in the number of non-Muslim households.

To summarize, the central findings of the article are as follows. The closures and openings of state firms between 1848 and 1868 appear to have affected the isolation of Muslim and non-Muslim households in their close proximity as they led to differential changes in the sizes of the Muslim and non-Muslim populations. Whereas the opening of Cairo railway station differentially increased Muslims' isolation, the closures of textiles firms differentially decreased it. And the opposite effects hold for the isolation of non-Muslims, which differentially decreased close to the railway station and increased close to the closures of the textiles firms. In the next two sub-sections, we conduct a number of robustness checks before we examine some of the mechanisms that may be driving these findings in more depth.

5.3 Robustness Checks

There are a number of concerns about the findings in Table 4 that we attempt to address in this sub-section. We relegate the results of this sub-section to section (C) of the online appendix in order to save space.

First, the control group includes (a) locations that had at least one state firm in their proximity in both 1848 and 1868 (type 3) and (b) locations that did not have any state firms in their proximity in either year (type 4). One may be concerned though that type 3 locations witnessed multiple openings and closures of firms and hence may not constitute a proper

control group. To address this concern, we re-estimated equation (6) using locations of type (4) as the control group and including an indicator variable for locations of type (3) as an additional regressor. The results are shown in Table C.1 and are unchanged from the main findings.

Second, there is a concern that the controls may be driving the results. We thus re-estimated equation (6) without controls. The results are in Table C.2. The effects remain unchanged for textiles. But for the railway station, while its impact on isolation is robust, its effects on Muslim and non-Muslim population changes are reversed. As the station lies at the northwestern edge of the city, it is crucial, we argue, to include the set of controls in the regression especially distance to the city center.

Third, since non-Muslims include Copts, non-Coptic Christians, and Jews, who may have heterogeneous responses to state firms, we re-estimated equation (6) with Copts and Muslims only, as Copts were the largest non-Muslim group. The results in Table C.3 are similar to the main findings.

Fourth, we were concerned that the effects of textiles and railways may overlap if they are both included in the same regression. So we re-estimated equation (6) using one type of state firms at a time. The results are in Tables C.4 and C.5 and are also similar to the main findings.

Fifth, one concern is that locations in the control group may be different from the treated locations with respect to unobservable characteristics. We thus re-estimated the regressions for each type of state firms while restricting the sample to locations that lie within a 1-kilometer radius from the opening or closure of state firms. The results are in Tables C.6 and C.7 and are similar to the main findings.

Finally, we were concerned that we assumed an arbitrary type of serial correlation between the errors based on clustering within the same quarter that is defined according to the 1848-census administrative boundaries. We thus re-estimated the regressions while correcting for more general forms

of spatial correlation between locations. The results are in Tables C.8 and C.9 and are similar to the main findings.

5.4 Understanding the Mechanisms

5.4.1 Industrialization, Population Movements, and Segregation

To explore the mechanisms that could be driving our main findings in more depth, we estimate, as a first step, the impact of openings or closures of state firms between 1848 and 1868 on changes in the number of households of certain characteristics. In particular, we estimate the following equation:

$$\Delta y_{jl} = \tilde{\theta}_{0l} + \tilde{\theta}_{1l} TextilesClosure_j + \tilde{\theta}_{2l} RailwaysOpening_j + Z_j \tilde{\Theta}_l + \tilde{\epsilon}_{jl} \tag{7}$$

where Δy_{jl} is the change at location j in the number of households of a given characteristic l. These include seven characteristics which are defined at the level of the household head: (1) the number of state firm workers, (2) the number of Egyptian rural immigrants (born outside Cairo), (3) the number of foreigners, (4) the number of unskilled workers, (5) the number of artisans, (6) the number of white-collar workers, and (7) the number of households living in low-status dwellings (courtyards, huts, rooms, mills, stables, bathhouses). Z_j is defined as in equation (6).

Then as a second step, we explore the correlation between these population changes and the change in the isolation index:

$$\Delta isolation_j = \theta_0 + \sum_{l=1}^{7} \theta_l \Delta y_{jl} + Z_j \Theta + \epsilon_j \tag{8}$$

As before, we estimate the two equations separately for locations with at least one Muslim household and for locations with at least one non-Muslim household. Those correspond to the samples used in columns (2)

and (5) in panel (a) of Table 4.

The results of the first step of this exercise (equation (7)) for locations with at least one Muslim household are shown in Table 5. Panel (5a) indicates that, relative to locations in the control group, the closures of textiles firms generated in their proximity a greater decrease in the number of households headed by unskilled workers and rural immigrants (although the latter effect is not statistically significant). It also generated a greater increase in the number of foreigner households. Breaking down these population changes by religion in panels (5b) and (5c) reveals that the effects on unskilled workers and rural immigrants are attributable to Muslims, but that the effect on foreigners is due to non-Muslims.

With respect to railways, panel (5a) reveals that the opening of Cairo railway station triggered greater increases in the numbers of households headed by state firm workers, rural immigrants, foreigners, and unskilled workers, and in the number of households residing in low-status dwellings, with the effects on low-status dwellings households, rural immigrants, and unskilled workers being of the largest magnitudes. According to panels (5b) and (5c), the effects are primarily due to Muslims.

The results for the restricted sample of locations with at least one non-Muslim household are shown in Table 6 and are qualitatively similar to those in Table 5 albeit with a few exceptions. With respect to the closures of textiles firms, the positive effect on the change in the number of foreigners now loses its statistical significance whereas their effect on the change in the number of immigrants gains statistical significance. Also, there is now a positive effect on the change in the number of state firm workers and a negative effect on the change in the number of white-collar workers. With respect to the railway station, the effect on the change in the number of foreigners is now statistically insignificant, but there is a negative and significant effect on the change in the number of white-collar workers.

Table 5: Industrialization and Population Changes (300-Meters Radius) - Locations with at Least One Muslim Household

(a) Population Changes

	Δ Number of households						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	State firm workers	Immigrants	Foreigners	Unskilled	Artisans	White-Collar	Low-S D
=1 if all textile state firms closed (500m radius)	1.224	-5.279	6.544**	-9.600**	-1.015	2.678	0.500
	(0.801)	(4.311)	(2.724)	(3.673)	(3.398)	(4.900)	(2.948)
=1 if railways station opened (500m radius)	8.499***	29.109***	10.393***	15.463**	7.990	8.264	42.710***
	(1.727)	(6.790)	(2.195)	(4.820)	(5.720)	(5.180)	(6.512)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clusters	137	137	137	137	137	137	137
Locations	918	918	918	918	918	918	918
R2	0.605	0.430	0.272	0.317	0.426	0.324	0.544

(b) Muslim Population Changes

	Δ Number of Muslim households						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	State firm workers	Immigrants	Foreigners	Unskilled	Artisans	White-Collar	Low-S D
=1 if all textile state firms closed (500m radius)	0.986	-5.932	-1.336	-8.918**	-5.230	3.770	1.130
	(0.729)	(4.295)	(1.670)	(3.149)	(3.741)	(4.609)	(2.902)
=1 if railways station opened (500m radius)	6.697***	25.196***	8.376***	18.541***	8.843	8.743	40.744***
	(1.317)	(6.178)	(1.511)	(4.319)	(5.981)	(5.310)	(6.221)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clusters	137	137	137	137	137	137	137
Locations	918	918	918	918	918	918	918
R2	0.596	0.419	0.173	0.320	0.468	0.399	0.542

(c) Non-Muslim Population Changes

	Δ Number of non-Muslim households						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	State firm workers	Immigrants	Foreigners	Unskilled	Artisans	White-Collar	Low-S D
=1 if all textile state firms closed (500m radius)	0.238	0.652*	7.880***	-0.682	4.216***	-1.092*	-0.630***
	(0.160)	(0.348)	(2.121)	(0.779)	(0.892)	(0.642)	(0.170)
=1 if railways station opened (500m radius)	1.801**	3.913***	2.017	-3.079**	-0.853	-0.479	1.966***
	(0.807)	(1.084)	(2.396)	(1.134)	(1.073)	(1.514)	(0.384)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clusters	137	137	137	137	137	137	137
Locations	918	918	918	918	918	918	918
R2	0.377	0.349	0.296	0.401	0.509	0.520	0.394

Source: Cairo's panel sample of locations that are observed in both 1848 and 1868 and defined using the 300-meters radius. Locations are restricted to those with at least one Muslim household. Those are based on the 1848 and 1868 geocoded population census samples of Cairo aggregated to the household level and matched with information on locations of large state firms and other controls.
Notes: $*p < 0.1, **p < 0.05, ***p < 0.01$. Standard errors clustered at the quarter level according to the 1848-census administrative boundaries are in parentheses.

To summarize these results, we focus on the effects that are qualitatively robust across both samples for two reasons, (a) the effect must be large enough to be pronounced for the whole city, i.e. in the sample with at least one Muslim household and (b) the effect must be observed in the restricted sample of locations with at least one non-Muslim household because it is in these locations that Muslims and non-Muslims likely interact. Basically, compared to the control group, the opening of Cairo railway station in 1856 attracted in its proximity greater net *inflows* of households residing in low-status dwellings, rural immigrants, unskilled workers, state firm workers, and foreigners; all these groups were mostly Muslims. Perhaps in a similar vein, the closures of textiles firms generated greater net *outflows* of rural immigrants and unskilled workers, both groups were mostly Muslims, and a greater net *inflow* of foreigners, who were mostly non-Muslims. In the next sub-section, we attempt to interpret these findings.

The results of the second step of the exercise (equation (8)), the correlation between population movements and isolation, are in Table 7. Panel (7a) reveals that a greater increase in the number of households headed by rural immigrants, unskilled workers, or inhabitants of low-status dwellings differentially augments the isolation of Muslim households. By contrast, a greater increase in the number of foreigner households differentially reduces Muslims' isolation. panel (7b) shows that the opposite correlations hold with respect to the isolation of non-Muslim households. These results likely stem from the fact that Muslims were over-represented among rural immigrants, unskilled workers, and inhabitants of low-status dwellings, and were under-represented among foreigners (see Table A.2 in the online appendix). Consequently, a greater increase in the population size of one of the first three groups differentially aggravates (mitigates) the isolation of Muslims (non-Muslims), whereas a greater increase in the foreigner population has the opposite effects. Interestingly, changes in the numbers of

Table 6: Industrialization and Population Changes (300-Meters Radius) - Locations with at Least One Non-Muslim Household

(a) Population Changes

	Δ Number of households						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	State firm workers	Immigrants	Foreigners	Unskilled	Artisans	White-Collar	Low-S D
=1 if all textile state firms closed (500m radius)	1.654*	-17.446**	2.937	-13.968**	-4.056	-11.435**	4.768
	(0.991)	(7.333)	(3.356)	(4.922)	(4.231)	(3.676)	(3.017)
=1 if railways station opened (500m radius)	6.545**	23.515**	4.390	12.300**	-0.148	-18.117**	45.369***
	(2.316)	(8.162)	(2.987)	(6.034)	(6.919)	(6.205)	(8.503)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clusters	94	94	94	94	94	94	94
Locations	505	505	505	505	505	505	505
R2	0.644	0.569	0.326	0.515	0.590	0.572	0.701

(b) Muslim Population Changes

	Δ Number of Muslim households						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	State firm workers	Immigrants	Foreigners	Unskilled	Artisans	White-Collar	Low-S D
=1 if all textile state firms closed (500m radius)	0.897	-17.830**	-6.978***	-12.857**	-10.880**	-9.610**	5.698*
	(0.852)	(7.333)	(2.020)	(4.430)	(4.378)	(3.389)	(2.921)
=1 if railways station opened (500m radius)	4.376**	19.655**	1.317	16.926**	-2.132	-14.815**	43.499***
	(1.852)	(7.325)	(2.029)	(5.468)	(7.341)	(6.219)	(8.171)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clusters	94	94	94	94	94	94	94
Locations	505	505	505	505	505	505	505
R2	0.629	0.553	0.314	0.523	0.632	0.659	0.703

(c) Non-Muslim Population Changes

	Δ Number of non-Muslim households						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	State firm workers	Immigrants	Foreigners	Unskilled	Artisans	White-Collar	Low-S D
=1 if all textile state firms closed (500m radius)	0.757**	0.383	9.915**	-1.110	6.824***	-1.824**	-0.930***
	(0.337)	(0.542)	(3.381)	(1.030)	(1.332)	(0.858)	(0.220)
=1 if railways station opened (500m radius)	2.169*	3.860**	3.072	-4.626**	1.983	-3.302**	1.871***
	(1.125)	(1.360)	(2.866)	(1.476)	(1.899)	(1.380)	(0.414)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clusters	94	94	94	94	94	94	94
Locations	505	505	505	505	505	505	505
R2	0.500	0.467	0.323	0.491	0.623	0.560	0.461

Source: Cairo's panel sample of locations that are observed in both 1848 and 1868 and defined using the 300-meters radius. Locations are restricted to those with at least one non-Muslim household. Those are based on the 1848 and 1868 geocoded population census samples of Cairo aggregated to the household level and matched with information on locations of large state firms and other controls.
Notes: $*p < 0.1, **p < 0.05, ***p < 0.01$. Standard errors clustered at the quarter level according to the 1848-census administrative boundaries are in parentheses.

households headed by state firm workers, artisans, or white-collar workers are not correlated with changes in isolation.

5.4.2 Interpreting the Impact of State Industrialization on Population Movements and Segregation

Conceptually, the opening or closure of a state firm may alter the residential segregation between religious groups via at least three mechanisms. First, state firms may have a direct effect on the demand side of the labor market by attracting people to work in the firm. Second, state firms may have an indirect "multiplier effect" on the labor market through inducing private firms in their close proximity to relocate, thus attracting or driving away non-state firm workers. Under the first two mechanisms, if commuting cost is sufficiently high, which is likely the case in nineteenth-century Cairo where people probably walked to their workplace, state firms may alter the residential choice of workers in both state firms and outside. Third, apart from the labor market mechanisms, state firms may also affect amenities in their proximity, thus inducing people to live close by, or rather away from, the firm. For example, a state firm may be polluting or noisy thus driving residents away from it. The three effects may differ across religious groups because of inter-group differences in occupational choices, the private businesses they are involved in, and the weight they put on certain amenities when making their residential choices.

While the results in the previous subsection do not allow us to disentangle the three mechanisms, they at least offer some clues. To begin with, it appears unlikely that the first mechanism is the primary driver of the results. The reason is that the impact of state firms on the change in the number of households headed by state firm workers is positive and statistically significant in only the case of the opening of the railway station, and even there its magnitude is modest compared to the impact of the station

Table 7: Correlations between Population Changes and Isolation

(a) Correlations between Population Changes and Isolation of Muslims (300-Meters Radius) - Locations with at Least One Muslim Household

	Δ Isolation of Muslim households			
	(1)	(2)	(3)	(4)
Change in number of state firm workers	0.000			
	(0.000)			
Change in number of immigrants		0.001***		
		(0.000)		
Change in number of foreigners		-0.001***		
		(0.000)		
Change in number of unskilled workers			0.001**	
			(0.000)	
Change in number of artisans			-0.000	
			(0.000)	
Change in number of white-collar workers			0.000	
			(0.000)	
Change in number of households in low-status dwellings				0.001**
				(0.000)
Controls	Yes	Yes	Yes	Yes
Clusters	137	137	137	137
Locations	918	918	918	918
R2	0.120	0.213	0.187	0.155

(b) Correlations between Population Changes and Isolation of Non-Muslims (300-Meters Radius) - Locations with at Least One Non-Muslim Household

	Δ Isolation of non-Muslim households			
	(1)	(2)	(3)	(4)
Change in number of state firm workers	-0.000			
	(0.001)			
Change in number of immigrants		-0.001***		
		(0.000)		
Change in number of foreigners		0.002**		
		(0.001)		
Change in number of unskilled workers			-0.001***	
			(0.000)	
Change in number of artisans			0.000	
			(0.000)	
Change in number of white-collar workers			-0.000	
			(0.000)	
Change in number of households in low-status dwellings				-0.001***
				(0.000)
Controls	Yes	Yes	Yes	Yes
Clusters	94	94	94	94
Locations	505	505	505	505
R2	0.201	0.358	0.313	0.250

Source: Cairo's panel sample of locations that are observed in both 1848 and 1868 and defined using the 300-meters radius. Those are based on the 1848 and 1868 geocoded population census samples of Cairo aggregated to the household level and matched with information on locations of large state firms and other geographic information. Notes: $*p < 0.1, **p < 0.05, ***p < 0.01$. Standard errors clustered at the quarter level according to the 1848-census boundaries are in parentheses.

on other population movements such as inhabitants of low-status dwellings, rural immigrants, and unskilled workers.

Similarly, the third mechanism (amenities) may account for certain findings but is also unlikely, we argue, to be the primary driver of the findings. On the one hand, we documented that the closures of textiles firms attracted in their proximity a greater net inflow of non-Muslim foreigners, mostly Europeans, which may reflect the negative externalities that these firms created during their lifespan. Indeed, there is historical evidence on these externalities which is manifested in complaints made by foreigners residing close to *al-Khurunfish* textiles firm demanding its closure (Al-Gritli, 1952, p. 64). On the other hand though, we found that the opening of the railway station attracted a greater net inflow of Muslim foreigners which is not consistent with the (likely) negative externalities of the station. Perhaps more importantly, we failed to observe neither a positive effect of the closures of textiles firms on attracting a greater net inflow of white-collar workers (arguably, the richest segment of the population that would put a higher weight on amenities) nor a negative effect of the opening of the railway station triggering a larger "flight" of that group. Together, these pieces of evidence suggest that labor market considerations were probably more important determinants of residential choice than amenities.

This leaves us with the second mechanism, the labor market mechanism that operates through an indirect multiplier effect, as the most likely candidate. Indeed, the fact that the opening of the railway station (or the closures of the textiles firms) generated greater net inflows (or outflows) of rural immigrants and unskilled workers, that in most cases were of the largest magnitudes compared to other population movements, seem to support that mechanism. Basically, it seems plausible that the opening of the railway station crowded in unskilled jobs in its proximity that probably attracted unskilled workers as well as poor and stranded rural immigrants

who recently arrived into the city. Unskilled jobs around the station included drivers of animal-drawn vehicles, water porters, porters, laborers, servants, and construction workers. Likewise, the closures of textiles firms crowded out unskilled jobs and thus pushed away rural immigrants and unskilled workers. Since Muslims were over-represented among rural immigrants and unskilled workers, the opening of the railways station (the closures of textiles firms) resulted in greater net inflows (outflows) of Muslims that were translated into a differentially higher (lower) isolation of Muslims and a differentially lower (higher) isolation of non-Muslims.[14]

Although the "indirect" labor market mechanism is our preferred explanation, one cannot rule out the direct effect of firms on recruitment or their effect on amenities which may account for at least part of the effects.

5.4.3 Industrialization and the Housing Market

If industrialization triggered population movements that altered segregation, a natural question is if and how the housing market responded. Unfortunately, it is not possible to examine this question in full because we do not observe housing prices, but the census samples provide two pieces of information that may offer some useful clues. The first piece of information is the "type of dwelling" that allows us to identify (a) "low-status dwellings," such as courtyards, huts, rooms, stables, mills, bathhouses, which we could think of as "urban slums" and (b) "multiple-household dwellings," such as tenement houses, which we could think of as "middle-class dwellings." The second piece of information is the "type of property rights on dwellings" that includes ownership (almost all private), *waqf* or religious endowment, and undefined property rights (likely, slums).

[14]The effects of the railways and the closures of textiles firms on foreigners could also be explained by this mechanism whereby the station crowded in job opportunities for Muslim foreigners whereas the closures of textiles firms encouraged non-Muslim foreigners to re-locate their businesses that were perhaps crowded out by those firms.

To examine the correlation between industrialization and the housing outcomes we use the same specification as in equation 7 with the following dependent variables (measured as the change between 1848 and 1868): (1) the total number of dwellings, (2) the number of low-status dwellings, (3) the number of multiple-household dwellings, (4) the number of dwellings of other types, (5) the number of owned dwellings, (6) the number of *waqf* dwellings, and (7) the number of dwellings with undefined property rights.

The results of this exercise are shown in Table 8. First, the closures of textiles firms are correlated with a greater decrease in the number of low-status dwellings and a greater increase in the number of multiple-household dwellings in their proximity, relative to locations in the control group. Second, compared to the control group, the opening of the railway station is correlated with a bigger rise in the total number of dwellings in its proximity, which is attributable to a greater increase in the number of low-status dwellings and in the number of dwellings with undefined property rights. We also observe a larger decline in the number of multiple-household dwellings around the railway station. We interpret these two sets of results as evidence that the housing market *responded* to state industrialization; a response that seems to be consistent with the population movements that we documented in the two previous subsections. As the closures of textiles firms generated greater net outflows of rural immigrants and unskilled workers, who likely resided in low-status dwellings, we observe a greater decrease in this "poor" type of dwellings following the closures of the firms and the flight of these population groups. Similarly, as the opening of the railway station attracted greater net inflows of rural immigrants and unskilled workers, we observe greater increases in low-status dwellings and dwellings with undefined property rights which perhaps marked the creation of an "urban slum" around the station.[15]

[15] At the city level, the share of ownerships decreased from 76 to 68 percent between

Table 8: Industrialization and the Housing Market (300-Meters Radius - All Locations) - *Dependent Variable is the Change in the Number of Dwellings in a Given Category*

	Dwelling Types				Property Rights Types		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Total	Low-Status	Multiple-HH	Other	Owned	Waqf	Undefined
=1 if all textile state firms closed (500m radius)	-10.059	-3.403**	2.884***	-9.539	-7.019	-2.646	-0.394
	(7.081)	(1.300)	(0.838)	(5.965)	(4.891)	(1.796)	(2.252)
=1 if railways station opened (500m radius)	27.638***	38.781***	-2.456**	-8.687	6.874	3.078	17.686***
	(7.456)	(3.885)	(0.775)	(7.012)	(8.347)	(1.974)	(3.229)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clusters	137	137	137	137	137	137	137
Locations	919	919	919	919	919	919	919
R2	0.374	0.671	0.307	0.232	0.405	0.217	0.391

Source: Cairo's panel sample of locations that are observed in both 1848 and 1868 and defined using the 300-meters radius. Those are based on the 1848 and 1868 geocoded population census samples of Cairo aggregated to the household level and matched with information on locations of large state firms and other controls.
Notes: $*p < 0.1, **p < 0.05, ***p < 0.01$. Standard errors clustered at the quarter level according to the 1848-census boundaries are in parentheses.

6 Conclusion

This article documented the impact of industrialization on the residential segregation between religious groups using an early program of state industrialization in nineteenth-century Cairo. The program that lasted from 1816 to 1882 spanned several industries, most notably textiles, besides the construction of one of the first railways in the Middle East connecting Cairo and Alexandria. To examine this question, we employed a novel data source, individual-level census samples from 1848 and 1868 that contain the street address of each household along with a rich set of demographic and socioeconomic information. The data allow us to geo-locate each household at the street level; a fine geographic level that is quite unusual in studies of segregation, both historical and contemporary. We merge this data source with information on the locations of Cairo's large state firms.

We first documented that industrialization had little of an impact on the city-level segregation in Cairo, which was quite high to begin with. We then explored if the openings and closures of state firms between 1848

1848 and 1868, the share of *waqf* dwellings remained stable at 17-18 percent, but the share of dwellings with undefined property rights increased from 5 to 14 percent.

and 1868 affected local segregation. We found that the largest effect on segregation came from the opening of Cairo railway station in 1856 that differentially increased Muslims' isolation in its proximity, followed by the closures of two large textiles firms that differentially decreased it. We attribute these findings to an "indirect" labor market mechanism whereby state firms attract greater net inflows of rural immigrants and unskilled workers in order to possibly benefit from the unskilled jobs that are crowded in around the firm (but not necessarily to work in the firm). Because Muslims were over-represented among these groups, industrialization was correlated with greater net inflows of Muslims that was translated into a differentially higher Muslims' isolation (equivalently, a differentially lower non-Muslims' isolation). While we cannot rule out other mechanisms, most importantly, the direct impact of firms on recruiting people and their (likely negative) effect on the level of amenities in the neighborhood, we argue that these are unlikely to be the primary drivers of our findings.

The findings open new areas for research. For one thing, one may wonder if the subsequent waves of industrialization in twentieth-century Egypt, whether on part of the state or the private sector, may have impacted segregation in Cairo and other Egyptian cities in the long run. For another, as with most historical case studies of this sort, a normal concern is to what degree one is able to generalize these findings beyond the historical context. While we think that there are certain aspects of this study that may be specific to Egypt including, for example, the historically high level of segregation and the long-standing socioeconomic advantage of the non-Muslim minority over the Muslim majority, we think that the main argument of the article, that industrialization may cause population movements because of a labor market mechanism, and that this may in turn impact residential segregation between ethno-religious groups at the local level is quite generalizable to other contexts especially in understanding the

process of formation of urban slums in developing countries. It remains an open empirical research question if industrialization in contexts that are similar to Egypt (e.g. India) generated similar effects on segregation.

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Appendix for Online Publication

Appendix A Data Appendix

This section shows two tables. First, we show the data on large state firms in Cairo in 1848 and 1868 with information on industry, name of state firm, employment size in 1848 and 1868 (estimated from the population census samples), and longitude and latitude. Second, we show the descriptive statistics on certain socioeconomic variables for each religious group in 1848 and 1868.

Table A.1: Large State Firms in Cairo in 1848 and 1868

Industry	State Firm	Size in 1848	Size in 1868	Longitude	Latitude
Military	Munitions (Old Cairo)	413	190	31.2324	30.0281
Military	*al-Zuhurat* (weapons) (Citadel)	150	0	31.2577	30.0295
Military	Cannons (Citadel)	138	50	31.2577	30.0295
Military	Guns (*al-Hod al-Marsud*)	463	170	31.2481	30.0323
Military	Rope-making (*Bulaq*)	250	0	31.2328	30.0612
Military	Arsenal (*Bulaq*)	1825	10	31.2284	30.0633
Military	Machines (*Bulaq*)	188	50	31.2307	30.0708
Paper and Printing	*Bulaq* printing house	300	200	31.2284	30.0597
Paper and Printing	Paper (*Bulaq*)	125	10	31.2284	30.0597
Textiles	Cotton textiles (*al-Sayyida Zaynab*)	563	0	31.2423	30.0318
Textiles	Cotton textiles (*al-Khurunfish*)	1388	0	31.2594	30.0515
Textiles	Linen textiles (*Bulaq*)	463	20	31.2328	30.0612
Textiles	Baize (*Bulaq*)	250	0	31.2328	30.0612
Textiles	Cotton textiles (*al-Sabtiyah*)	375	0	31.2365	30.0655
Textiles	Cotton textiles (*Bulaq*)	913	100	31.2311	30.0662
Transportation	*al-Aziziya* steam ships station	0	210	31.2295	30.0612
Transportation	*al-Ingirariya* steam ships station	0	150	31.2295	30.0612
Transportation	Railways station	0	1000	31.2471	30.0626
Transportation	Telegraph station	0	110	31.2284	30.0633

Sources: The 1848 and 1868 census samples of Cairo and information on state firms in Sami (1928), Al-Gritli (1952), and Fahmy (1954).
Notes: The list is restricted to state firms that had at least 10 workers in the population census sample in either 1848 or 1868.

Table A.2: Characteristics of Cairo's Muslim and Non-Muslim Populations in 1848 and 1868

	Muslims		**Non-Muslims**	
	1848	**1868**	**1848**	**1868**
State firm workers	10.5%	3.5%	6%	3.5%
Rural immigrants	27.25%	11.35%	8.71%	5.56%
Foreigners	7%	5.5%	25%	25%
Unskilled workers	45%	39.5%	17%	17%
Artisans	35%	38%	37%	32%
White-collar workers	20%	22.5%	46%	51%
Residents in low-status dwellings	15.15%	14.6%	3.19%	0.91%

Sources: The 1848 and 1868 census samples of Cairo.

Appendix B City-level Segregation

B.1 Creation of "Artificial Neighborhoods"

In order to measure the city-level segregation consistently across 1848 and 1868, we construct "artificial neighborhoods" whose boundaries are constant in the two years. These were constructed using a grid of 20*20 and 25*25 cells that "discretize" the city space. We then match every household to a cell in the grid, where we only keep cells that are populated in both years.

To be specific, we use the following procedure in creating the neighborhoods:

1. Using the pooled sample of geocoded streets in both years, we compute:

   ΔLatitude = Max Latitude − Min Latitude

   and:

   ΔLongitude = Max Longitude − Min Longitude

   where Max (Min) Longitude (Latitude) refers to the maximum (minimum) longitude (latitude) observed in the sample.

2. In order to create the grid we divide the city space into equal cells:
   Step Latitude $= \Delta \frac{\text{Latitude}}{k}$
   and:
   Step Longitude $= \Delta \frac{\text{Longitude}}{l}$.
   where we chose neighborhoods to be squares with $k = l = 20$ or 25.[16]

3. The two previous steps allow us to create a point at the center of each cell at regular intervals. For $i = 1, 2, ..., k + 1$ and $y = 1, 2, ..., l + 1$ we create all points $x^{i,y}$ with coordinates:

$$x^{i,y}_{latitude} = \text{Min Latitude} + (i - 1) \times \text{Step Latitude}$$

$$x^{i,y}_{longitude} = \text{Min Longitude} + (y - 1) \times \text{Step Longitude}$$

4. We match every household to the closest point (i.e. cell or neighborhood) $x^{i,y}$.

5. We only keep cells (neighborhoods) such that:
   a) The neighborhood must be populated in each year. In practice, we restricted neighborhoods to those with at least five households matched to the cell in each year.
   b) There must be at least two different streets matched to the point in each year.

There are at least two caveats to this procedure though. First, since we impose regular intervals when creating the grid, we arbitrarily chose artificial neighborhoods to be of a particular shape. Second, as we restrict neighborhoods to those which were populated in both years, we are not able to examine the emergence of new neighborhoods.

[16] As an alternative, we test all possible combinations of k and l which are greater than 1 and smaller than 60 and we select the pair that maximizes the number of "populated" neighborhoods.

B.2 Spatial Dissimilarity and Isolation Indexes

With artificial neighborhoods, it is possible to compute the "standard" isolation indexes consistently in both 1848 and 1868. We also compute "spatial" versions of the segregation indexes which we explain below.

We proceed in two steps. First, we count the numbers of Muslim, non-Muslim, and the total number of households in the *local environment* of each "artificial neighborhood." Basically, we draw a circle of radius y (300 and 500 meters) around each neighborhood and define the *local environment* as all the "artificial neighborhoods" whose center lies within the circle. The total number of households in the local environment is then computed as the weighted sum of the number of households in all artificial neighborhoods within the circle:

$$\tilde{PopTotal}_{j,t} = \frac{1}{\Phi_{j,t}} \sum_{q=1}^{n} PopTotal_{q,t} \times \phi(j,q) \tag{B.1}$$

where $\tilde{PopTotal}_{j,t}$ is the total number of households in the local environment of an "artificial neighborhood" j in year t and $PopTotal_{q,t}$ is the number of households in artificial neighborhood q in year t. $\phi(j,q)$ is a weighting function and $\Phi_{j,t}$ is a normalization factor such that:

$$\Phi_{j,t} = \sum_{q=1}^{n} \phi(j,q)$$

We define $\phi(j,q)$, following Reardon et al. (2008):

$$\phi_{j,q} = \begin{cases} \left[1 - \left(\frac{d(j,q)}{y}\right)^2\right]^2 & \text{if } d(j,q) \leq y \\ 0 & \text{if } d(j,q) > y \end{cases} \tag{B.2}$$

where $d(j,q)$ is the euclidean distance between the centers of artificial neighborhoods j and q.

We compute the number of Muslim and non-Muslim households in the local environment of each artificial neighborhood which we denote by $\tilde{PopMuslim}_{j,t}$ ($\tilde{PopNonMuslim}_{j,t}$) respectively using the same methodology. Using the same notation as in Reardon and O'Sullivan (2004) we define π_m as the share of group m in the city, π_{qm} as the share of group m inside "artificial neighborhood" q, and $\tilde{\pi}_{qm}$ as the share of group m in the local environment of "artificial neighborhood" q.

We are now able to define the spatial versions of the dissimilarity and isolation (for Muslims) indexes. The spatial dissimilarity index is defined as:

$$\tilde{Dissimilarity}_t = \frac{1}{2} \sum_{k \in M, \bar{M}} \sum_{q=1}^{n} \frac{PopTotal_{q,t}}{PopTotal_t \times I} \times \left| \tilde{\pi}_{q,k,t} - \pi_{k,t} \right| \quad \text{(B.3)}$$

where I is the "interaction index":

$$I = \sum_{k \in M, \bar{M}} \pi_k \times (1 - \pi_k)$$

whereas the spatial isolation index is defined as:

$$\tilde{Isolation}_t = \sum_{q=1}^{n} \frac{PopMuslim_{q,t}}{PopMuslim_t} \times \tilde{\pi}_{j,t} \quad \text{(B.4)}$$

Appendix C Results of the Robustness Checks

In this section, we introduce the results of the following robustness checks: 1) we modify the control group to include only locations that did not have in their proximity any state firms in either 1848 or 1868, 2) we drop the controls, 3) we limit the sample to Muslim and Coptic Christian households only, 4) we estimate a separate regression for each type of industry, 5) we limit the sample to locations that lie within a 1-kilometer radius from the opening/closures of each type of industry, and 6) we correct for more general forms of spatial correlation.

Table C.1: Industrialization and Segregation: Different Control Group

(a) Change in Isolation

	Δ Isolation of Muslim households		Δ Isolation of non-Muslim households	
	(1)	(2)	(3)	(4)
	300 meters	500 meters	300 meters	500 meters
=1 if all textile state firms closed (500m radius)	-0.054***	-0.022**	0.090***	0.030***
	(0.014)	(0.007)	(0.021)	(0.007)
=1 if railways station opened (500m radius)	0.111***	0.159***	-0.090***	-0.147***
	(0.022)	(0.036)	(0.022)	(0.036)
Industrialized in both 1848 and 1868	-0.015	-0.001	-0.020	-0.000
	(0.013)	(0.007)	(0.018)	(0.008)
Constant	-0.004	-0.049	0.174***	0.165***
	(0.046)	(0.061)	(0.049)	(0.027)
Controls	Yes	Yes	Yes	Yes
Clusters	137	138	94	125
Locations	918	921	505	747
R2	0.288	0.459	0.416	0.512

(b) Population Changes - Locations with at Least One Muslim Household

	Δ Number of Muslim households		Δ Number of non-Muslim households	
	(1)	(2)	(3)	(4)
	300 meters	500 meters	300 meters	500 meters
=1 if all textile state firms closed (500m radius)	-6.257	-21.489	1.551	12.589***
	(13.710)	(20.463)	(1.370)	(2.744)
=1 if railways station opened (500m radius)	42.949**	116.201*	-0.176	-21.592***
	(16.689)	(64.027)	(1.908)	(5.280)
Industrialized in both 1848 and 1868	-24.692*	-44.549**	-2.146**	0.340
	(13.253)	(19.936)	(1.036)	(1.934)
Constant	100.691	-44.286	51.172***	117.366***
	(67.606)	(145.021)	(6.179)	(13.130)
Controls	Yes	Yes	Yes	Yes
Clusters	137	138	137	138
Locations	918	921	918	921
R2	0.411	0.589	0.501	0.518

(c) Population Changes - Locations with at Least One Non-Muslim Household

	Δ Number of Muslim households		Δ Number of non-Muslim households	
	(1)	(2)	(3)	(4)
	300 meters	500 meters	300 meters	500 meters
=1 if all textile state firms closed (500m radius)	-36.645**	-32.304*	3.058	14.043***
	(14.551)	(19.050)	(2.193)	(2.744)
=1 if railways station opened (500m radius)	2.223	40.085	-2.262	-24.751***
	(19.776)	(53.299)	(2.271)	(5.210)
Industrialized in both 1848 and 1868	1.313	-60.937**	-5.369	0.680
	(10.396)	(18.225)	(3.726)	(2.508)
Constant	-7.050	-103.436	18.506**	24.492**
	(70.105)	(83.677)	(8.532)	(10.083)
Controls	Yes	Yes	Yes	Yes
Clusters	94	125	94	125
Locations	505	747	505	747
R2	0.631	0.703	0.502	0.527

Source: Cairo's panel sample of locations that are observed in both 1848 and 1868 and defined using the 300 and 500 meters radii. Those are based on the 1848 and 1868 geocoded population census samples of Cairo aggregated to the household level and matched with information on locations of large state firms and other controls.
Notes: $*p < 0.1, **p < 0.05, ***p < 0.01$. Standard errors clustered at the quarter level according to the 1848-census boundaries are in parentheses.

Table C.2: Industrialization and Segregation: Without Controls

(a) Change in Isolation

	Δ Isolation of Muslim households		Δ Isolation of non-Muslim households	
	(1)	(2)	(3)	(4)
	300 meters	500 meters	300 meters	500 meters
=1 if all textile state firms closed (500m radius)	-0.051***	-0.021**	0.069***	0.024**
	(0.014)	(0.007)	(0.018)	(0.007)
=1 if railways station opened (500m radius)	0.146***	0.172***	-0.161***	-0.171***
	(0.016)	(0.020)	(0.011)	(0.020)
Clusters	137	138	94	125
Locations	918	921	505	747
R2	0.221	0.389	0.304	0.403

(b) Population Changes - Locations with at Least One Muslim Household

	Δ Number of Muslim households		Δ Number of non-Muslim households	
	(1)	(2)	(3)	(4)
	300 meters	500 meters	300 meters	500 meters
=1 if all textile state firms closed (500m radius)	-24.979	-42.527	4.583**	16.787***
	(16.200)	(26.127)	(2.192)	(2.477)
=1 if railways station opened (500m radius)	1.649	-48.509***	14.932***	25.917***
	(5.936)	(10.423)	(1.607)	(1.052)
Clusters	137	138	137	138
Locations	918	921	918	921
R2	0.016	0.020	0.082	0.218

(c) Population Changes - Locations with at Least One Non-Muslim Household

	Δ Number of Muslim households		Δ Number of non-Muslim households	
	(1)	(2)	(3)	(4)
	300 meters	500 meters	300 meters	500 meters
=1 if all textile state firms closed (500m radius)	-46.071**	-48.147*	5.980*	18.035***
	(19.831)	(28.160)	(3.076)	(2.126)
=1 if railways station opened (500m radius)	-4.656	-54.014***	14.333***	24.527***
	(9.509)	(12.050)	(1.589)	(1.266)
Clusters	94	125	94	125
Locations	505	747	505	747
R2	0.048	0.026	0.084	0.232

Source: Cairo's panel sample of locations that are observed in both 1848 and 1868 and defined using the 300 and 500 meters radii. Those are based on the 1848 and 1868 geocoded population census samples of Cairo aggregated to the household level and matched with information on locations of large state firms.
Notes: $*p < 0.1, **p < 0.05, ***p < 0.01$. Standard errors clustered at the quarter level according to the 1848-census boundaries are in parentheses.

Table C.3: Industrialization and Segregation: Coptic and Muslim Households Only

(a) Change in Isolation

	Δ Isolation of Muslim households		Δ Isolation of Coptic households	
	(1)	(2)	(3)	(4)
	300 meters	500 meters	300 meters	500 meters
=1 if all textile state firms closed (500m radius)	-0.024**	-0.000	0.048**	0.001
	(0.011)	(0.005)	(0.017)	(0.006)
=1 if railways station opened (500m radius)	0.121***	0.171***	-0.114***	-0.138***
	(0.013)	(0.039)	(0.019)	(0.039)
Constant	0.029	-0.077	0.136**	0.170***
	(0.036)	(0.062)	(0.067)	(0.049)
Controls	Yes	Yes	Yes	Yes
Clusters	137	138	74	102
Locations	918	921	378	588
R2	0.355	0.497	0.528	0.580

(b) Population Changes - Locations with at Least One Muslim Household

	Δ Number of Muslim households		Δ Number of Coptic households	
	(1)	(2)	(3)	(4)
	300 meters	500 meters	300 meters	500 meters
=1 if all textile state firms closed (500m radius)	-4.563	-17.225	-0.986	0.525
	(13.078)	(19.023)	(2.052)	(1.658)
=1 if railways station opened (500m radius)	35.568**	59.707	3.917	-28.845***
	(12.182)	(51.124)	(4.563)	(6.361)
Constant	96.690*	21.440	70.388***	128.585***
	(54.943)	(124.440)	(9.212)	(13.269)
Controls	Yes	Yes	Yes	Yes
Clusters	137	138	137	138
Locations	918	921	918	921
R2	0.410	0.584	0.560	0.601

(c) Population Changes - Locations with at Least One Coptic Household

	Δ Number of Muslim households		Δ Number of Coptic households	
	(1)	(2)	(3)	(4)
	300 meters	500 meters	300 meters	500 meters
=1 if all textile state firms closed (500m radius)	-37.631**	-30.737*	-9.220**	-0.493
	(11.083)	(15.846)	(2.805)	(1.961)
=1 if railways station opened (500m radius)	14.057	-43.057	-2.283	-30.644***
	(13.374)	(42.003)	(6.783)	(7.135)
Constant	-138.957**	-371.446***	10.551	3.831
	(54.057)	(99.964)	(16.463)	(11.648)
Controls	Yes	Yes	Yes	Yes
Clusters	74	102	74	102
Locations	378	588	378	588
R2	0.737	0.779	0.693	0.628

Source: Cairo's panel sample of locations that are observed in both 1848 and 1868 and defined using the 300 and 500 meters radii. Those are based on the 1848 and 1868 geocoded population census samples of Cairo aggregated to the household level and matched with information on locations of large state firms and other controls.
Notes: $*p < 0.1, **p < 0.05, ***p < 0.01$. Standard errors clustered at the quarter level according to the 1848-census boundaries are in parentheses.

Table C.4: Industrialization and Segregation: Textiles

(a) Change in Isolation

	Δ Isolation of Muslim households		Δ Isolation of non-Muslim households	
	(1)	(2)	(3)	(4)
	300 meters	500 meters	300 meters	500 meters
=1 if all textile state firms closed (500m radius)	-0.058***	-0.027***	0.099***	0.036***
	(0.015)	(0.008)	(0.021)	(0.008)
Constant	0.016	0.089	0.186***	0.176***
	(0.055)	(0.088)	(0.052)	(0.034)
Controls	Yes	Yes	Yes	Yes
Clusters	137	138	94	125
Locations	918	921	505	747
R2	0.230	0.304	0.385	0.386

(b) Population Changes - Locations with at Least One Muslim Household

	Δ Number of Muslim households		Δ Number of non-Muslim households	
	(1)	(2)	(3)	(4)
	300 meters	500 meters	300 meters	500 meters
=1 if all textile state firms closed (500m radius)	-7.382	-21.965	1.594	13.231***
	(13.380)	(19.700)	(1.308)	(2.723)
Constant	84.423	6.097	48.397***	98.735***
	(59.850)	(102.033)	(5.181)	(15.065)
Controls	Yes	Yes	Yes	Yes
Clusters	137	138	137	138
Locations	918	921	918	921
R2	0.396	0.568	0.497	0.496

(c) Population Changes - Locations with at Least One Non-Muslim Household

	Δ Number of Muslim households		Δ Number of non-Muslim households	
	(1)	(2)	(3)	(4)
	300 meters	500 meters	300 meters	500 meters
=1 if all textile state firms closed (500m radius)	-36.830**	-33.013*	3.080	15.154***
	(14.102)	(17.188)	(2.096)	(2.869)
Constant	-7.098	-174.815**	17.353*	27.042**
	(68.617)	(82.798)	(9.064)	(9.965)
Controls	Yes	Yes	Yes	Yes
Clusters	94	125	94	125
Locations	505	747	505	747
R2	0.631	0.686	0.495	0.498

Source: Cairo's panel sample of locations that are observed in both 1848 and 1868 and defined using the 300 and 500 meters radii. Those are based on the 1848 and 1868 geocoded population census samples of Cairo aggregated to the household level and matched with information on locations of large state firms and other controls.
Notes: $*p < 0.1, **p < 0.05, ***p < 0.01$. Standard errors clustered at the quarter level according to the 1848-census boundaries are in parentheses.

Table C.5: Industrialization and Segregation: Railway Station

(a) Change in Isolation

	Δ Isolation of Muslim households		Δ Isolation of non-Muslim households	
	(1)	(2)	(3)	(4)
	300 meters	500 meters	300 meters	500 meters
=1 if railways station opened (500m radius)	0.128***	0.166***	-0.136***	-0.160***
	(0.027)	(0.038)	(0.022)	(0.038)
Constant	-0.012	-0.052	0.016	0.135***
	(0.060)	(0.064)	(0.062)	(0.024)
Controls	Yes	Yes	Yes	Yes
Clusters	137	138	94	125
Locations	918	921	505	747
R2	0.189	0.426	0.273	0.465

(b) Population Changes - Locations with at Least One Muslim Household

	Δ Number of Muslim households		Δ Number of non-Muslim households	
	(1)	(2)	(3)	(4)
	300 meters	500 meters	300 meters	500 meters
=1 if railways station opened (500m radius)	46.159**	120.252*	-0.487	-25.693***
	(16.734)	(64.159)	(1.969)	(6.239)
Constant	70.046	-95.867	48.095***	118.647***
	(62.144)	(141.418)	(5.684)	(13.512)
Controls	Yes	Yes	Yes	Yes
Clusters	137	138	137	138
Locations	918	921	918	921
R2	0.401	0.576	0.493	0.439

(c) Population Changes - Locations with at Least One Non-Muslim Household

	Δ Number of Muslim households		Δ Number of non-Muslim households	
	(1)	(2)	(3)	(4)
	300 meters	500 meters	300 meters	500 meters
=1 if railways station opened (500m radius)	21.442	48.872	-3.571*	-30.645***
	(19.660)	(55.088)	(2.126)	(6.409)
Constant	55.660	-140.107*	12.077	10.895
	(70.286)	(81.020)	(9.037)	(9.778)
Controls	Yes	Yes	Yes	Yes
Clusters	94	125	94	125
Locations	505	747	505	747
R2	0.611	0.679	0.489	0.440

Source: Cairo's panel sample of locations that are observed in both 1848 and 1868 and defined using the 300 and 500 meters radii. Those are based on the 1848 and 1868 geocoded population census samples of Cairo aggregated to the household level and matched with information on locations of large state firms and other controls.
Notes: $*p < 0.1, **p < 0.05, ***p < 0.01$. Standard errors clustered at the quarter level according to the 1848-census boundaries are in parentheses.

Table C.6: Industrialization and Segregation: Closures of Textiles Firms and Limiting Sample to a 1-Kilometer Radius

(a) Change in Isolation

	Δ Isolation of Muslim households		Δ Isolation of non-Muslim households	
	(1)	(2)	(3)	(4)
	300 meters	500 meters	300 meters	500 meters
=1 if all textile state firms closed (500m radius)	-0.037**	-0.025***	0.064**	0.027***
	(0.012)	(0.006)	(0.019)	(0.007)
Constant	-0.547**	-0.603***	0.156	0.565***
	(0.246)	(0.071)	(0.342)	(0.080)
Controls	Yes	Yes	Yes	Yes
Clusters	70	70	49	63
Locations	463	463	279	382
R2	0.257	0.339	0.407	0.391

(b) Population Changes - Locations with at Least One Muslim Household

	Δ Number of Muslim households		Δ Number of non-Muslim households	
	(1)	(2)	(3)	(4)
	300 meters	500 meters	300 meters	500 meters
=1 if all textile state firms closed (500m radius)	0.397	-0.448	1.850	13.843***
	(11.817)	(16.946)	(1.282)	(2.854)
Constant	-186.048	-373.585*	93.657***	242.907***
	(177.051)	(190.374)	(16.867)	(29.798)
Controls	Yes	Yes	Yes	Yes
Clusters	70	70	70	70
Locations	463	463	463	463
R2	0.424	0.587	0.465	0.478

(c) Population Changes - Locations with at Least One Non-Muslim Household

	Δ Number of Muslim households		Δ Number of non-Muslim households	
	(1)	(2)	(3)	(4)
	300 meters	500 meters	300 meters	500 meters
=1 if all textile state firms closed (500m radius)	-29.012**	-23.237	4.535*	13.884***
	(14.142)	(14.550)	(2.449)	(3.049)
Constant	110.380	-465.029**	100.166**	118.982**
	(173.549)	(179.081)	(30.734)	(35.338)
Controls	Yes	Yes	Yes	Yes
Clusters	49	63	49	63
Locations	279	382	279	382
R2	0.680	0.732	0.492	0.472

Source: Cairo's panel sample of locations that are observed in both 1848 and 1868 and defined using the 300 and 500 meters radii. Those are based on the 1848 and 1868 geocoded population census samples of Cairo aggregated to the household level and matched with information on locations of large state firms and other controls.
Notes: $*p < 0.1, **p < 0.05, ***p < 0.01$. Standard errors clustered at the quarter level according to the 1848-census boundaries are in parentheses.

Table C.7: Industrialization and Segregation: Opening of the Railway Station and Limiting Sample to a 1-Kilometer Radius

(a) Change in Isolation

	Δ Isolation of Muslim households		Δ Isolation of non-Muslim households	
	(1)	(2)	(3)	(4)
	300 meters	500 meters	300 meters	500 meters
=1 if railways station opened (500m radius)	0.096**	0.086**	-0.119***	0.002
	(0.028)	(0.030)	(0.027)	(0.023)
Constant	-1.537**	1.423*	0.884	0.900
	(0.538)	(0.817)	(1.493)	(0.534)
Controls	Yes	Yes	Yes	Yes
Clusters	31	31	27	31
Locations	185	185	159	183
R2	0.820	0.522	0.817	0.884

(b) Population Changes - Locations with at Least One Muslim Household

	Δ Number of Muslim households		Δ Number of non-Muslim households	
	(1)	(2)	(3)	(4)
	300 meters	500 meters	300 meters	500 meters
=1 if railways station opened (500m radius)	21.404	23.497	-2.844	-0.839
	(15.719)	(46.584)	(2.014)	(7.138)
Constant	2347.267**	1979.583**	395.971***	226.526
	(886.469)	(961.702)	(104.348)	(137.598)
Controls	Yes	Yes	Yes	Yes
Clusters	31	31	31	31
Locations	185	186	185	186
R2	0.810	0.906	0.682	0.822

(c) Population Changes - Locations with at Least One Non-Muslim Household

	Δ Number of Muslim households		Δ Number of non-Muslim households	
	(1)	(2)	(3)	(4)
	300 meters	500 meters	300 meters	500 meters
=1 if railways station opened (500m radius)	19.860	12.954	-1.883	-0.765
	(12.923)	(42.767)	(2.393)	(7.192)
Constant	2265.183**	1615.751*	430.812**	189.610
	(951.190)	(935.252)	(123.399)	(150.443)
Controls	Yes	Yes	Yes	Yes
Clusters	27	31	27	31
Locations	159	183	159	183
R2	0.862	0.916	0.675	0.820

Source: Cairo's panel sample of locations that are observed in both 1848 and 1868 and defined using the 300 and 500 meters radii. Those are based on the 1848 and 1868 geocoded population census samples of Cairo aggregated to the household level and matched with information on locations of large state firms and other controls.
Notes: $*p < 0.1, **p < 0.05, ***p < 0.01$. Standard errors clustered at the quarter level according to the 1848-census boundaries are in parentheses.

Table C.8: Industrialization and Segregation in 1848 and 1868: Estimation Using a Spatial Autoregressive Model (SAR)

(a) Change in Isolation

	Δ Isolation of Muslim households		Δ Isolation of non-Muslim households	
	(1)	(2)	(3)	(4)
	300 meters	500 meters	300 meters	500 meters
main				
=1 if all textile state firms closed (500m radius)	-0.044***	-0.018***	0.068***	0.024***
	(0.005)	(0.003)	(0.008)	(0.003)
=1 if railways station opened (500m radius)	0.094***	0.112***	-0.075***	-0.100***
	(0.013)	(0.009)	(0.017)	(0.010)
Constant	-0.026	-0.039**	0.142***	0.129***
	(0.024)	(0.017)	(0.038)	(0.015)
rho				
Constant	0.755***	0.771***	0.776***	0.772***
	(0.055)	(0.044)	(0.065)	(0.046)
sigma				
Constant	0.043***	0.024***	0.048***	0.025***
	(0.001)	(0.001)	(0.002)	(0.001)
Controls	Yes	Yes	Yes	Yes
Locations	918	921	505	747

(b) Population Changes - Locations with at Least One Muslim Household

	Δ Number of Muslim households		Δ Number of non-Muslim households	
	(1)	(2)	(3)	(4)
	300 meters	500 meters	300 meters	500 meters
main				
=1 if all textile state firms closed (500m radius)	-3.393	-16.330**	1.737**	10.461***
	(4.557)	(6.318)	(0.586)	(0.921)
=1 if railways station opened (500m radius)	32.656**	82.767***	-0.878	-16.255***
	(12.716)	(20.612)	(1.635)	(2.994)
Constant	20.024	-135.143***	38.409***	88.478***
	(24.039)	(39.221)	(3.203)	(5.884)
rho				
Constant	0.875***	0.893***	0.678***	0.804***
	(0.032)	(0.028)	(0.059)	(0.043)
sigma				
Constant	42.764***	57.575***	5.495***	8.335***
	(1.018)	(1.369)	(0.130)	(0.197)
Controls	Yes	Yes	Yes	Yes
Locations	918	921	918	921

(c) Population Changes - Locations with at Least One Non-Muslim Household

	Δ Number of Muslim households		Δ Number of non-Muslim households	
	(1)	(2)	(3)	(4)
	300 meters	500 meters	300 meters	500 meters
main				
=1 if all textile state firms closed (500m radius)	-24.231***	-25.513***	3.159**	11.651***
	(5.996)	(6.382)	(1.071)	(1.068)
=1 if railways station opened (500m radius)	-6.327	18.155	-2.001	-17.140***
	(13.228)	(19.495)	(2.371)	(3.264)
Constant	-42.134	-201.530***	9.254*	15.746**
	(30.640)	(31.447)	(5.532)	(5.248)
rho				
Constant	0.882***	0.876***	0.742***	0.816***
	(0.038)	(0.033)	(0.067)	(0.044)
sigma				
Constant	38.415***	52.233***	6.889***	8.682***
	(1.234)	(1.378)	(0.220)	(0.228)
Controls	Yes	Yes	Yes	Yes
Locations	505	747	505	747

Source: Cairo's panel sample of locations that are observed in both 1848 and 1868 and defined using the 300 and 500 meters radii. Those are based on the 1848 and 1868 geocoded population census samples of Cairo aggregated to the household level and matched with information on locations of large state firms and other controls.
Notes: $*p < 0.1, **p < 0.05, ***p < 0.01$. Standard errors are in parentheses. Regressions are estimated using an SAR model where we control for the "spatially" lagged change in isolation (i.e. change in isolation in nearby locations) as an additional regressor in equation 6. The constant under "rho" refers to the coefficient of this additional regressor.

Table C.9: Industrialization and Segregation in 1848 and 1868: Estimation Using a Spatial Error Model (SEM)

(a) Change in Isolation

	Δ Isolation of Muslim households		Δ Isolation of non-Muslim households	
	(1)	(2)	(3)	(4)
	300 meters	500 meters	300 meters	500 meters
main				
=1 if all textile state firms closed (500m radius)	-0.051***	-0.021***	0.082***	0.029***
	(0.005)	(0.003)	(0.009)	(0.004)
=1 if railways station opened (500m radius)	0.119***	0.118***	-0.117***	-0.105***
	(0.015)	(0.010)	(0.020)	(0.011)
Constant	-0.020	-0.016	0.159**	0.161***
	(0.030)	(0.021)	(0.050)	(0.020)
lambda				
Constant	0.778***	0.853***	0.812***	0.856***
	(0.052)	(0.036)	(0.057)	(0.038)
sigma				
Constant	0.043***	0.024***	0.047***	0.025***
	(0.001)	(0.001)	(0.002)	(0.001)
Controls	Yes	Yes	Yes	Yes
Locations	918	921	505	747

(b) Population Changes - Locations with at Least One Muslim Household

	Δ Number of Muslim households		Δ Number of non-Muslim households	
	(1)	(2)	(3)	(4)
	300 meters	500 meters	300 meters	500 meters
main				
=1 if all textile state firms closed (500m radius)	-4.186	-16.238**	1.939**	11.928***
	(5.452)	(7.557)	(0.677)	(1.055)
=1 if railways station opened (500m radius)	39.867**	93.405***	-0.116	-13.851***
	(15.485)	(24.173)	(1.922)	(3.388)
Constant	51.184	-77.145	45.913***	112.939***
	(32.807)	(52.845)	(3.797)	(7.050)
lambda				
Constant	0.882***	0.897***	0.727***	0.840***
	(0.031)	(0.028)	(0.058)	(0.038)
sigma				
Constant	42.854***	58.302***	5.488***	8.224***
	(1.021)	(1.387)	(0.130)	(0.195)
Controls	Yes	Yes	Yes	Yes
Locations	918	921	918	921

(c) Population Changes - Locations with at Least One Non-Muslim Household

	Δ Number of Muslim households		Δ Number of non-Muslim households	
	(1)	(2)	(3)	(4)
	300 meters	500 meters	300 meters	500 meters
main				
=1 if all textile state firms closed (500m radius)	-26.769***	-25.831***	3.662**	13.705***
	(7.520)	(7.719)	(1.299)	(1.250)
=1 if railways station opened (500m radius)	6.556	29.510	-2.682	-15.482***
	(16.656)	(22.809)	(2.886)	(3.718)
Constant	-5.042	-151.507***	14.354**	26.013***
	(44.952)	(44.855)	(7.190)	(6.880)
lambda				
Constant	0.894***	0.893***	0.761***	0.841***
	(0.036)	(0.030)	(0.068)	(0.040)
sigma				
Constant	38.757***	52.681***	6.921***	8.624***
	(1.247)	(1.392)	(0.222)	(0.227)
Controls	Yes	Yes	Yes	Yes
Locations	505	747	505	747

Source: Cairo's panel sample of locations that are observed in both 1848 and 1868 and defined using the 300 and 500 meters radii. Those are based on the 1848 and 1868 geocoded population census samples of Cairo aggregated to the household level and matched with information on locations of large state firms and other controls.
Notes: $*p < 0.1, **p < 0.05, ***p < 0.01$. Standard errors are in parentheses. Regressions are estimated using an SEM model where we allow for spatial correlation in the error term. The constant under "lambda" refers to the coefficient of this additional regressor.