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## Abstract

Price booms in labor-intensive exports are expected to benefit labor. The surging demand for labor can increase labor coercion, though, if labor is relatively scarce. Using a unique natural experiment, the Lancashire cotton famine in 1861–1865 that prompted Egypt to quadruple its cotton output, and a novel data source, Egypt's population censuses of 1848 and 1868, I document that the cotton famine had a positive impact on labor coercion in rural Egypt. Agricultural slavery emerged, with an influx of imported slaves from Sudan. Owners of large estates confiscated areas with larger (non-slave) local populations. It also had a positive impact on the non-coercive employment in agriculture of local labor. I explain these findings by the scarcity of local labor relative to cotton expansion, and by large landholders' exclusive right to coerce local labor. The findings accentuate the far-reaching unintended consequences of globalization on labor in poorer economies.



JEL Classification: F16, J47, N35

Keywords: Globalization, Slavery, Labor coercion, Labor scarcity, Cotton



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# Export Booms and Labor Coercion

## Evidence from the Lancashire Cotton Famine

Mohamed Saleh*

March 28, 2020

**Abstract**

Price booms in labor-intensive exports are expected to benefit labor. The surging demand for labor can increase labor coercion, though, if labor is relatively scarce. Using a unique natural experiment, the Lancashire cotton famine in 1861–1865 that prompted Egypt to quadruple its cotton output, and a novel data source, Egypt's population censuses of 1848 and 1868, I document that the cotton famine had a positive impact on labor coercion in rural Egypt. Agricultural slavery emerged, with an influx of imported slaves from Sudan. Owners of large estates confiscated areas with larger (non-slave) local populations. It also had a positive impact on the non-coercive employment in agriculture of local labor. I explain these findings by the scarcity of local labor relative to cotton expansion, and by large landholders' exclusive right to coerce local labor. The findings accentuate the far-reaching unintended consequences of globalization on labor in poorer economies.

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> "The barbarism of the [U.S.] South, while destroying itself, [appeared] in the providence of God to be working out the regeneration of Egypt."
>
> North American Review 98, no. 203 (1864), p. 483, quoted in Earle (1926)

# 1 Introduction

The surge in unemployment and inequality in the last three decades has reinvigorated the debate on the impact of globalization on the labor market. According to the Stolper and Samuelson (1941)'s theorem, a price boom in labor-intensive exports is predicted to benefit labor in the exporting sector. Consistent with this prediction, a wide range of empirical studies document positive effects of export price booms on employment, wages, and innovation (Wagner 2002, Macis and Schivardi 2016, Bustos 2011). [1]

This literature assumes, though, that labor cannot be coerced. However, coercion of labor is commonplace, both historically and today, and the transition to non-coercive employment is a modern innovation. Under the possibility of labor coercion, the rising demand for labor that results from an export boom can increase coercion, if labor is relatively scarce (Domar 1970, Acemoglu and Wolitzky 2011). [2] Slave imports in the labor-scarce Americas surged during export booms. The influx of foreign workers into the labor-scarce Gulf countries since the 1973 oil boom has been regulated via an employer sponsorship system that restricts ability to exit employment (Zahra 2015).

This paper examines the impact of export price booms on labor coercion, and on the non-coercive employment of labor, by drawing on a unique natural experiment: The boom in cotton prices that occurred during the American Civil War in 1861–1865. The blockade of the US Confederacy ports, which curtailed US cotton exports to English textile manufacturers, caused cotton prices to surge in what became known as the Lancashire cotton famine. Egypt, an important cotton producer after the US, Brazil, and India, that had liberalized its trade since 1842, quadrupled its cotton production and exports, and they remained at a high level even after prices subsided (Figure 1).

There are three distinguishing features of rural Egypt on the eve of the cotton famine. First, there were two sources of labor: (1) local Egyptian labor, 74% of which were

1. In a similar vein, import competition is found to hurt labor in importing countries (Revenga 1992, Kletzer 1998, 2001, Liu and Trefler 2008, Autor et al. 2013).

2. If, on the other hand, an export boom improves the outside option of workers, it can lead to a reduction in coercion. In this vein, the Black Death in medieval Europe, and the consequent drop in labor supply, marked the shift from labor coercion to market employment.

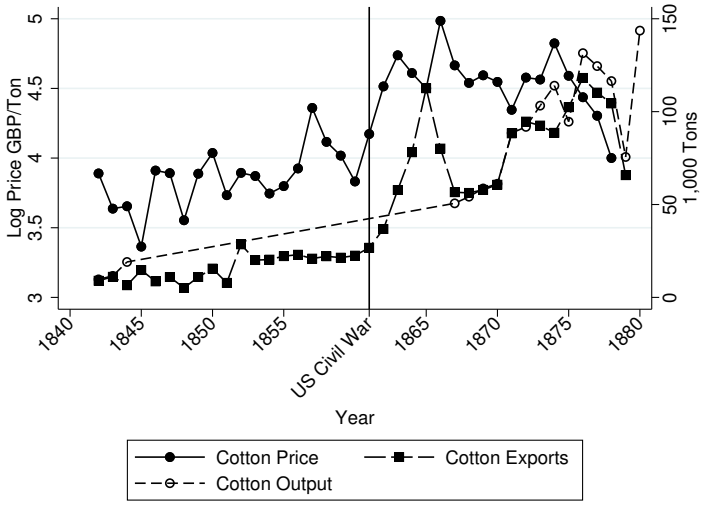


Figure 1 – Export price, quantity exported, and total output of Egypt's long-staple cotton in 1842–1880

Notes: Original quantities are in *cantar*/*quintal*, which I converted into tons according to the rate in Owen (1969, pp. 381-385). Original prices are in either Austrian *thaler* (*talaris*), which was preferred by international traders because of its relative stability, or in Egyptian piaster, which was exchanged for European currencies at fixed rates (according to silver content) between 1835 and 1885. I converted prices into British pounds (GBP) according to the rate in Owen (1969, pp. 381-385) and Officer (2016). The real price of cotton in 1850–1880 that is reported by Jacks (2019) shows a similar spike in 1861–1865. Sources: Owen (1969, pp. 34, 73, 90-91, 123, 126) and Ministère de l'Intérieur (1873, pp. 172-173).

farmers. There was a chronic shortage of local labor in agriculture, though, due to widespread land desertion, as people fled their land in order to avoid unfavorable land assignments, corvée, and conscription. (2) Imported slaves, as enslavement of foreign (but not local) non-Muslims was permitted by Islamic law. Slaves were mostly from Sudan, which had been ruled by Egypt since 1820. Yet, while domestic and military slavery had long existed in the Middle East, agricultural slavery was extremely rare (Cuno 2009). [3] Observing these two labor sources allows me to examine not only the impact of the cotton famine on labor coercion, in the form of the *emergence* of agricultural slavery, but also on the non-coercive employment in agriculture of local labor. I am thus able to investigate whether coercive and non-coercive employment are complements or substitutes.

Second, three types of landholders existed: [4] (1) landholding farmers, who held usufruct rights, and were mostly small landholders, (2) area headmen, who were in charge of al-

3. After the Abbasids' attempt to introduce agricultural slavery in 9$^{\text{th}}$-century Iraq, which ended with a massive slave rebellion, agricultural slavery disappeared from the region.

4. I use the term "landholder" and not "landowner," because rights on land (except on large estates) were technically usufruct rights, and not private property, with the state being the legal owner.

locating usufruct rights within their villages, and were mostly medium landholders, and (3) owners of large estates, who were top state officials, forming estates on land that was confiscated from usufruct holders. But whereas landholding farmers and area headmen were not legally able to coerce local workers, the local labor force on large estates was required to work for the absentee owner, in exchange for subsistence plots, cash wage, share of the crop, or payment of tax arrears. This enables me to investigate the heterogeneous effects of the famine by landholder size on slavery, and on the employment of local labor, whether coercive (by large estates) or non-coercive (by other landholders).

Third, Egypt abolished slavery and emancipated its slave population in 1877, due to European (not internal) pressure. This allows me to study the impact of the abolition on non-coercive employment in agriculture, and whether the latter took the form of landholders, or cash wage agricultural workers and sharecroppers. This sheds light on the historical transition to non-coercive employment.

The historical context offers multiple advantages. (1) Despite the emerging empirical literature on the impact of export booms on labor coercion in agriculture in the Americas (Bobonis and Morrow 2014, Dippel et al. 2017), and in industrialized economies (Naidu and Yuchtman 2013), there is a dearth of evidence on their impact on the emergence of indigenous coercive institutions in non-colonial and non-industrialized environments. In this regard, studying the impact of the American Civil War on labor in pre-colonial Egypt at the onset of the "First Globalization Era" (1870–1914) illustrates that globalization can have far-reaching unintended consequences, including the unintended exportation of institutional arrangements, such as agricultural slavery, from the core to the periphery. [5] (2) Egyptian cotton producers did not have international market power on the eve of the famine, and hence, the famine can be treated as exogenous. By contrast, it is challenging to examine the impact of export booms on slavery in exporting countries with market power (e.g., US South). (3) Owners of large estates had political power to coerce local labor, which is somewhat similar to serfdom in Eastern Europe (Ogilvie and Carus 2014). (4) There were two forms of labor coercion: agricultural imported slavery and coercion of local labor by large estates, which is a richer context than the focus of most of the literature. [6] (5) The cotton boom was large, with a huge long-standing effect. Cotton's

5. Egypt was an (autonomous) Ottoman province, before it fell to British colonization in 1882.

6. Although slaves were imported, slavery still entailed the coercion of foreign labor by raiders. It is similar to slavery in the Americas.

share in Egypt's exports rose from 25% to 80%; a share that it retained for over a century until the oil boom in the 1970s, which is a symptom of the "Dutch Disease."

I am able to address these questions, because of a novel data source: two repeated cross-sectional nationally-representative individual-level samples of Egypt's population censuses of 1848 and 1868 that I digitized from the original Arabic manuscripts at the National Archives of Egypt (Saleh 2013). These are two of the earliest population censuses from any non-Western country to include information on every household member, including females, children, and slaves. They are also the only surviving individual-level comprehensive source on slaves in Egypt, and possibly in the Middle East, before the abolition. I aggregated the samples to the household level, and restricted them to households in a *panel* of 25 districts in rural Egypt that are observed in *both* 1848 and 1868, out of 70 districts in 1848, which allows me to control for district fixed effects.

The main specification is a difference-in-differences strategy, where I compare the evolution of outcomes between 1848 and 1868, across villages with varying levels of cotton suitability, which I measure by the Food and Agriculture Organization's Global Agro-Ecological Zones (henceforth, FAO-GAEZ) cotton suitability index (ranges from 0 to 1). There are two main outcomes of interest: (1) slavery, which I measure by the number of slaves and blacks in a household, and by a dummy variable =1 if there is at least one slave or black in a household, and (2) the occupational distribution of the rural Egyptian labor force, which I measure by four dummy variables indicating if the household head is farmer, white-collar worker, artisan, or unskilled non-agricultural worker. The "farmer" outcome captures the non-coercive (self-)employment in agriculture. I do not observe wages, though, which is a common shortcoming of historical censuses. I control for district fixed effects, suitability to cereals and beans, and a host of household characteristics.

The identifying assumption is that, in the absence of the cotton famine, villages with variant levels of cotton suitability would have witnessed similar evolution of slavery and of the occupational distribution of Egyptian labor, conditional on controls. There is no pre-famine census other than the 1848 census, and hence I cannot readily test for differences in the pre-treatment trends. However, four pieces of evidence come in support of the parallel trends assumption: (1) high- and low-cotton suitability villages are not statistically different with respect to most observables in 1848, (2) using ages of slaves to trace the growth of household slaveholdings over time suggests that households in villages

with varying levels of cotton suitability were on parallel trends of slaveholdings prior to 1848, (3) historical evidence suggests that the trend of the proportion of farmers, which was likely in decline before 1848 due to land desertion, did not vary by cotton suitability, (4) other village-specific shocks to employment in 1848–1868, notably the construction of the Suez Canal in 1859–1864, are unlikely to be correlated with cotton suitability. [7]

I document that slavery was relatively rare in rural Egypt in 1848, with only 1% of free-headed households owning any slaves, in comparison to 3% in cities, and an average slaveholdings of 0.06. The cotton famine caused the emergence of agricultural slavery, though. While the number of slaves and blacks in households located in villages at the $10^{\text{th}}$ percentile of cotton suitability did not statistically change in 1848–1868, it increased by 0.16 in households at the $90^{\text{th}}$ percentile, which is three times the average in 1848. The effect is attributable to an increase in slaveholdings of free-headed households. Furthermore, the proportion of slave-owners among free-headed households increased by 7 percentage points in villages at the $90^{\text{th}}$ percentile, while it remained unchanged at the $10^{\text{th}}$ percentile. Slaves were likely employed in agriculture. For one, the effect is observed among farmers only. For another, the effect is driven by a surge in male black slaves aged between 6 and 20. If the effect on slaveholdings were a pure income effect, one would expect most slaves to be females as in cities.

The famine had a positive impact on the non-coercive employment in agriculture of Egyptian labor too, suggesting that coercive and non-coercive employment were complements. Whereas the proportion of farmers in villages at the $10^{\text{th}}$ percentile declined in 1848–1868, with workers shifting to white-collar, artisanal, and unskilled non-agricultural jobs, it remained unchanged in villages at the $90^{\text{th}}$ percentile. The effect is attributable to landholding farmers, and not cash wage agricultural workers and sharecroppers.

I interpret both effects by a labor demand shock, which triggered, on the one hand, a surge in slave raids in the Nilotic and Western Sudan. It also led, on the other hand, to the preservation of the local landholding farmer base in cotton-suitable villages, via reducing land desertion (land assignments became more profitable). Two remarks are in order: (1) The results are not (entirely) driven by a labor supply shift: Prices of male black slaves, and wages of local cash wage agricultural workers, both increased by the 1870s. (2) The results are not driven either by the movement of already existing slaves

7. The Suez Canal *opening* took place in 1869, after the period of study.

(Egypt's slave population tripled from 55,072 (1.2% of the population) in 1848 to 173,654 (3.1%) in 1868), or by cross-village migration of local labor (the effect on the proportion of farmers is observed among village natives, and not immigrants).

The findings are robust to a number of specifications. First, I use a village's distance to the Damietta Nile branch as an alternative measure of cotton suitability that is based on Egypt's perennial irrigation network on the eve of the famine. Second, I restrict the sample to households in a panel of 105 villages that are observed in both the 1848 and 1868 census samples, which permits me to control for village fixed effects. Third, I aggregate the samples to the district level, in order to account for the potential spillover effects across neighboring villages within the same district.

Next, I allow the effect of the cotton famine to vary by landholder type. I find that the effect on slaveholdings is highest among area headmen, followed by landholding farmers, in areas outside large estates. I fail to find an impact among owners of large estates, though. However, whereas the size of the local (non-slave) population of areas outside large estates is not impacted by the famine, I find a positive effect on local population size of large estates. The latter effect is because owners of large estates confiscated areas with larger populations, and not because they attracted local immigrants.

Finally, I examine the effect of the abolition of slavery in 1877 on the non-coercive employment in agriculture, using the 1848, 1868, 1882, 1897, 1907, and 1917 censuses. I find that the abolition had a positive impact on the proportion of landholders, and a negative effect on the proportion of cash wage agricultural workers. This suggests that slavery was replaced with an expansion in the landholder base.

In the final section, I investigate the mechanisms of the findings. I explain the effects by: (1) scarcity of local labor relative to cotton expansion, (2) technical characteristics of cotton production, and (3) inter-landholder differences in wealth and political power. With respect to (1), I show that higher cotton-suitability districts witnessed greater expansion between 1844 and 1877 in real area, and cotton area and yield, and that this expansion is positively correlated with slavery and the proportion of farmers. Labor scarcity remained a binding constraint, necessitating an expansion in the landholder base, through WWI. With respect to (2), I argue that cotton had relatively high labor intensity, and that Egyptian landholders were (rightly) optimistic about the future world demand for Egyptian cotton. I fail to find evidence, though, that cotton cultivation in Egypt

exhibited increasing returns to scale, higher relative productivity of women and children, or higher turnover cost. Finally, with respect to (3), I argue that slaveholdings were positively correlated with landholding size (wealth) in areas outside large estates, where area headmen were the wealthiest landholders. However, owners of large estates had the exclusive right to coerce local labor, which they preferred to slaves, presumably because it was cheaper and/or more productive.

The rest of the paper proceeds as follows. Section 2 reviews the literature. Section 3 provides a historical background. I discuss the data in Section 4. The empirical analysis is presented in Section 5. I investigate the mechanisms in Section 6. Section 7 concludes.

## 2 Contribution to the Literature

A growing body of empirical literature examines the impact of export booms on labor coercion. Naidu and Yuchtman (2013) document that prosecutions of England's industrial workers under the Master and Servant Law in 1858–1875 were positively correlated with an industry's output price. Wages were not correlated with output prices before the repeal of the law in 1875, but they became positively correlated afterwards. Bobonis and Morrow (2014) show that coffee prices were positively correlated with literacy in Puerto Rico in the absence of coercion, but not under coercion. Dippel et al. (2017) argue that the decline in sugar prices in 1838–1913 did not depress wages in the British West Indies in the post-abolition period. The reason, the authors argue, is that the decline in prices weakened the coercive institutions that were created by large planters. Hence, in colonies that were more sugar-suitable, incarcerations (coercion) subsided, and wages rose. The paper contributes to this literature in various ways. First, it studies slavery as an outcome, whereas the literature focused on other forms of coercion (incarcerations, prosecutions). The impact of export booms on slavery is not specific to Egypt, though. Slave plantations emerged in pre-colonial western and central Africa in response to export booms during the 19$^{\text{th}}$ century (Lovejoy 2012, pp. 135-184). Second, while this literature demonstrates that coercive and non-coercive employment are substitutes, this paper suggests that they can be complements. Third, it brings novel evidence from a non-colonial setting.

Acemoglu and Wolitzky (2011) emphasize the impact of labor scarcity on coercion. According to their theory, labor scarcity can have two countervailing effects on coercion.

On the one hand, it increases output price, leading to higher coercion due to the labor demand effect (Domar 1970). On the other hand, it improves worker's outside option, thus lowering coercion. The paper's findings are consistent with the relative scarcity of local labor. The cotton famine increased the demand for labor, holding worker's outside option constant. Area headmen and landholding farmers increased coercion by purchasing slaves, while owners of large estates responded by coercing more local workers.

The paper is also related to a large body of literature on the adverse long-term effects of labor coercion on development (Engerman and Sokoloff 1997, Nunn 2008, Dell 2010, Nunn and Wantchekon 2011, Acemoglu et al. 2012, Fenske 2013, Dell and Olken 2020). [8] The paper explores export booms as one potential cause of slavery.

The impact of geography on labor coercion has long occupied scholars. In this literature, the affinity between slavery and cotton has been a recurring theme (Marx 1861, Nilsson 1994, Beckert 2015). [9] This association has been traced to specific features of cotton production, including effort intensity (Fenoaltea 1984), returns to scale which made cotton more conducive to gang labor (Fogel 1989), the relative productivity of women and children (Goldin and Sokoloff 1984), and the high cost of labor turnover (Hanes 1996). Another group of studies traced slavery in the US South to other factors beyond geography (Conrad and Meyer 1958, Fogel and Engerman 1974, Wright 1978, Olmstead and Rhode 2011). The paper shows that cotton suitability is *not* sufficient to induce coercion: Cotton suitability was not correlated with slavery before the famine, and cotton continued to be produced by landholders after the abolition. It is rather the *interaction* of cotton suitability and the cotton famine that increased coercion.

The paper contributes to the literature on the impact of trade on economic development. Acemoglu et al. (2005) demonstrate that the transatlantic trade accelerated the development of northwestern Europe. Greif (2005) emphasizes how trade can affect impersonal exchange. Belloc and Bowles (2013) demonstrate that trade liberalization can increase the cost of deviation from inferior cultural-institutional conventions. Hanlon (2015) argues that the Lancashire cotton famine led to a specific path of technical innovation in the English textile industry. Juhász (2018) shows that the blockade in France during the Napoleonic wars helped the growth of the textile industry. The paper shows

8. I do not study the long-term effects of slavery in this paper, because at its peak, slaves constituted 3% of Egypt's population in 1868, which is too small to generate substantial long-term effects.

9. Marx (1861) noted that "without slavery there would be no cotton."

how globalization can have far-reaching effects on labor in the periphery.

Finally, the paper contributes to Egyptian history. Prior to the discovery of Egypt's 1848 and 1868 population censuses in the 1980s, scholars noted the surge in slavery in rural Egypt during the cotton famine, using European consular reports and travelers' narratives (Earle 1926, Baer 1967, Fredriksen 1977, Mowafi 1981). Helal (1999) and Cuno (2009) were the first to exploit the 1848 and 1868 censuses to study slavery during the cotton famine. However, both studies compared slaveholdings before and after the famine in a few non-random (cotton-suitable) villages. Exploiting two nationally-representative samples of the censuses that I digitized, I am able to provide the first econometric evidence on the impact of the cotton famine on slavery. I am also able to examine its impact on local labor, whether its effects on slavery and local labor varied by landholder size, and the effect of the abolition, which have not been addressed before.

# 3 Historical background

## 3.1 Cultivation of long-staple cotton

Due to its dry climate, Egypt's agriculture relies entirely on irrigation from the Nile river. Up to 1800, most land produced a single "winter" crop per year; mainly, wheat, beans, barley, flax, and Egyptian clover. Because the annual Nile inundation started in June and reached its maximum in September, inundation water was stored in basins, formed by natural and manmade *nili* canals and dikes, to provide water during the fall when these crops were sown (Cuno 1992, pp. 16-19).

In 1821, a French industrialist, Louis Alexis Jumel, discovered the superior quality of a long-staple cotton seed in Egypt. Realizing its potential as an export crop, Muhammad Ali Pasha, the autonomous Ottoman viceroy of Egypt in 1805–1848, increased long-staple cotton cultivation, among other export summer crops such as rice and sesame, by investing in perennial irrigation that provided water during the (low-water) spring season, the planting season of these crops (Owen 1969, pp. 28-57). New deep *sayfi* (summer) canals were constructed, many *nili* canals were deepened (thus converted into *sayfi* canals), and the supply of water-lifting tools (*shadufs* and waterwheels) was increased (Rivlin 1961, pp. 213-249). As perennially-irrigated lands produced multiple crops per year, these projects increased the *cropped* area. According to Rivlin (1961, pp. 265-270), whereas

the *real* area increased only modestly from 4.04 million *feddans* in 1798–1801 to 4.31 million *feddans* in 1844, the cropped area, which was presumably equal to the real area in 1798–1801, increased by 16% reaching 5.01 million *feddans* in 1844.[10] The cropped area increased by a further 50% under Ali's successors, reaching 7.52 million *feddans* in 1874, although the real area increased by only 11% during the same period.[11]

## 3.2 The Lancashire cotton famine

From 1808 to 1842, Ali monopolized the trade of all export crops. The state decided on the crop mix, and purchased all output from farmers at predetermined (lower) prices to sell it on international markets. The monopoly system was dissolved in 1842, following Egypt's defeat in the Ottoman-Egyptian War that reinstated Ottoman dominance over Egypt. Importantly, the defeat made Egypt subject to the 1838 Anglo-Ottoman Balta Liman Treaty that abolished state monopolies and reduced tariffs.

After 1842, farmers were allowed to sell crops directly to exporters, and consequently, became more responsive to international price shocks. The Lancashire cotton famine was the first cotton shock after Egypt's liberalization of trade.[12] Egypt's cotton output and exports quadrupled during the 1860s, and remained at a high level even after prices subsided.[13] India and Brazil expanded on their cotton production too, and India replaced the US South as the top producer of cotton. But Egyptian cotton was of higher quality, and thus not a perfect substitute. Following the cotton famine, England became Egypt's largest importer of cotton (≈80%). Since then, the Egyptian economy became centered

10. Rivlin (1961, pp. 265-270) reports that the real area was 3.01 million *feddans* in 1813–1814 and 2.68 million in 1820–1821. However, as Rivlin recognizes, these numbers cannot be taken at face value, since they are much lower than the figures reported in both 1798–1801 and 1844.

11. There are inconsistencies across data sources, though. The cropped area in 1874 (7.52 million *feddans*) (U.S. House of Representatives 1877, p. 905) is much higher than the figure for 1877 (4.37 million) (Ministère de l'Intérieur 1877, vol. 2: pp. 54-77, 84-99, 118-166), and for 1893–1894 (6.3 million) (Ministry of Finance 1909a, p. 270). By contrast, the real area in 1874 (4.81 million *feddans*) (U.S. House of Representatives 1877, p. 905) is much lower than the figure for 1877 (5.74 million) (Ministère de l'Intérieur 1877, vol. 1: pp. 123-129), and for 1893–1894 (5.39 million) (Ministry of Finance 1909a, p. 270), although it is close to the figure for 1873 (4.62 million) (Ministère de l'Intérieur 1873, p. 300). I prefer to use the country-level cropped and real area numbers for 1874 in U.S. House of Representatives (1877), because (1) the cropped area in Ministère de l'Intérieur (1877) is *lower* than the real area in the same source (which is definitely an error), (2) Ministère de l'Intérieur (1873) does not report the cropped area, and (3) Ministry of Finance (1909a) is much later than the period of study. However, I use the district-level data in Ministère de l'Intérieur (1877) on the area and yield of each crop in Table 7a, due to its finer geographic detail.

12. There was an earlier cotton boom in 1834–1837 that took place due to a bubble in the US stock market. It did not affect Egyptian farmers though, because of the state monopoly system.

13. Appendix Figure A.2 shows that cotton seed prices and exports boomed as well.

around cotton. The shock was unexpected by Egyptian landholders, and the cotton expansion was not state planned, but was rather due to individual decisions of farmers. [14]

There was a smaller boom in export prices of wheat, barley, maize, and beans in 1853–1856 due to the Crimean War that increased the demand for food (Cuno 1992, p. 182) (Appendix Figure A.1). Wheat exports doubled, but beans, maize, and barley exports did not increase, probably because farmers switched from consuming wheat to the other cereals. [15] This was only a temporary rise though, and exports dropped in the late 1850s to the extent that Egypt became a net importer in 1864–1866. [16] And even though wheat exports started to recover by the late 1860s, they continued to fluctuate and never rose back to their mid-1850s levels. Owen (1969, p. 125) explains this phenomenon by the low quality of Egypt's wheat that limited its international competitiveness. [17]

Appendix Figure A.6 illustrates the evolution of the relative shares of cotton, cereals, and beans, out of the cropped area and the total value of exports. Panel (A) shows that cotton area increased 6.5 times, and its share of cropped area jumped from 3% to 12%, between 1844 and 1874. Consistent with the rise in their output (Appendix Figure A.5), cereals and beans area increased by 56%, and their share of the cropped area rose from 70% to 74%. This suggests that cotton expansion during the cotton famine was via increasing the real and/or cropped area, rather than switching land from cereals and beans to cotton. Panel (B) shows that the status of cereals and beans as the major export crops came to an end due to the cotton famine, as cotton's share of exports climbed from 25% to 80%, and remained unrivaled as Egypt's major export until the 1970s.

### 3.3 Slavery on the eve of the Lancashire cotton famine

Slavery was a long-standing institution in Egypt. Enslavement of foreign non-Muslims via raids (*ghazwas*) was permitted by Islamic law. [18] Slavery was self-perpetuating in law; a slave's conversion to Islam did not result in emancipation, and the offspring of a

14. Faced by pressure from Manchester cotton spinners who called for state intervention to increase cotton production, Sa'id Pasha, Egypt's viceroy in 1854–1863, replied that, "prices alone will prove a sufficient stimulus without any effort on my part," (Owen 1969, p. 96).

15. The surge in wheat exports may be attributable to landholders' shift from consuming wheat to exporting it, without necessarily increasing the output. However, Appendix Figure A.5 suggests that wheat output increased (slightly) between 1844 and 1874.

16. The 1864–1865 drop was due to a livestock plague (Owen 1969, pp. 99-100).

17. Appendix Figures A.3 and A.4 reveal that there were no export booms between 1848 and 1868 for Egypt's other export crops: linseed, flax, sesame, sugar, and rice.

18. Enslavement of local non-Muslims in Muslim territories was not permitted, though.

male slave were automatically slaves. In practice though, the slave population was not sustainable by natural growth, and annual slave imports were probably necessary to meet the demand for slaves. [19]

There were three ethnicities (colors) of slaves. In 1848, 94% of slaves were blacks (*aswad*, *sudani*) from the Nilotic and Western Sudan (Darfur, Kurdufan, and Sennar). The remaining 6% were either Abyssinians (*habashi*) from Ethiopia, or whites (*abyad*) from Circassia and Georgia. Enslavement of the Nilotic and Ethiopian populations was widespread; 30-50% of the local population was slave (Lovejoy 2012, p. 186). A proportion of the enslaved population was exported to Egypt, Arabia, and the Ottoman Empire, and to a much lesser extent, the Americas, while a significant proportion of slaves were sold and employed locally. Black and Abyssinian slaves were transported to Egypt in caravans (among other imports) via the Red Sea or, more commonly, via trans-Saharan routes (Fredriksen 1977, pp. 29-42). Nubians controlled slave trade within Egypt.

While slaves were commonly employed as domestic servants, employing slaves in agriculture had been exceedingly rare before the cotton famine. [20] In 1848, slaves were over-represented in cities: They constituted 3% of the urban population (where 75% of slaves were females), compared to less than 1% in rural Egypt. [21]

Panel (A) of Figure 2 shows estimates of slave prices in Cairo slave market in 1800–1877. Whites (not shown in the figure) were the most expensive, followed by Abyssinians and blacks. Within each ethnicity, females were more expensive than males. Slave prices increased over time. Black males became more expensive in 1872 than in 1846–1850 (and converged to black female price), which may have been driven by the increased demand for black male slaves during the cotton famine (see Section 5.3).

19. Most slaves were not able to reproduce. First, 90% of slaves in 1848 lived in their owners' households. As male slaves were only allowed to marry female slaves, their options were limited to female slaves in their owners' households. Second, 65% of slave-owning households in 1848 had either only-male slaves or only-female slaves. Third, castration of male slaves was a common practice, probably as a condition to grant them access to the owner's household. Fourth, while a female slave was permitted to have children from her owner, her offspring in this case were free.

20. Military slavery, a long-standing institution, was in decline. Recruiting slaves in the army was abolished in 1822, as the state turned to conscripting Egyptians. In 1811, Ali massacred many Mamluks, white military slaves who ruled Egypt for centuries. Although he attempted to recruit black slaves in the army after his invasion of Sudan in 1820, his attempt failed (Fredriksen 1977, pp. 86-93). In 1848 (resp. 1868), former Mamluks constituted only 4% (resp. 6%) of the urban slave population.

21. Within rural Egypt, slaves were over-represented in the non-cotton-growing Nile Valley. They constituted 4% of the Valley's population, compared to less than 0.01% in the cotton-growing Nile Delta. Slaves in the Valley (55% of whom were males) worked in state-owned plantations and public works (Helal 1999, pp. 110-122).

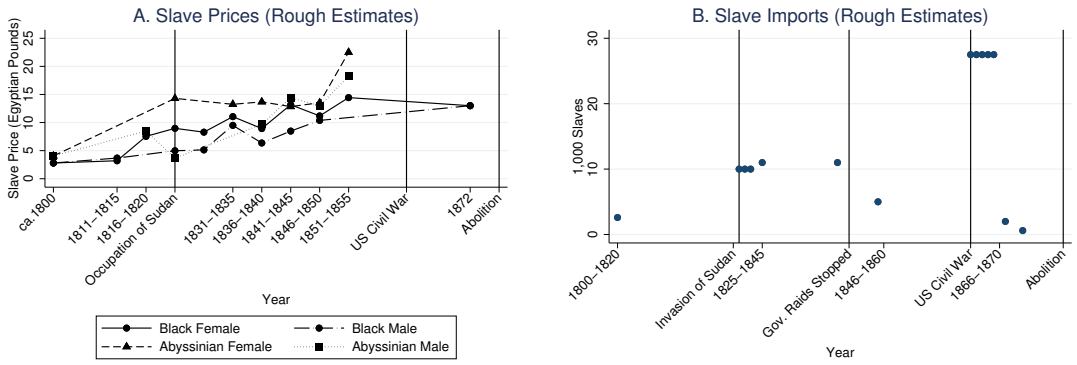


Figure 2 – Slave prices and imports in Egypt in 1800–1877

Sources: Prices: Fredriksen (1977, pp. 70-71). Imports: 1800–1820: Mowafi (1981, pp. 32-34); 1821–1860: Fredriksen (1977, pp. 50-57); 1861–1877: Baer (1967).

Panel (B) shows estimates of annual slave imports. Egypt imported around 1200–4000 slaves annually in 1800–1820. Imports increased to 10,000 slaves after the invasion of Sudan in 1820, and remained roughly at this level until the state stopped its slave raids in Sudan in 1845. Notwithstanding, the 1848 census reveals that these numbers are probably exaggerated, as there were around 55,072 slaves in 1848, which is lower than what one would expect under an annual inflow of 10,000 slaves in 1820–1845. As the task of capturing slaves shifted to private raiders, imports dropped to about 5,000 slaves annually in 1846–1860. The cotton famine in 1861–1865 witnessed an unprecedented influx of slaves, about 27,500 per year. This is supported by the 1868 census, which shows that the slave population tripled between 1848 and 1868, going up from 55,072 (1.2% of the population) to 173,654 (3.1%).

Accounts on the treatment of slaves are mixed. On the one hand, it appears that slaves were badly treated during the raiding and the transportation phases (Fredriksen 1977, pp. 45-47). Death in trans-Saharan caravans due to thirst, fatigue, and malnutrition was quite common (20-30% of slaves). On the other hand, once arrived in Egypt, slaves were generally well treated by their owners, and even received better treatment than local small landholders and agricultural workers (Fredriksen 1977, pp. 105-109). [22]

European pressure (and not internal forces) resulted in the abolition of slavery and the emancipation of slaves in 1877. Slaveholders did not expect it. In fact, Muslim jurists were strongly against the abolition as it contradicted Islamic law (Baer 1967).

22. Relatedly, I failed to find any accounts of slave rebellions or slave-specific epidemics in Egypt.

## 3.4 Land tenure and local labor in agriculture

Around 47% of the real cultivable area in 1844 was *kharaj* land, on which landholders held usufruct rights in exchange for paying the *kharaj* land tax (Rivlin 1961, pp. 256-257). The state delegated to area headmen the assignment of usufruct within their villages.[23]

Large estates accounted for 53% of the real area in 1844 (and 4% of the rural population in 1848). These were mostly formed via the state confiscation of land from usufruct holders. Land was then granted to Ali's family members and top state officials. The former usufruct holders had to work for the large estate owner as tenants, sharecroppers, or wage workers. There were two legal types of large estates formed on *kharaj* land. First, *'uhdas* were tax farms on *kharaj* land, introduced in the 1830s.[24] In *'uhdas*, a tax farmer (*al-muta'ahid*) paid a village's tax arrears. In exchange, he temporarily took the usufruct from landholders, meaning that they had to work for the tax farmer without pay, until they paid back their taxes. *'Uhdas* accounted for 28% of the real area in 1844, but they declined by the 1860s as the land was returned back to landholders (Cuno 1992, pp. 157-160). Second, hamlets (*'izbas*) were estates on which farmers were given subsistence plots, in exchange for working without pay on owner's estate (Richards 1978). The 1844 cadaster did not record the land share held in *'izbas*.

In addition to *'uhdas* and *'izbas*, there were large estates designated as *'ushr* land, on which landholders enjoyed private property rights and paid a lower land tax called the *'ushr*. These were of at least two types: (3) *Ib'adiyas* (17% of real area) were formed on barren land for reclamation. Labor was supplied by landless farmers from neighboring villages who worked as sharecroppers or for wage (Cuno 1992, pp. 162-3). (4) *Jifliks* (8% of real area) were formed on confiscated *kharaj* land and granted exclusively to members of Ali's family. The former usufruct holders on *jifliks* often remained as tenants or sharecroppers (Cuno 1992, pp. 161-2).[25] The local population of *ib'adiyas* and *jifliks* worked for the large landholder either without pay or for subsistence wages.

In 1848, farmers constituted 74% of the rural labor force. The remaining 26% were white-collar workers, artisans, and unskilled non-agricultural workers. Around 84% of

23. The state owned *kharaj* land, and the usufruct was a temporary right renewable upon paying the tax and inheritable upon state approval, but not transformable into tax-exempt endowments (*waqf*).

24. Tax farming was originally abolished in 1813.

25. The area share of *'ushr* land (*ib'adiyas* + *jifliks*) remained stable at 25% between 1844 and 1873 (Ministère de l'Intérieur 1873, p. 300). We do not know the share of *'ushr* land before 1844, but *ib'adiyas* remained stable in 1801–1844. They amounted to 0.75 million *feddans* in 1798–1801, 0.98 million in 1813–1814, 0.72 million in 1820–1821, and 0.72 million in 1844 (Rivlin 1961, pp. 255-270).

these farmers were landholding farmers, 14% were landless farmers (cash wage agricultural workers and sharecroppers), and 2% were area headmen. Technically, both landholding farmers and area headmen were usufruct holders.

There was a chronic shortage of labor in agriculture, due to widespread land desertion (Cuno 1992, Helal 2007). The rural labor force was subject to the discretionary power of area headmen in assigning land, and in enforcing the land tax. They were also subject to various forms of state coercion: (1) unpaid forced employment (corvée) on public works, which lasted until the 1880s (Baer 1962, pp. 28-33), (2) military conscription, and (3) mobility restrictions, which lasted until 1857 (Helal 2007, pp. 164-169).

# 4 Data

**Egypt's 1848 and 1868 population censuses** The censuses include a wide range of variables, such as sex, age, relationship to household head, slave/free status, nationality, religion, ethnicity (e.g., black), occupation, place of residence, and place of origin. [26] Households are clearly delineated. A household record starts with a list of its free members, followed by its (free) servants and slaves who are residing in the household. Within each category, males are recorded before females. [27]

The population census samples are two repeated cross-sections of around 80,000 individuals in each of 1848 and 1868. I used stratified sampling by province in each year, where I applied (random) systematic sampling by page on the entirety of each province's registers (Saleh 2013). [28] I do *not* observe the same households, or the same set of villages, in both 1848 and 1868. For the purpose of this article, I aggregate the census samples to the household level, which is a suitable level to measure slaveholdings, and restrict the analysis to households residing in rural Egypt. [29] Throughout the analysis, I weight the observations in order to ensure that the sample is nationally representative. [30]

26. Other variables that are not used in the analysis are name, infirmities, physical description (in 1868 only), dwelling type, and type of property right on dwelling (e.g., private ownership, *waqf*). Both dwelling type and property right on dwelling do not vary within rural Egypt.

27. An example of a record of a male slave in the 1868 census sample is: Farag al-'Abd, male, slave, able-bodied, 25 years, under the government's control (i.e. Egyptian), brown (Abyssinian), medium height, with non-connected eyebrows and no facial scars, house of Ibrahim Selim, tribe of Selim Selim (which is a sub-tribe of *Awlad Mousa*), village of *Awlad Mousa*, district of *al-'Arin*, province of *al-Sharqiya*.

28. Egyptian censuses have three administrative levels: province, district, and sub-district (= village (*qarya/nahya*) in rural provinces, urban quarter (*shiyakha*) in urban provinces).

29. This means excluding urban provinces: Cairo, Alexandria, Rosetta, *Qusayr*, *'Arish*, and Damietta.

30. An individual's weight is equal to the inverse sampling probability, which varies across provinces.

I further restrict the sample to households residing in a panel of districts that are observed in both 1848 and 1868, in order to include district fixed effects. Because some provinces are missing in 1868 though, due to the non-survival of census registers and/or non-enumeration, this restriction results in two final cross-sectional samples of 2,469 households in 1848, and 3,321 households in 1868, residing in 609 villages in 25 "matched" districts, out of 70 districts in 1848. [31] As a robustness check, I exploit the fact that among the 609 villages that are observed in either 1848 or 1868, there are 105 villages that are observed in both years. I thus restrict the analysis to households residing in this panel of villages, which allows me to control for village fixed effects.

**Slavery** The first outcome is household slaveholdings. While an individual's slave/free status is explicitly mentioned in both 1848 and 1846, it is measured with error in the latter year, as census takers often omitted the "slave" label (*'abd*), using other labels instead, such as "black" (*aswad*), "Sudanese" (*sudani*), and "follower" (*tabi'*). But as individuals with these alternative labels are always listed at the end of the household census return, and do not have any blood or marriage relationship to the household head, they are almost certainly slaves (Cuno 2009). Households are either headed by a free head, who may or may not own slaves, or by a slave head, where all household members are slaves. I thus measure household slaveholdings by (1) the number of slaves and blacks residing in a household, (2) a dummy variable =1 if a household is headed by a free head and has at least one slave or black, (3) the number of slaves and blacks in free-headed households, and (4) a dummy variable =1 if a household is headed by a slave or black.

**Occupational distribution of Egyptian labor** The second outcome is the non-coercive employment in agriculture of local free labor. I use occupational titles to create four indicator variables that exhaust the occupational distribution: (1) =1 if HH head is a farmer, which includes area headmen (*shaykh al-hissa*), landholding farmers (*fellah*), cash wage agricultural workers (*shaghal*, *tammali*), and sharecroppers (*muzari'*), (2) =1

A household's weight takes into account cross-province differences in both the average household size and the sampling probability.

31. Appendix Table B.1 shows that households in matched districts are not statistically different from those in non-matched districts with respect to most variables in 1848. The exceptions are that matched districts have a higher proportion of slave-headed households and of non-Muslim households, and a lower proportion of Bedouin households. Households in matched districts have, on average, a lower number of male free members who are 50+ years of age. I control for these variables (except slave-headed households which is an outcome) in the empirical analysis.

if HH head is a white-collar worker, (3) =1 if HH head is an artisan, and (4) =1 if HH head is an unskilled non-agricultural worker. These variables capture the employment of local labor at the village level, which takes the form of self-employment (area headmen, landholding farmers, artisans), and wage employment (cash wage agricultural workers, sharecroppers, white-collar workers, unskilled non-agricultural workers). [32]

**Crop suitability** I employ the FAO-GAEZ crop suitability indices for cotton, wheat, barley, beans, and maize. Because Egyptian agriculture is irrigation-fed, I use the crop suitability indices under irrigation and intermediate input level for the baseline period (1961–1990). [33] The crop suitability indices are continuous. I transformed each crop measure into an index varying between 0 and 1, with 1 being the highest value in the sample, and 0 the lowest. I created a cereals suitability index that is equal to the maximum of the suitability indices of wheat, barley, beans, and maize. [34] Figure 3 maps the cotton and cereals suitability indices for villages in the 25 matched districts. [35]

**Control variables** I control for a number of household characteristics. First, I include two dummy variables indicating non-Muslim and Bedouin households, respectively. Non-Muslims were richer than Muslims on average, and Bedouins were granted land to settle in rural Egypt. Therefore, they probably had more slaves, and a different occupational distribution. Second, I control for the sex and age composition of free household members. This captures a household's capacity to employ its own members in agriculture as unpaid household labor, which is an alternative option to purchasing slaves and recruiting local non-household wage labor on the market.

32. The censuses do not record non-household workers who are employed by each household (with the exception of domestic servants). Also, I do not observe if a landholding farmer is a cash wage agricultural worker or sharecropper on other's farms.

33. I use FAO-GAEZ Data Portal Version 3.0.1. The crop suitability indices under rain-fed agriculture show no variation within Egypt. The crop suitability indices under irrigation are not available at the low level of input, presumably because the irrigation infrastructure requires a sufficiently high level of input. The crop suitability indices under irrigation assume that water resources are available and that the irrigation infrastructure is in place. They take into account the type of soil and the terrain slope.

34. I matched the grid-cell-level crop suitability indices with Egyptian villages according to the 2006 population census administrative boundaries. I then matched the villages in the 2006 census with the villages in the census samples in 1848 and 1868 by village name, which seldom changes over time.

35. Appendix Figure A.7 shows the cotton and cereals suitability indices for villages in the full rural sample (70 districts).


Figure 3 – Cotton and cereals suitability indices of villages in the matched districts

Notes: Crop suitability indices range from 0 (lowest value in the sample) to 1 (highest value). Cereals suitability index is the maximum of the suitability indices of wheat, barley, beans, and maize. The maps show the crop suitability indices at the village level (609 villages) in matched districts (25 districts). Among the 609 villages, there are 504 unique villages (105 villages appear in both 1848 and 1868).
Sources: FAO-GAEZ crop suitability indices under irrigation and intermediate input level in 1961–1990.

# 5 Empirical analysis

## 5.1 Empirical specification

I study the impact of the Lancashire cotton famine on slavery, and on the non-coercive employment in agriculture of Egyptian non-slave labor, using a difference-in-differences strategy. I exploit the time variation of the famine and the cross-village variation in cotton suitability. The basic specification is thus:

$$\begin{aligned} y_{hvdt} = \quad & \alpha_d + \delta 1868_t + \beta_1(cotton_v \times 1868_t) + \beta_2(cereals_v \times 1868_t) \\ & + \beta_3 cotton_v + \beta_4 cereals_v + X_{hvdt}\gamma + \epsilon_{hvdt} \end{aligned} \tag{1}$$

where $y_{hvdt}$ is the outcome of household $h$ residing in village $v$ in district $d$ in census year $t \in \{1848, 1868\}$, $\alpha_d$ are a full set of district fixed effects to control for district time-invariant heterogeneity, $1868_t$ =1 for households in the 1868 census sample to control for aggregate employment shocks in 1868, $cotton_v$ is the FAO-GAEZ cotton suitability index in village $v$, $cereals_v$ is the maximum suitability to wheat, barley, beans, and maize in village $v$, $X_{hvdt}$ is a vector of household-level controls, and $\epsilon_{hvdt}$ is an error term. Standard errors are clustered at the village level, the level of aggregation of the cotton suitability index. Regressions are weighted by a household's inverse probability of sampling.

The main regressor is the interaction of $1868_t$ and cotton suitability ($cotton_v$). The coefficient $\beta_1$ captures the differential growth of slavery, and of the occupational distribution of local labor, in 1848–1868 across more cotton-suitable villages and less cotton-suitable villages. The underlying hypothesis is that households who resided in villages that were more cotton suitable, were more susceptible to being impacted by the Lancashire cotton famine in 1861–1865, regardless of the actual treatment (intention-to-treat analysis). Controlling for cereals suitability enables me to account for for the potential confounding effect of the price boom of cereals in 1853–1856 on employment.

## 5.2 Discussion of the parallel trends assumption

The validity of equation (1) rests on the "parallel trends" assumption: In the absence of the Lancashire cotton famine, slavery and the occupational distribution of local labor would have evolved equally in 1848–1868 across villages with different cotton suitability values,

conditional on controls. This assumption will be violated if there are omitted baseline village characteristics, or village-specific changes in 1848–1868, that are correlated with both cotton suitability and the subsequent changes in outcomes.

We lack an additional "pre-treatment" population census (besides the 1848 census), and hence I cannot readily test for the existence of pre-treatment differential trends of outcomes by cotton suitability. However, I provide four pieces of evidence in support of the parallel trends assumption: (1) I examine baseline differences in outcomes and observables across high- and low-cotton suitability villages in 1848, (2) I exploit the age profiles of slaves to trace the growth of household slaveholdings over time, (3) I provide historical evidence that the proportion of farmers did not evolve differently by cotton suitability before 1848, (4) I argue that other village-specific shocks to employment in 1848–1868 are unlikely to be correlated with cotton suitability.

**Baseline differences by cotton suitability in 1848** Appendix Table B.2 shows household baseline differences in 1848 across "high-cotton" villages (above the median cotton suitability) and "low-cotton" villages (below the median). The table reveals that cotton suitability is not correlated with slavery, or with the occupational distribution of local labor, in 1848. Examining other household characteristics, households in high-cotton villages are less likely to be non-Muslim, have fewer free female members who are 21–30 years, and more free female members who are 41–50 and 50+ years. I control for these household characteristics in equation (1).

**Tracing household slaveholdings over time** I observe a household's stock of slaves in 1848 or 1868. But the age profiles of slaves enable me to reconstruct the yearly number (flow) of slaves that were purchased by each household, under the assumption that a slave is purchased at age 6 and lives up to age 50, which is supported by historical evidence. [36] I thus pool the 1848 and 1868 households in matched districts, and create a "pseudo-panel" that traces yearly slave purchases of each household in 1848 (1868) from 1804 (1824) to

36. I focus on slaves aged 6–50 (with non-missing age) who live in free-headed households. I exclude slaves who are born into slavery: those who have at least one slave parent in the household, and those below 6 (who are less likely to have been purchased). According to Fredriksen (1977, pp. 44-5), slaves were mostly purchased below the age of 15. I exclude slaves above 50, because I observe extremely few of them, which suggests that most slaves died before that age.

1848 (1868),[37] in order to estimate the following regression:

$$slavespurchased_{hvdt} = \alpha_h + \delta_t + \sum_{j=1809}^{1868} \beta_{1j} cotton_v + \sum_{j=1808}^{1868} \beta_{2j} cereals_v + \epsilon_{hvdt} \quad (2)$$

where $slavespurchased_{hvdt}$ is the number of slaves purchased by household $h$ in village $v$ in district $d$ in period $t \in \{1809-1818, 1819-1828, ..., 1859-1868\}$ with $1804-1808$ being the omitted period,[38] $\alpha_h$ are household fixed effects, $\delta_t$ are period fixed effects. Standard errors are clustered at the village level. If the parallel trends assumption holds, I would expect $\beta_1$ to be not statistically different from 0 for all periods up to 1858, and to be positive in $1859-1868$.

The coefficients $\hat{\beta}_1$ are plotted in panel (A) of Appendix Figure A.8. The growth of household slaveholdings in more cotton-suitable villages is not statistically different from that in less cotton-suitable villages up to 1858, but the difference becomes positive in 1859–1868, which is arguably attributable to the cotton famine. This finding is consistent with Figure 2, which suggests that Egypt's slave imports remained stable between the invasion of Sudan in 1820 and the abolition of state slave raids in 1845.

**Tracing the proportion of farmers over time** Rivlin (1961, p. 269) reports that the land area held by farmers was stable between 1820–1821 and 1844, whereas McCarthy (1976, p. 16) estimates that the total population remained stable during the same period. While local labor's desertion of land may have reduced the proportion of farmers over time, it is unlikely that this declining trend varied across high- and low-cotton suitable villages. Tracing the trend of the proportion of farmers across decennial cohorts of birth, among local workers who aged 20-60, reveals no correlation with cotton suitability, both before and after the cotton famine (panel (B) of Appendix Figure A.8). While this is consistent with the parallel trends assumption, it also suggests that the impact of the famine did not vary by cohort.

**Village-specific employment shocks in 1848–1868** Apart from the Crimean War in 1853–1856, which I account for by including cereals suitability as a control (see section

37. These are the earliest and latest possible dates of purchasing a slave aged 6–50 in each of 1848 and 1868. For example, the oldest slaves in 1848 are 50, i.e. born in 1798, and purchased at age 6 in 1804.

38. I estimate the flow of slaves by decade, rather than by year, because of age heaping. I also tried 5-year and 15-year intervals, and the results (available upon request) are similar.

3.2), a major contemporaneous employment shock was the construction of the Suez Canal in 1859–1869. Up to 1864, farmers were drafted to the canal construction with low pay and under harsh conditions. I do not observe the Suez Canal region in the 1868 census, but there are two remarks that mitigate this concern. First, slaves were *not* employed in the Suez Canal construction, and thus the growth in slavery in 1848–1868 is not (directly) altered by this shock. Second, drafting local workers for the Suez Canal construction did not vary systematically across cotton-growing and non-cotton-growing regions. [39]

## 5.3 Impact of Lancashire cotton famine on slavery and local labor

### 5.3.1 Slavery

The effect of the Lancashire cotton famine on slavery is shown in Table 1. Slavery was rare in rural Egypt in 1848. Only 1% of free-headed households owned any slaves, and the average number of slaves and blacks in a household was 0.06. The cotton famine led to the emergence of slavery, though. Column (1) indicates that the famine had a positive and statistically significant effect on the number of slaves and blacks in households. The effect is greater when controlling for cereals suitability in column (2), and for household characteristics in column (3). Based on the estimates in column (3), whereas households located in villages at the $10^{\text{th}}$ percentile of cotton suitability witnessed no change in their number of slaves and blacks in 1848–1868, those in villages at the $90^{\text{th}}$ percentile increased their slaveholdings by 0.16, which is three times the average slaveholdings in 1848.

The impact on the number of slaves and blacks in a household can be decomposed into four effects: (1) an increase in the proportion of slave-owning free-headed households (extensive margin 1), (2) an increase in the proportion of slave-headed households where all members are slaves (extensive margin 2), (3) an increase in the average slaveholdings among slave-owning free-headed households (intensive margin 1), and (4) an increase in the average number of slaves in slave-headed households (intensive margin 2). Columns (4)–(6) reveal that the proportion of slave-owning households out of free-headed households did not change in villages at the $10^{\text{th}}$ percentile of cotton suitability, but increased by 7 percentage points in villages at the $90^{\text{th}}$ percentile. Column (7) shows that the effect

39. Workers were drafted from both the (cotton-growing) Delta and the (non-cotton-growing) Valley: (1) A petition signed by 35 supervisors in 1861 reveals that their subordinates were all from the Delta (Al-Shinnawi 2010, p. 351), and (2) I found at the Egyptian Archives lists of adult males in the Valley who were drafted for an unnamed operation in 1864, which is most likely the Suez Canal construction.

on the number of slaves and blacks is attributable to the increase in the average slaveholdings of free-headed households. In fact, column (8) shows no effect on the proportion of slave-headed households.

Table 1 – The Lancashire cotton famine and slavery

| | Number of slaves and blacks in HH | | | =1 if slaveowner free-headed HH | | | No. of slaves & blacks in free-headed HH | =1 if slave-headed HH |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Cotton × 1868 | 0.446*** | 0.540* | 0.504* | 0.173*** | 0.242** | 0.235** | 0.568* | -0.011 |
| | (0.153) | (0.296) | (0.301) | (0.050) | (0.101) | (0.098) | (0.300) | (0.018) |
| Cereals × 1868 | | -0.115 | -0.193 | | -0.071 | -0.087 | -0.209 | 0.001 |
| | | (0.295) | (0.302) | | (0.082) | (0.082) | (0.295) | (0.019) |
| Cotton | -0.122 | 0.083 | 0.130 | -0.037* | -0.081 | -0.079 | 0.089 | -0.003 |
| | (0.087) | (0.237) | (0.253) | (0.022) | (0.061) | (0.066) | (0.248) | (0.020) |
| Cereals | | -0.186 | -0.156 | | 0.041 | 0.055 | -0.134 | 0.007 |
| | | (0.249) | (0.257) | | (0.051) | (0.056) | (0.246) | (0.021) |
| 1868 | -0.102 | -0.075 | -0.036 | -0.042 | -0.030 | -0.022 | -0.063 | 0.006 |
| | (0.086) | (0.103) | (0.094) | (0.026) | (0.027) | (0.026) | (0.088) | (0.007) |
| HH controls? | No | No | Yes | No | No | Yes | Yes | Yes |
| District FE? | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Clusters (villages) | 609 | 609 | 609 | 609 | 609 | 609 | 609 | 609 |
| Obs (households) | 5790 | 5790 | 5736 | 5760 | 5760 | 5723 | 5723 | 5736 |
| $R^2$ | 0.015 | 0.016 | 0.091 | 0.044 | 0.044 | 0.126 | 0.099 | 0.010 |
| Av. dep. var. in 1848 | 0.058 | 0.058 | 0.058 | 0.013 | 0.013 | 0.013 | 0.049 | 0.004 |

Notes: Regressions are weighted by the inverse sampling probability of households. Standard errors clustered at the village level are in parentheses. $*p < 0.10, **p < 0.05, ***p < 0.01$. Household-level controls are dummy variables for non-Muslim and Bedouin HHs, and the sex and age composition of HH free members.
Sources: The 1848 and 1868 population census samples. Data on crop suitability are from FAO-GAEZ under irrigation and intermediate input in the baseline period (1961–1990).

**Were slaves employed in agriculture?** The censuses do not report the tasks of slaves, and hence I do not observe if slaves were employed as domestic servants, thus reflecting an income effect of the famine, or as agricultural workers. But following Cuno (2009), I use two pieces of evidence to argue that slaves worked in agriculture.

First, Table 2 suggests that it was farmers who purchased slaves. Second, I examine the effect on slaveholdings broken down by sex and age. Table 3 shows that the effect in Table 1 is mostly due to purchasing black male slaves in working age (6–20), which

suggests that slaves were purchased to work in agriculture. For one, the bias towards male slaves in working age comes in contrast to the sex ratio of slaves in cities, of which 75% in each of 1848 and 1868 were females (suggesting that they were mostly domestic servants). If purchasing slaves were an (pure) income effect, one would expect most slaves to be females, as in cities. For another, it comes in contrast to the balanced sex ratio of slaves in rural Egypt in 1848. [40] [41]

**Cross-village migration of slaves** The cotton famine caused an increase in Egypt's slave imports, and not (only) movement of slaves within Egypt from low cotton-suitable to high cotton-suitable villages, via slave secondary markets. Table 1 shows that household slaveholdings did not change in 1848–1868 in lower cotton-suitable villages. Furthermore, the population censuses reveal that Egypt's slave population tripled between 1848 and 1868 (see Section 3.3), which suggests a surge in slave imports.

**Labor demand or slave supply?** I explain the positive impact on slaveholdings by a labor demand shock that was induced by the cotton famine. The surge in demand for labor triggered an increase in the number of slaves who were captured in Sudan. Indeed, historians document a surge in slave raids in the Nilotic and Western Sudan during this episode and a rise in the wealth of raiders, who were typically local chiefs. Major slave raiders during this period came from northern Sudan, such as al-Zubayr Rahma Mansour, who was later appointed as governor. The fact that prices of black male slaves increased slightly by 1872 (Figure 2) suggests that it was a labor demand shift, rather than a supply shift, that caused the increase in the quantity of slaves imported by Egypt.

40. There was no shortage of female slaves during this period. The female slave population in cities doubled between 1848 and 1868, suggesting that new female slaves were imported. Figure 2 shows that female slave prices declined slightly by 1872.

41. It is not possible to determine which agricultural tasks were assigned to slaves. Male slaves may have worked in land preparation, sowing, and cotton picking. Households may have also sent their slaves to contribute to the construction and maintenance of summer canals, waterwheels, and steam engines for irrigation. The district-level growth between 1844 and 1873 of the length of summer canals per *feddan*, and the province-level growth of waterwheels and of steam engines per *feddan* over the same period, are all positively correlated with cotton suitability, but the coefficients are too noisy and the sample size is too small in the case of provinces (Appendix Table B.3).

Table 2 – The Lancashire cotton famine and slaveholdings among farmer and non-farmer free household heads

| | No. of slaves and blacks in free-headed HH | | =1 if slaveowning free-headed HH | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Farmer × Cotton × 1868 | 0.848*** | 1.854*** | 0.283*** | 0.505** |
| | (0.321) | (0.623) | (0.106) | (0.244) |
| Non-farmer × Cotton × 1868 | -0.132 | -0.659 | -0.019 | -0.047 |
| | (0.147) | (0.451) | (0.074) | (0.193) |
| Farmer × Cereals × 1868 | | -0.799 | | -0.186 |
| | | (0.615) | | (0.203) |
| Non-farmer × Cereals × 1868 | | 0.264 | | -0.019 |
| | | (0.392) | | (0.161) |
| Farmer × 1868 | -0.298 | -0.242 | -0.118** | -0.100* |
| | (0.181) | (0.218) | (0.055) | (0.054) |
| Non-farmer × 1868 | 0.129 | 0.179 | 0.045 | 0.061 |
| | (0.085) | (0.112) | (0.039) | (0.038) |
| HH controls? | No | Yes | No | Yes |
| District FE? | Yes | Yes | Yes | Yes |
| Farmer FE? | Yes | Yes | Yes | Yes |
| Farmer FE × Cotton? | Yes | Yes | Yes | Yes |
| Farmer FE × Cereals? | No | Yes | No | Yes |
| Clusters (villages) | 574 | 574 | 574 | 574 |
| Obs (households) | 4032 | 4020 | 4032 | 4020 |
| $R^2$ | 0.029 | 0.117 | 0.067 | 0.155 |

Notes: Regressions are weighted by the inverse sampling probability of households. Sample is restricted to free household heads with non-missing occupational titles. Farmers consist of area headmen, landholding farmers, cash wage agricultural workers, and sharecroppers. Non-farmers are white-collar workers, artisans, and unskilled non-agricultural workers. Robust standard errors clustered at the village level are in parentheses. $*p < 0.10, **p < 0.05, ***p < 0.01$.
Sources: The 1848 and 1868 population census samples. Data on crop suitability are from FAO-GAEZ under irrigation and intermediate input in the baseline period 1961–1990.

### 5.3.2 Occupational distribution of local labor

The effect on local labor is shown in Table 4. [42] The table shows that the famine had a positive and statistically significant effect on the proportion of farmers. While free household heads located in villages at the 10$^{\text{th}}$ percentile of cotton suitability shifted between 1848 and 1868 from farming to white-collar and unskilled non-agricultural jobs, the proportion of farmers remained stable in villages at the 90$^{\text{th}}$ percentile. The decline in the proportion of farmers in low cotton-suitable villages can be explained by the continuous

42. 98.6% of free household heads in rural Egypt in the 1848 and 1868 samples are Egyptians. Foreigners are mostly Turks, Maghribis, and Levantines.

Table 3 – The Lancashire cotton famine and the sex and age composition of slaves in free-headed households

(a) Male slaves

| | (1) Total | (2) 0-5 | (3) 6-20 | (4) 21-40 | (5) 41-50 | (6) 50+ |
|---|---|---|---|---|---|---|
| Cotton × 1868 | 0.458** | 0.019 | 0.327** | 0.099 | 0.022** | -0.010 |
| | (0.195) | (0.038) | (0.132) | (0.082) | (0.010) | (0.009) |
| Cotton | -0.020 | 0.035 | -0.094 | 0.031 | 0.001 | 0.006 |
| | (0.156) | (0.030) | (0.083) | (0.074) | (0.006) | (0.007) |
| Cereals × 1868 | -0.146 | -0.002 | -0.144 | 0.018 | -0.023** | 0.004 |
| | (0.189) | (0.040) | (0.115) | (0.083) | (0.011) | (0.007) |
| Cereals | -0.031 | -0.041 | 0.071 | -0.057 | -0.000 | -0.004 |
| | (0.150) | (0.033) | (0.070) | (0.076) | (0.004) | (0.005) |
| 1868 | -0.071 | -0.009 | -0.025 | -0.045* | 0.003 | 0.005 |
| | (0.055) | (0.010) | (0.029) | (0.026) | (0.004) | (0.003) |
| Household-level controls? | Yes | Yes | Yes | Yes | Yes | Yes |
| District FE? | Yes | Yes | Yes | Yes | Yes | Yes |
| Clusters (villages) | 609 | 609 | 609 | 609 | 609 | 609 |
| Obs (households) | 5723 | 5723 | 5723 | 5723 | 5723 | 5723 |
| $R^2$ | 0.109 | 0.031 | 0.102 | 0.071 | 0.030 | 0.009 |
| Mean dep. var. | 0.063 | 0.007 | 0.033 | 0.021 | 0.002 | 0.001 |

(b) Female slaves

| | (1) Total | (2) 0-5 | (3) 6-20 | (4) 21-40 | (5) 41-50 | (6) 50+ |
|---|---|---|---|---|---|---|
| Cotton × 1868 | 0.110 | 0.007 | 0.008 | 0.068 | 0.007 | 0.013 |
| | (0.123) | (0.030) | (0.050) | (0.069) | (0.015) | (0.008) |
| Cotton | 0.110 | 0.054* | 0.002 | 0.062 | -0.004 | -0.002 |
| | (0.106) | (0.031) | (0.043) | (0.047) | (0.006) | (0.003) |
| Cereals × 1868 | -0.063 | -0.005 | 0.017 | -0.037 | -0.022 | -0.013 |
| | (0.123) | (0.036) | (0.047) | (0.060) | (0.024) | (0.008) |
| Cereals | -0.103 | -0.055 | -0.005 | -0.054 | 0.006 | 0.004 |
| | (0.106) | (0.033) | (0.041) | (0.044) | (0.005) | (0.004) |
| 1868 | 0.008 | 0.004 | -0.004 | -0.004 | 0.013 | 0.001 |
| | (0.037) | (0.012) | (0.015) | (0.015) | (0.011) | (0.001) |
| Household-level controls? | Yes | Yes | Yes | Yes | Yes | Yes |
| District FE? | Yes | Yes | Yes | Yes | Yes | Yes |
| Clusters (villages) | 609 | 609 | 609 | 609 | 609 | 609 |
| Obs (households) | 5723 | 5723 | 5723 | 5723 | 5723 | 5723 |
| $R^2$ | 0.066 | 0.033 | 0.048 | 0.048 | 0.023 | 0.019 |
| Mean dep. var. | 0.036 | 0.006 | 0.015 | 0.013 | 0.001 | 0.001 |

Notes: Regressions are weighted by the inverse sampling probability of households. Sample is restricted to free-headed households. Robust standard errors clustered at the village level are in parentheses. $*p < 0.10, **p < 0.05, ***p < 0.01$.
Sources: The 1848 and 1868 population census samples. Data on crop suitability are from FAO-GAEZ under irrigation and intermediate input in the baseline period 1961–1990.

desertion from land, which was due to unfavorable land assignments by area headmen, high land tax rate, and state coercion in the form of corvée and military conscription (see Section 3.4). The famine hindered this desertion in more cotton-suitable villages.

**Were farmers wage workers or landholders?** The positive effect of the cotton famine on the proportion of farmers can be attributable to landholding farmers, or to cash wage agricultural workers and sharecroppers (who are landless farmers). Appendix Table B.4 reveals that it is driven by the positive impact on the proportion of landholding farmers, which suggests that the famine led to preserving the landholder base in cotton-suitable villages. This can be explained by two channels: (1) higher cotton prices made land more profitable in cotton-suitable villages, thus reducing landholding farmers' incentive to abandon the land at a given land tax rate, and even inducing deserters to return (Helal 2007, p. 170), and (2) area headmen's ability to confiscate the usufruct from landholders was largely constrained by the state. [43]

**Cross-village migration of local labor** The impact on the proportion of farmers may have been driven by migration from lower cotton-suitability villages to higher cotton-suitability villages. However, I fail to find an impact of the famine on migration (Appendix Table B.5). Furthermore, the impact on the proportion of farmers (and of landholding farmers) is observed among village natives, and not immigrants.

**Labor demand or local labor supply?** In a similar vein to the positive impact on slavery, I explain the positive impact on the proportion of (landholding) farmers among local workers by a labor demand shock. As the cotton famine increased the demand for labor, slaves and local labor were complements. Average daily cash wages of agricultural workers more than doubled between 1840–1841 (Al-Hitta 1950, pp. 91-95) and 1873 (Ministère de l'Intérieur 1873, p. 269), which is consistent with a labor demand shift.

43. Up to 1813, both the duration and inheritability of the usufruct (and hence, the discretion of area headmen) varied geographically. It was permanent and inheritable in the Delta, but changed annually in the Valley due to fluctuations in the real area with the Nile inundation. However, the state had attempted since 1813 to make land assignments stable by reducing headmen's discretion. It ordered area headmen to leave no land in their areas unused, and no able-bodied individual without land, and imposed punishments on non-compliers (Helal 2007, pp. 164-6).

### 5.3.3 Robustness checks

I conduct a number of robustness checks. First, I employ an alternative measure of cotton suitability that is based on Egypt's irrigation technology in 1840. Second, I control for village fixed effects. Third, I conduct the analysis at the district level.

**Alternative measure of cotton suitability** As a second measure of cotton suitability, I employ a village's distance to the eastern Damietta Nile branch. Cotton suitability in Egypt depended on the availability of summer irrigation. According to Gliddon (1841, p. 15), areas closer to the Damietta branch were more suitable to cotton, because it was technically easier to dig summer canals from the Damietta branch, which was much deeper than the (western) Rosetta branch (Rivlin 1961, p. 224). Consequently, 61% of the total length of summer canals in 1840 originated from the Damietta branch (Rivlin 1961, p. 281).[44] Appendix Table B.6 shows that the effects of the Lancashire cotton famine on slavery, and on the occupational distribution of local free labor, are similar when using the distance to the Damietta branch.

**Village fixed effects** There are 105 villages that appear in both the 1848 and 1868 samples. As a robustness check, I restrict the analysis to households residing in these villages, and I re-estimate equation (1) controlling for village fixed effects. This accounts for time-invariant characteristics of villages that may be correlated with cotton suitability. The results are shown in Appendix Table B.7, and are similar to the main findings.

**District-level analysis** The cotton famine may have spillover effects across villages. To (partially) account for this possibility, I re-estimate the findings by aggregating the outcomes to the district level. The results, shown in Appendix Table B.8, are similar to the main findings.

44. In 1840, 86% of the total length of summer canals was in the Delta: 61% originated from the Damietta branch, which consisted of canals in eastern and central Delta, and 25% from the Rosetta branch, which consisted of canals in western Delta (Rivlin 1961, pp. 213-249). Rivlin (1961, p. 224) mentions that "This higher elevation of water [of the Damietta branch] was due to the fact that the Damietta branch followed a more sinuous and consequently a longer course and had less of an incline than that of the Rosetta branch."

### 5.3.4 Summary of findings

The impact of the cotton famine on slavery, and on the non-coercive employment in agriculture of local labor, can be summarized as follows. First, the famine caused a surge in labor coercion in the form of slavery. Given that slavery was relatively rare in rural Egypt prior to the famine, the impact marked the introduction of slavery in cotton-suitable villages. Slaves were likely employed in agriculture: The demand for slaves came from farmers, and slaves were mostly male blacks in working age. Second, the famine had a positive impact on the non-coercive employment in agriculture of local labor, in the form of landholding farmers, suggesting that coercive and non-coercive employment were complements. Both effects are arguably driven by a labor demand shock, that triggered (1) a rise in slave raids and imports from the Nilotic and Western Sudan, and (2) the preservation of the landholding farmer base in more cotton-suitable villages.

## 5.4 Impact of Lancashire cotton famine by landholding size

Landholders varied in wealth and political power. In this section, I investigate whether the effect of the cotton famine varied by landholding size. I use the census samples to identify large, medium, and small landholders, and non-landholders. First, the censuses record the legal type of each household's area of residence within a village, which enables me to identify if the area is a large estate (e.g., *'uhda*, *jiflik*, *ib'adiya*).[45] I observe 669 areas within the 609 villages in the matched districts in 1848 and 1868, out of which there are 29 areas designated as large estates, on which 4% of households resided.[46] Second, for households in areas outside large estates, occupational titles permit me to determine whether the household head is an area headman, landholding farmer, or non-landholder: (1) area headmen are typically medium landholders (6-50 *feddans*) (Richards 1978, p. 504), (2) landholding farmers are typically small landholders (0-5 *feddans*) (Cuno 2009), and (3) non-landholders include everyone else.[47]

I use this information to measure slaveholdings and the employment of locals by each

45. An area of residence is the fourth level of the administrative division in rural Egypt below province, district, and village, and is equivalent to a street in cities.

46. There are 20 large estates in the 1848 sample (16 *'uhdas* and 4 *jifliks*), and 9 large estates in the 1868 sample (4 *jifliks* and 5 *ib'adiyas*). 80% of areas outside large estates are *hissas* (village sections).

47. I do not observe the surface area of each landholding, though. Using data on the land distribution at the province level in 1844 from Rivlin (1961, pp. 256-257), and at the district level in 1877 from Ministère de l'Intérieur (1877, vol. 1: pp. 124-129), I fail to detect any impact of the cotton famine on land concentration, measured by the land share of large estates (results available upon request).

Table 4 – The Lancashire cotton famine and the occupational distribution of local labor

| | =1 if HH head farmer | | =1 if HH head white-collar | | =1 if HH head artisan | | =1 if HH head non-agr. unskilled | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Cotton × 1868 | 0.757*** | 1.219** | -0.215** | -0.330* | -0.068 | -0.126 | -0.474*** | -0.763** |
| | (0.201) | (0.552) | (0.102) | (0.191) | (0.099) | (0.326) | (0.159) | (0.341) |
| Cereals × 1868 | | -0.454 | | 0.096 | | 0.052 | | 0.306 |
| | | (0.486) | | (0.195) | | (0.283) | | (0.298) |
| Cotton | -0.080 | -0.026 | 0.036 | 0.036 | 0.014 | -0.060 | 0.030 | 0.051 |
| | (0.140) | (0.406) | (0.048) | (0.119) | (0.055) | (0.256) | (0.134) | (0.282) |
| Cereals | | -0.057 | | 0.014 | | 0.073 | | -0.029 |
| | | (0.350) | | (0.114) | | (0.222) | | (0.233) |
| 1868 | -0.513*** | -0.457*** | 0.176*** | 0.173** | 0.006 | 0.003 | 0.331*** | 0.281*** |
| | (0.113) | (0.124) | (0.055) | (0.068) | (0.055) | (0.060) | (0.090) | (0.101) |
| HH controls? | No | Yes | No | Yes | No | Yes | No | Yes |
| District FE? | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Clusters (villages) | 574 | 574 | 574 | 574 | 574 | 574 | 574 | 574 |
| Obs (households) | 4032 | 4020 | 4032 | 4020 | 4032 | 4020 | 4032 | 4020 |
| $R^2$ | 0.065 | 0.100 | 0.030 | 0.045 | 0.020 | 0.079 | 0.045 | 0.071 |
| Av. dep. var. in 1848 | 0.672 | 0.672 | 0.055 | 0.055 | 0.094 | 0.094 | 0.179 | 0.179 |

Notes: Regressions are weighted by the inverse sampling probability of households. Sample is restricted to free Egyptian household heads. Standard errors clustered at the village level are in parentheses. $*p < 0.10, **p < 0.05, ***p < 0.01$. Household-level controls are dummy variables for non-Muslim and Bedouin HHs, and the sex and age composition of HH free members.
Sources: The 1848 and 1868 population census samples. Data on crop suitability are from FAO-GAEZ under irrigation and intermediate input in the baseline period 1961–1990.

landholder type. First, with regard to slaveholdings, I estimate the following model:

$$\begin{aligned} slaves_{lsvdt} = \quad & \theta_s + \alpha_d + \textstyle\sum_{s=1}^{4} \beta_{1s}(landholdersize_s \times cotton_v \times 1868_t) \\ & + \textstyle\sum_{s=1}^{4} \beta_{2s}(landholdersize_s \times 1868_t) \\ & + \textstyle\sum_{s=1}^{4} \beta_{3s}(landholdersize_s \times cotton_v) + \beta_4(cereals_v \times 1868_t) + \epsilon_{lsvdt} \end{aligned} \tag{3}$$

where $slaves_{lsvdt}$ is the number of slaves and blacks who are owned by landholder $l$ of size $s$. There are four sizes: (1) non-landholders in areas outside large estates, (2) landholding farmers in areas outside large estates, (3) area headmen in areas outside large estates, and (4) large estates. For the first three groups, the unit of observation is the household; the level at which I observe each landholder's slaveholdings. For large estates, the unit of observation is the area, where I define the slaveholdings of the estate owner as the number of slaves and blacks in slave-headed households who reside on the estate (by contrast, slaves in free-headed households who reside on the estate do not belong to the estate owner). Each area designated as a large estate is thus treated as a single observation.

Second, with respect to local labor, recall that the censuses do not record the employment of local non-household labor at the household level. I thus aggregate the census samples to the area level, in order to estimate the following model:

$$\begin{aligned} localworkers_{avdt} = \quad & \alpha_d + \delta 1868_t + \beta_1(cotton_v \times 1868_t) + \beta_2(largeestate_a \times cotton_v \times 1868_t) \\ & + \beta_3(largeestate_a \times 1868_t) + \beta_4(largeestate_a \times cotton_v) \\ & + \beta_5(cereals_v \times 1868_t) + \beta_6 cotton_v + \beta_7 cereals_v + \epsilon_{lvdt} \end{aligned} \tag{4}$$

where $localworkers_{avdt}$ is the size of the free local population in area $a$ in village $v$ in district $d$ in census year $t$, and $largeestate_a$ =1 if area $a$ is a large estate.

The results are shown in Table 5. Column (1) shows that the positive impact of the famine on slaveholdings is highest among area headmen, followed by landholding farmers. Slaveholdings of area headmen in villages at the 90$^{\text{th}}$ percentile of cotton suitability increased in 1848–1868 by 3 slaves, while it did not change among headmen at the 10$^{\text{th}}$ percentile. By contrast, I fail to detect an impact among owners of large estates. Thus, the impact on slaveholdings by landholding size is an inverted-U curve: It is a statistical 0 among non-landholders, positive among landholding farmers, reaches its peak among area headmen, and then drops to a statistical 0 among owners of large estates.

Second, column (2) suggests that large estates responded to the famine by increasing

their non-slave local population instead. Large estates in villages at the 90$^{th}$ percentile of cotton suitability grew in 1848–1868 by 214 individuals (4 times the average area population in 1848), whereas those at the 10$^{th}$ percentile lost population by 365 individuals. I fail to find an impact on the local population size in areas outside large estates. Columns (3) and (4) show that large estates in cotton areas did not gain population by attracting immigrants, but rather by confiscating areas with larger native populations.

Table 5 – The Lancashire cotton famine, slavery, and local labor by landholding size

| | Number of slaves and blacks | Number of free local individuals | | |
|---|---|---|---|---|
| | (1) | (2) Total | (3) Immigrants | (4) Natives |
| Non-landholder × Cotton × 1868 | 0.07 | 53.62 | -1.33 | 54.96 |
| | (0.34) | (39.29) | (14.68) | (42.14) |
| Landholding farmer × Cotton × 1868 | 0.36** | | | |
| | (0.15) | | | |
| Area headman × Cotton × 1868 | 7.96* | | | |
| | (4.44) | | | |
| Large estate × Cotton × 1868 | -66.48 | 1943.49*** | -25.81 | 1969.30** |
| | (66.77) | (695.38) | (263.69) | (798.51) |
| Cereals × 1868 | -0.20 | -24.23 | -0.30 | -23.93 |
| | (0.28) | (35.94) | (15.28) | (33.49) |
| Non-landholder × 1868 | 0.15* | -18.37 | 0.94 | -19.31 |
| | (0.08) | (17.12) | (7.23) | (16.38) |
| Landholding farmer × 1868 | -0.17* | | | |
| | (0.09) | | | |
| Area headman × 1868 | -2.50 | | | |
| | (2.80) | | | |
| Large estate × 1868 | 39.76 | -1088.37*** | 32.00 | -1120.37** |
| | (39.69) | (395.27) | (149.27) | (455.40) |
| Landholder FE? | Yes | Yes | Yes | Yes |
| Landholder FE × Cotton? | Yes | Yes | Yes | Yes |
| District FE? | Yes | Yes | Yes | Yes |
| Clusters (villages) | 578 | 609 | 609 | 609 |
| Obs (landholders/areas) | 3900 | 669 | 669 | 669 |
| $R^2$ | 0.227 | 0.327 | 0.227 | 0.237 |
| Av. dep. var. in 1848 | 0.059 | 49.080 | 4.879 | 44.201 |

Notes: Immigrants (natives) are those born outside (inside) village of residence. Regression in column (1) are weighted by the inverse sampling probability of households for non-landholders, landholding farmers, and area headmen in areas outside large estates, and by the area population size for large estates. Regressions in columns (2)-(4) are weighted by the area population size. Robust standard errors clustered at the village level are in parentheses. $*p < 0.10, **p < 0.05, ***p < 0.01$.
Sources: The 1848 and 1868 population census samples. Data on crop suitability are from FAO-GAEZ in the baseline period 1961–1990.

## 5.5 Impact of abolition on non-coercive employment

Slavery was abolished, and slaves were emancipated, in 1877. Abolition leads to the substitution of slavery with non-coercive agricultural employment, in the form of cash wage agricultural workers and sharecroppers, or in the form of landholders. To examine the impact of the abolition, I exploit the variation across districts in their reliance on slaves during the famine. I estimate the following model:

$$y_{dt} = \alpha_d + \delta_t + \beta_1(\Delta Slavery_{d,1848-1868} \times Post1877_t) + \beta_2(cereals_d \times Post1877_t) + \epsilon_{dt} \quad (5)$$

where $y_{dt}$ is the outcome of district $d$ in census year $t \in \{1848, 1868, 1882, 1907, 1917\}$, $\Delta Slavery$ is the change in the slave population share between 1848 and 1868 in district $d$, and $Post1877_t$ is a dummy variable =1 for the post-1877 period. The first outcome is the proportion of freed slaves, which I measure by the proportion of Sudanese population. [48] The second outcome is the occupational composition of labor in agriculture, which is available in 1907 and 1917, but not in 1882. I classify employed individuals in agriculture into: (1) landholders who cultivate their own land, (2) cash wage agricultural workers, and (3) tenants and sharecroppers.

I estimate the model using both OLS and IV, where I employ a district's average cotton suitability as an IV for the change in slavery in 1848–1868. The results are shown in Table 6. Columns (1)-(2) show that higher cotton-suitability districts that witnessed greater growth in slavery in 1848–1868, did not have a statistically different growth in the proportion of emancipated slaves after the abolition, in comparison to lower cotton-suitability districts. Columns (3)-(8) reveal that these districts witnessed after 1877 a faster growth in the proportion of landholders, and a slower growth in the proportion of cash wage agricultural workers. This indicates that the greater expansion of real and cropped area in these districts after 1877, due to the continuous cotton expansion, caused the higher growth of its landholders base in 1848–1868, relative to less cotton-suitability districts, to perpetuate post 1877, through at least WWI.

48. While there was a sizable free Sudanese population in urban Egypt, almost all Sudanese people in rural Egypt were brought in as slaves. The 1882, 1907, and 1917 censuses (but not the post-1917 censuses) report the Sudanese population at the district level. The number of Sudanese declined by 1917, as (second-generation) Sudanese were increasingly (self-)identified as Egyptians.

Table 6 – Abolition of slavery and non-coercive employment in agriculture

| | Prop. (Ex-)slaves | | Prop. Landholders | | Prop. Cash wage workers | | Prop. Sharecroppers | |
|---|---|---|---|---|---|---|---|---|
| | (1) OLS | (2) IV | (3) OLS | (4) IV | (5) OLS | (6) IV | (7) OLS | (8) IV |
| Δ Slavery 1848−1868 × Post-1877 | -0.157 | -0.139 | 1.334 | 5.648** | -1.482* | -3.284*** | -0.216 | -0.321 |
| | (0.137) | (0.136) | (1.273) | (2.728) | (0.753) | (0.983) | (0.328) | (0.668) |
| Cereals × Post-1877 | 0.033 | 0.031 | -0.080 | -0.804 | -0.013 | 0.290 | -0.049 | -0.031 |
| | (0.053) | (0.049) | (0.630) | (0.655) | (0.216) | (0.269) | (0.229) | (0.207) |
| District FE? | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE? | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Clusters (districts) | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| Obs (district-year) | 118 | 118 | 93 | 93 | 93 | 93 | 93 | 93 |
| $R^2$ | 0.468 | 0.468 | 0.787 | 0.759 | 0.751 | 0.719 | 0.572 | 0.572 |
| KP Wald $F$-stat | | 15.564 | | 18.687 | | 18.687 | | 18.687 |
| Av. dep. var. in 1848 | 0.011 | 0.011 | 0.594 | 0.594 | 0.065 | 0.065 | 0.023 | 0.023 |

Notes: Standard errors clustered at the district level in parentheses. $*p < 0.10, **p < 0.05, ***p < 0.01$. Sources: The 1848 and 1868 population census samples, and the 1882, 1907, and 1917 population census reports (Ministère de l'Intérieur 1884, Ministry of Finance 1909b, 1920). Data on crop suitability are from FAO-GAEZ under irrigation and intermediate input level in the baseline period 1961–1990.

# 6 Mechanisms

The cotton famine had a positive effect on labor coercion in agriculture, which took two forms: (1) imported slavery, as slaveholdings of area headmen and landholding farmers increased, and (2) coercion of local labor, as owners of large estates confiscated areas with larger local populations. Furthermore, the famine had a positive effect on the non-coercive employment in agriculture of local workers, who worked as landholding farmers. The abolition in 1877 led to replacing slavery with an expansion in landholder base.

I explain these findings by three factors: (1) labor scarcity relative to cotton expansion, (2) technical features of cotton production in Egypt, and (3) inter-landholder differences in wealth and political power. I discuss each of these factors in turn.

## 6.1 Scarcity of local labor relative to cotton expansion

To provide evidence on this mechanism, I investigate whether higher cotton-suitability districts witnessed greater cotton expansion, and whether cotton expansion, if any, is positively correlated with the growth in household slaveholdings, and in the proportion of farmers among local labor. I first explore the impact of the famine on the cultivation

of cotton, cereals, and other crops, at the district level using a first-difference model:

$$\Delta cropoutcome_d = \beta_1 cotton_d + \beta_2 cereals_d + \epsilon_d \tag{6}$$

where $\Delta cropoutcome_d$ is the change between 1844 and 1877 in district $d$ in the outcome of three crop groups: (1) cotton, (2) cereals (wheat, barley, and beans), and (3) other crops. For each group, I study two outcomes: cultivated area (in 1,000 *feddans*), and yield (in 1,000 *qintars* for cotton, and in 1,000 *ardabbs* for wheat, barley, and beans). For the other crops, I only observe the cultivated area but not the yield.[49] The two regressors, $cotton_d$ and $cereals_d$, are the district averages of the cotton and cereals suitability indices, respectively (averaged across villages).

Second, I estimate the following model:

$$\begin{aligned} y_{hvdt} = \quad & \alpha_d + \delta 1868_t + \beta_1 cottonoutcome_{dt} + \beta_2 cerealsoutcome_{dt} \\ & + \beta_3 othercropoutcome_{dt} + X_{hvdt}\gamma + \epsilon_{hvdt} \end{aligned} \tag{7}$$

where $y_{hvdt}$ is slaveholdings or the occupation of household $h$ in village $v$ in district $d$ in census year $t$, $cottonoutcome_{dt}$, $cerealsoutcome_{dt}$, and $othercropoutcome_{dt}$ are the area or yield of cotton, cereals, and other crops, respectively in each of 1844 and 1877, where I assign the 1844 values to the 1848 census, and the 1877 values to the 1868 census.

The results are shown in Table 7. Holding cereals suitability constant at the cross-district average, a district at the 75$^{\text{th}}$ percentile of the cross-district distribution of cotton suitability increased its real area in 1844–1877 by 36,000 *feddans* more than a district at the 25$^{\text{th}}$ percentile, which amounts to 45% of the cross-district average real area in 1844 (column 1). Furthermore, in comparison to the 25$^{\text{th}}$-percentile district, cotton area at the 75$^{\text{th}}$-percentile increased by 4,000 *feddans* more (equal to the average cotton area in 1844) (column 3), and cotton yield by 7,500 *qintars* more (equal to 1.6 times the average cotton yield in 1844) (column 6). By contrast, the area and yield of cereals and of other crops did not change differentially across high-cotton and low-cotton districts during the same period (columns 4 and 7). Panel (7b) shows that the growth of slavery, and of the proportion of farmers, in 1848–1868 are each positively associated with cotton area and yield, but not with the area and yield of cereals, or with the area of other crops.

49. I measure these outcomes using province-level data in 1844 from Rivlin (1961, pp. 258-260), and district-level data in 1877 from Ministère de l'Intérieur (1877, vol. 2: pp. 54-77, 84-99, 118-166). Because the 1844 data are at the province level, I estimate each district's area and yield of every crop group in 1844 using district's share in the province's area and yield of that crop group in 1877.

Table 7 – The Lancashire cotton famine and cotton expansion

(a) Δ Area and yield of cotton, cereals, and other crops between 1844 and 1877

| | Δ Area (1,000 feddans) (1)-(5) | | | | | Δ Yield (1,000 qintars or ardabbs) (6)-(7) | |
|---|---|---|---|---|---|---|---|
| | (1) Total Real | (2) Total Cropped | (3) Cotton | (4) Cereals and beans | (5) Other crops | (6) Cotton | (7) Cereals and beans |
| Cotton (district average) | 443.151** | 125.035 | 51.305* | 158.088 | -137.227 | 93.353** | 436.650 |
| | (175.125) | (203.883) | (26.715) | (155.075) | (92.413) | (44.316) | (440.412) |
| Cereals (district average) | -232.793 | 126.617 | -8.923 | 59.931 | 120.827 | 12.773 | 255.585 |
| | (144.706) | (237.595) | (26.547) | (162.392) | (102.088) | (58.408) | (561.376) |
| Obs (districts) | 24 | 21 | 19 | 21 | 19 | 21 | 21 |
| $R^2$ | 0.243 | 0.244 | 0.252 | 0.322 | 0.091 | 0.204 | 0.310 |
| Mean dep. var. in 1844 | 80.052 | 100.245 | 4.484 | 57.422 | 39.924 | 4.604 | 166.287 |

(b) Slavery and employment of local labor

| | No. of slaves and blacks in free-headed HH | | =1 if slaveowner free-headed HH | | =1 if HH head farmer | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Cotton area | 0.028*** | | 0.010*** | | 0.026 | |
| | (0.003) | | (0.001) | | (0.015) | |
| Cereals area | -0.000 | | 0.000 | | 0.000 | |
| | (0.001) | | (0.000) | | (0.004) | |
| Other area | 0.001 | | -0.000 | | -0.001 | |
| | (0.002) | | (0.001) | | (0.007) | |
| Cotton yield | | 0.008*** | | 0.003*** | | 0.007** |
| | | (0.001) | | (0.000) | | (0.003) |
| Cereals yield | | 0.000 | | 0.000 | | -0.000 |
| | | (0.000) | | (0.000) | | (0.001) |
| 1868 | -0.001 | -0.012 | 0.004 | 0.005 | -0.273*** | -0.253*** |
| | (0.024) | (0.039) | (0.006) | (0.012) | (0.091) | (0.072) |
| HH controls? | Yes | Yes | Yes | Yes | Yes | Yes |
| District FE? | Yes | Yes | Yes | Yes | Yes | Yes |
| Clusters | 19 | 21 | 19 | 21 | 19 | 21 |
| Obs | 4174 | 4746 | 4174 | 4746 | 2927 | 3310 |
| $R^2$ | 0.106 | 0.104 | 0.149 | 0.141 | 0.110 | 0.107 |

Notes: Regressions in panel (b) are weighted by the inverse sampling probability of households. White-Huber robust standard errors are in parentheses in panel (a). Standard errors clustered at the district level are in parentheses in panel (b). $*p < 0.10, **p < 0.05, ***p < 0.01$. Cereals include wheat, barley, and beans.

Sources: The 1848 and 1868 population census samples. Data on crop area and yield are from Rivlin (1961, pp. 258-260) (1844), and Ministère de l'Intérieur (1877, vol. 2: pp. 54-77, 84-99, 118-166) (1877).

I argue that the rapid expansion in cotton cultivation created a large labor demand shock. Due to the relative scarcity of local labor, though, the demand shock increased labor coercion, and prevented the farmer base from declining, in higher cotton-suitability villages. Labor scarcity relative to cotton expansion remained a binding constraint until WWI, which necessitated expanding on the landholder base even after the abolition of slavery in 1877. This explanation is consistent with Domar (1970) and Acemoglu and Wolitzky (2011). But unlike the perfectly inelastic labor supply in both studies, Egypt's labor supply in agriculture responded, via (1) the importation of slaves by area headmen and landholding farmers, (2) the confiscation of larger local population areas by owners of large estates, and (3) the preservation of the landholding farmer base.

## 6.2 Technical differences between cotton and wheat

Whereas the cotton famine increased employment, both coercive and non-coercive, the Crimean War wheat boom did not impact employment. I examine a number of technical differences that may explain this inter-crop heterogeneity: (1) labor intensity, (2) landholders' expectation about the future world demand, (3) returns to scale, (4) relative productivity of women and children, and (5) labor turnover cost. Evidence comes in support of the first two explanations. These technical differences do not imply, though, that cotton suitability per se invokes labor coercion, without a price stimulus. Cotton was cultivated, both before the famine and after the abolition, using non-slave labor.

**Labor intensity** Cotton is more labor-intensive than wheat, and thus a cotton boom increases labor demand more than a wheat boom. Cotton requires a considerable amount of labor in land preparation, sowing, soil tending, picking, ginning, and trees uprooting Owen (1969, pp. 30-33). I do not observe the number of working hours, or the seasonality of labor demand (e.g., during the harvest season), which may vary across crops. However, I observe the number of cultivators per *feddan* of each crop in the 1939 agricultural census (Ministry of Agriculture 1939, pp. 60-69), which is the earliest data source that records this type of information. I estimate the following model:

$$\begin{aligned} laborperfed^{f}_{cp} = \; & \alpha_c + \beta_p + \epsilon_{cp}, \quad f \in \{0-1, 1-2, 2-3, 3-4, 4-5, 5-10, \\ & 10-20, 20-50, 50-100, 100-200, 200-500, 500^{+} feddans\} \end{aligned} \tag{8}$$

where $laborperfed^{f}_{cp}$ is the number of cultivators per *feddan* of crop $c$ in province $p$ on

landholding size $f$, $\alpha_c$ is a full set of crop fixed effects, where cotton is the omitted category, and $\beta_p$ is a full set of province fixed effects to control for inter-province heterogeneity in labor-to-land ratio. I estimate a separate regression for each landholding size, because crops may vary with respect to the landholding distribution.[50] The results of this exercise are shown in Appendix Table B.9. Although differences between cotton and wheat are not statistically significant, cotton has systematically higher labor-to-land ratio than wheat at any landholding size.

Although the results come from 1939, there are two remarks that mitigate this concern. First, according to a government guidebook from 1830 (Majlis al-Mashoura 1830), wheat, barley, and beans harvesting required 4-8 workers per *feddan*, which is similar to the average number of workers per *feddan* for these crops in 0-1 *feddan* landholdings in 1939. This suggests that the technology of production changed little between 1830 and 1939, especially on small landholdings. Second, mechanization of Egyptian agriculture started only in the 1970s (Richards 1981).

**Expectations about future world demand** Landholders probably expected a high return to investment in labor coercion during the cotton famine, as they were optimistic about the future world demand for Egyptian cotton. English textile manufacturers sent strong positive signals during the famine about the desirability of Egyptian cotton (Owen 1969, pp. 95-98). Egyptian long-staple cotton was of high quality, and Egypt was able to compete internationally because cotton production remained, in large part, manual even in the US South.[51] Egyptian landholders possibly imported the technology of employing slaves in cultivating cotton from the US.[52] To the contrary, Egypt was losing its international comparative advantage in wheat, which was mechanized in the US and Russia,

50. My objective is to measure inter-crop differences in labor intensity, holding landholding size constant. For example, a crop may have a higher labor-to-land ratio, because it is more likely to be produced in small landholdings, and not because it is more labor-intensive.

51. The Whitney cotton ginning machine was introduced in the US South during the 19$^{\text{th}}$ century. However, it did not fit the Egyptian cotton's longer staple, and hence cotton ginning in Egypt remained to be done manually. Globally, the mechanization of cotton harvesting took much longer than wheat, because of the technical difficulty of inventing a cotton-picking machine. It started in the US in the mid-1920s, and did not take off until after WWII, much later than wheat and other grains which were mechanized during the 19$^{\text{th}}$ century (Fite 1980, Musoke 1981).

52. Egyptians were exposed to the US South technology. According to Thayer, the American consul in Egypt, "so well understood is the condition in the cotton-favorable region in the United States, even by the poorest *fellahs* [Egypt's peasants], that it is difficult to persuade them to sell on terms which heretofore they would have been delighted to accept" (Owen 1969, p. 94). A number of former Confederate military officers were recruited in the Egyptian army in the aftermath of the American Civil War.

but remained produced manually in Egypt (Owen 1969, p. 125).

**Returns to scale** Fogel (1989, pp. 17-40) notes that sugar and cotton in the Americas were most efficiently produced by highly disciplined gang labor on large plantations, because the division of tasks both within and across gangs generated economies of scale. And since organizing gangs required coercion, the gang system was, the argument goes, compatible with slave labor, but not with free labor. This explanation does not seem to hold in the Egyptian case, though. First, the positive impact on slavery is observed among area headmen and landholding farmers, and not in large estates. I do not observe 50+ household slaveholdings, as in US cotton plantations with gang labor; the largest household slaveholdings in the 1868 sample is 23 slaves. Second, large estates in Egypt emerged due to the political power of their owners, and not because of economies of scale. Indeed, cotton revenue per unit of land in large estates was not different from that in areas outside large estates (Appendix Table B.10).

**Relative productivity of women and children** Goldin and Sokoloff (1984) explain the association of cotton and slavery in the US south by the higher productivity of women and children relative to men. According to this hypothesis, "slavery may have been a comparatively more profitable labor system in areas whose dominant crops favored the utilization of the female and younger portions of the labor force, whose leisure, education, and home production were valued far less than in a free labor system." However, this hypothesis does not seem to hold in Egypt. Although women and children were traditionally employed in cotton picking in Egypt before the cotton famine (Owen 1969, pp. 30-31), slaves imported during the famine were mostly males in working age (Table 3). Male slaves were probably recruited for tasks that required physical strength, such as land preparation, sowing, cotton ginning, and trees uprooting.

**Turnover cost** Hanes (1996) argues that economic activities that employed slaves exhibit higher turnover cost, i.e. the cost of search for labor if a worker quits the job or is fired, which induces employers to lock in labor.[53] This explanation is unlikely to hold in Egypt, because cotton suitability is not correlated with slavery before the cotton famine.

53. Hanes (1996) argues that domestic service and agriculture were sectors characterized by the coercion of labor, but he did not extend his argument to explain variation across crops.

### 6.3 Inter-landholder differences in wealth and political power

I trace the heterogeneous effect of the famine by landholding size to differences across landholders in wealth, and in their legal capacity to coerce local workers. In areas outside large estates, area headmen held more slaves than landholding farmers, because they were wealthier. Among landholding farmers, slaveholdings were likely increasing in wealth. [54]

Second, owners of large estates had the power to coerce locals, but other landholders did not. They were able to confiscate areas and to declare them as large estates. They further had the legal power to coerce the local population of a confiscated area to work on their estates without pay, in exchange for subsistence plots, or for paying tax arrears (see Section 3.4). They preferred to coerce locals, instead of slaves, because coercion of locals was cheaper, and because local workers were perhaps more productive. [55] By contrast, while area headmen were able to force people in their areas to work for them without pay, they lost this power (at least legally) by 1858 (Baer 1962, p. 152). Faced by local labor scarcity, both area headmen and landholding farmers resorted to purchasing slaves.

## 7 Conclusion

This paper analyzed the impact of export booms on labor coercion, using a natural experiment from 19$^{\text{th}}$-century rural Egypt: The Lancashire cotton famine in 1861–1865. Over the course of five years, Egypt's cotton production and exports quadrupled, and cotton's share in Egypt's exports jumped from a mere 25% to 80%; a status that cotton maintained, unrivaled, until the oil boom in the 1970s. Using a fine-grained data source, Egypt's 1848 and 1868 individual-level population census samples, I documented that the cotton famine had a positive and statistically significant impact on both labor coercion and the non-coercive employment in agriculture of Egyptian workers. For one, the famine led to the emergence of agricultural slavery in higher cotton-suitability villages. For another, these villages were more likely to preserve their landholding farmer base. The impact on slaveholdings peaked among area headmen, followed by landholding farmers,

54. Among landholding farmers, slave-owners had bigger households on average, excluding slaves, than non-slave-owners (9 versus 6).

55. Slaves were relatively expensive. A black male slave was worth, on average, 931 working days of a cash wage agricultural worker in 1841, and 703 days in 1873 (author's calculations based on data on slave prices from Fredriksen (1977, pp. 70-71), and on daily wages of cash wage agricultural workers in 1841 from Al-Hitta (1950, pp. 91-95), and in 1873 from Ministère de l'Intérieur (1873, p. 269)). Slaves on large estates often worked as supervisors of local workers (Helal 1999, pp. 110-122).

but I fail to find an impact on slaveholdings among owners of large estates, who resorted instead to the confiscation of larger local population areas. I interpret the results by (1) the scarcity of local labor relative to cotton expansion, (2) the labor intensity of cotton, (3) landholders' optimism about the future world demand for Egyptian cotton, and (4) the heterogeneity among landholders in wealth, and in coercive power over local labor.

The paper opens new and exciting areas of future research. First, the fact that one unintended consequence of the American Civil War, whose central conflict was about the abolition of slavery in the (cotton-producing) US South, had been the introduction of agricultural slavery in rural Egypt is intriguing. Indeed, the Lancashire cotton famine triggered, quite paradoxically, intensified raids in Sudan that resulted in capturing locals and selling them as slaves to area headmen and landholding farmers in cotton-suitable villages in rural Egypt. This suggests that globalization can have powerful, over-reaching, and totally unintended consequences, including the exportation of (probably, welfare-reducing) institutional arrangements. It raises the question of when international trade can be welfare-enhancing and when it can lead to inferior outcomes, at least for a segment of the population.

Second, the phenomenon that labor is relatively abundant in developing countries, which is a typical assumption in development economics, likely emerged during the $20^{\text{th}}$ century, and not before. If anything, labor was relatively scarce in these countries, up to WWI, or even later. The transformation to the relative abundance of labor, and the emergence of (landless) labor in agriculture, such as tenants, sharecroppers, and wage workers, require closer scrutiny. This is an important topic to study, because landless farmers are probably the poorest in these countries. They also contributed to the rapid urbanization and the creation of urban slums, in cities to which they migrated. Understanding the historical roots of this phenomenon requires further investigation.

Third, one dimension of coercion of labor that is less studied is mobility restrictions. Individuals fled to other villages when offered unprofitable land assignments by area headmen, and immigration was outlawed in China and the Middle East until the $19^{\text{th}}$ century. The Egyptian data offer a unique opportunity to study it in depth.

Finally, we know little about the impact of export booms on the emergence of private property rights. In Egypt, this process was completed by 1891, and it is plausible that it was impacted by the cotton famine. The emergence of landless farmers was often

accompanied by the legalization of private property on land. Whether trade can lead to the emergence of private property rights is another exciting topic.

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# Appendix

## A Additional figures

This section presents additional figures.

## B Additional tables

This section presents additional tables.

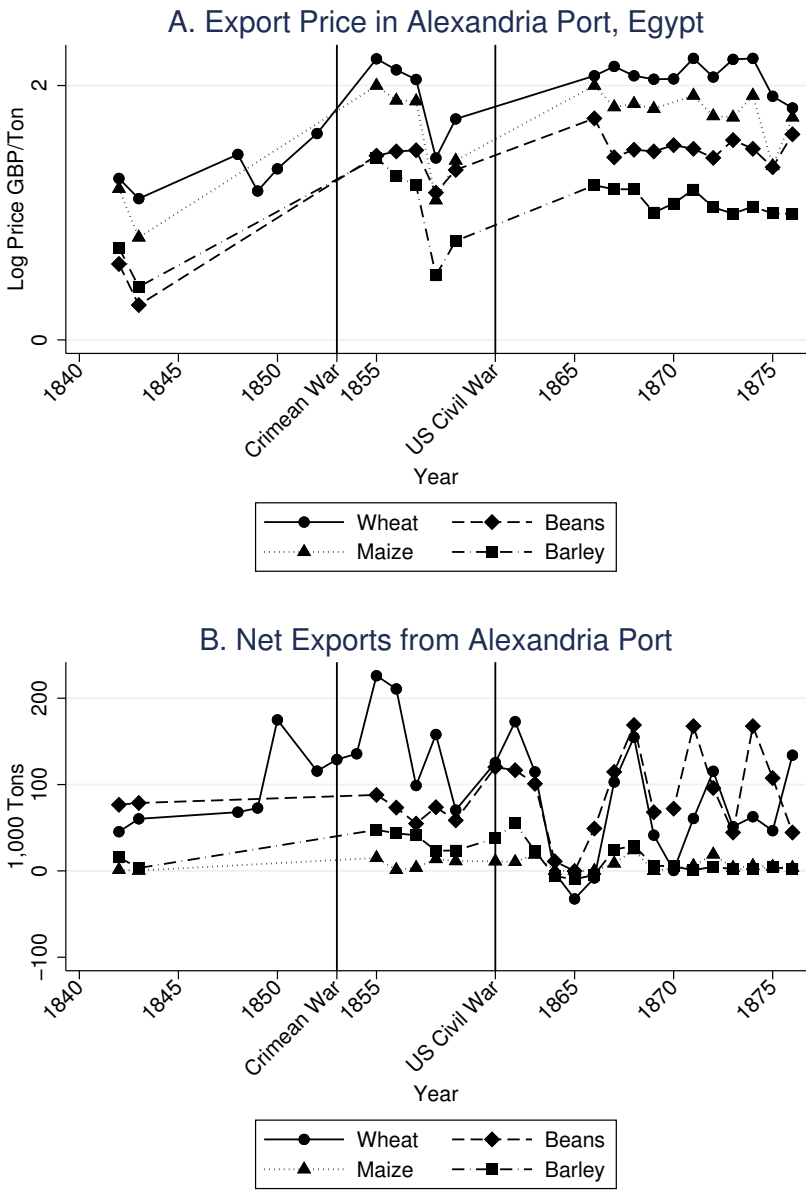


Figure A.1 – Export price and net quantity exported of wheat, beans, barley, and maize in Egypt in 1842–1876

Notes: Original quantities are reported in *ardabbs*. I converted *ardabbs* of wheat in Owen (1969) into tons according to the rate (1 *ardabb* = 133.6 kilograms) in Ministère de l'Intérieur (1873, p. 2). *Ardabbs* of wheat and maize in the other sources were first converted into bushels according to the rate (1 *ardabb* = 5 bushels = 135 kilograms) in U.K. Parliamentary Papers, Vol. 53 (1849, p. 359), Fowler (1861, p. 12), and U.S. House of Representatives (1877, p. 905). Bushels were then converted into tons using https://www.extension.iastate.edu/agdm/. *Ardabbs* of beans and barley were converted into tons according to the rate (1 *ardabb* = 197.7 kilograms) in Ministère de l'Intérieur (1873, p. 2). Original prices are reported in Egyptian piasters, which I converted into British pounds (GBP) according to the conversion rates in Owen (1969, pp. 381-385) and Officer (2016).
Sources: 1842–1843: U.K. Parliamentary Papers, Vol. 53 (1849, pp. 359-367); 1848–1850 and 1852–1854 (wheat only), 1861–1865: Owen (1969, pp. 80, 103); 1855–1858 (no information on imports): U.S. House of Representatives (1860, p. 358); 1859: Fowler (1861, p. 12); 1866–1876: U.S. House of Representatives (1877, pp. 918-933).

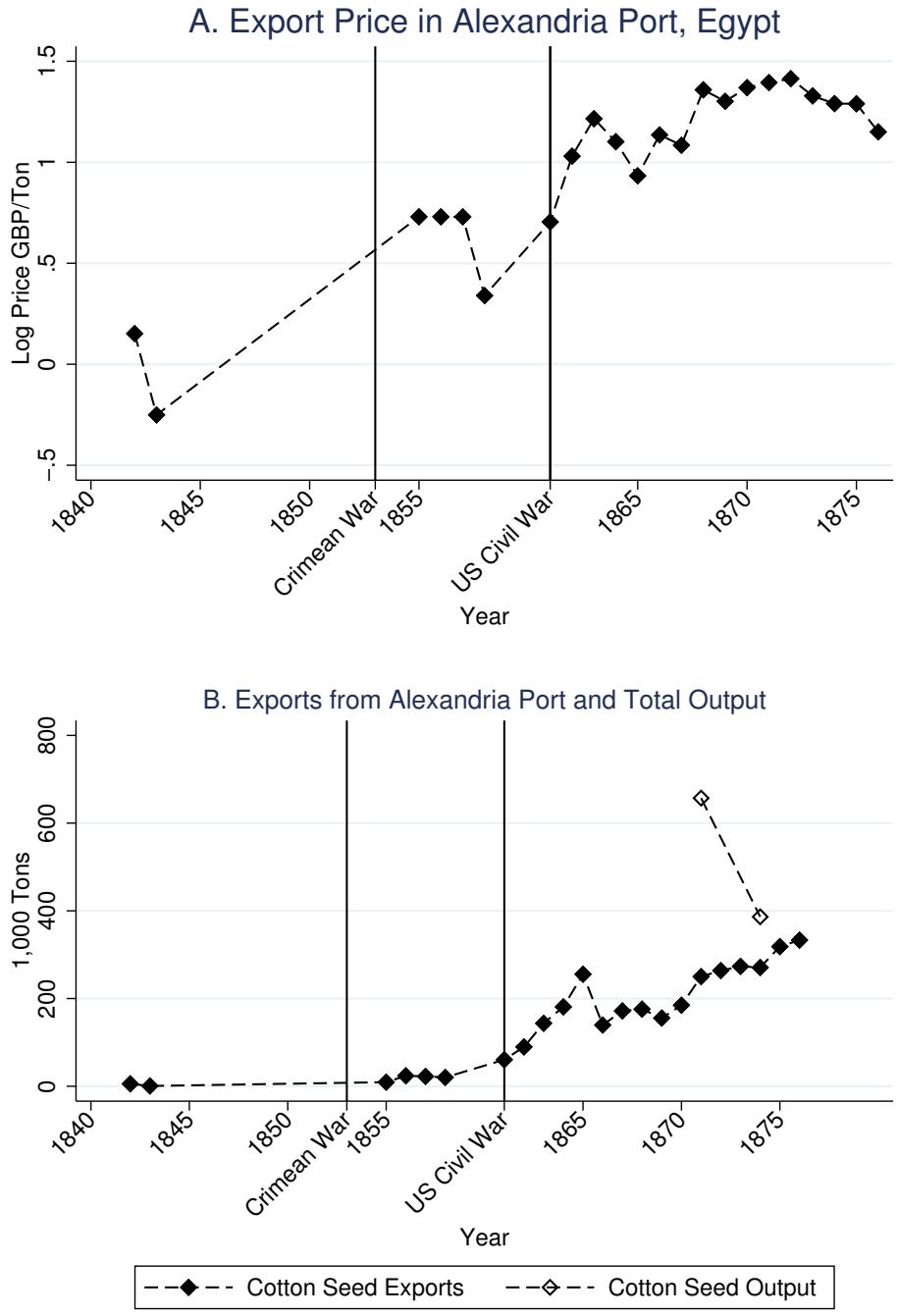


Figure A.2 – Export price, quantity exported, and total output of cotton seed in Egypt in 1842–1876

Notes: Original quantities are reported in *ardabbs*. I converted *ardabbs* into tons according to the conversion rate (1 *ardabb* = 197.7 kilograms) in Ministère de l'Intérieur (1873, p. 2). Original prices are reported in Egyptian piasters, which I converted into British pounds (GBP) according to the conversion rates in Owen (1969, pp. 381-385) and Officer (2016).
Sources: Owen (1969, pp. 34, 73, 90-91, 123, 126). Price in 1860: Ministère de l'Intérieur (1873, pp. 172-173).

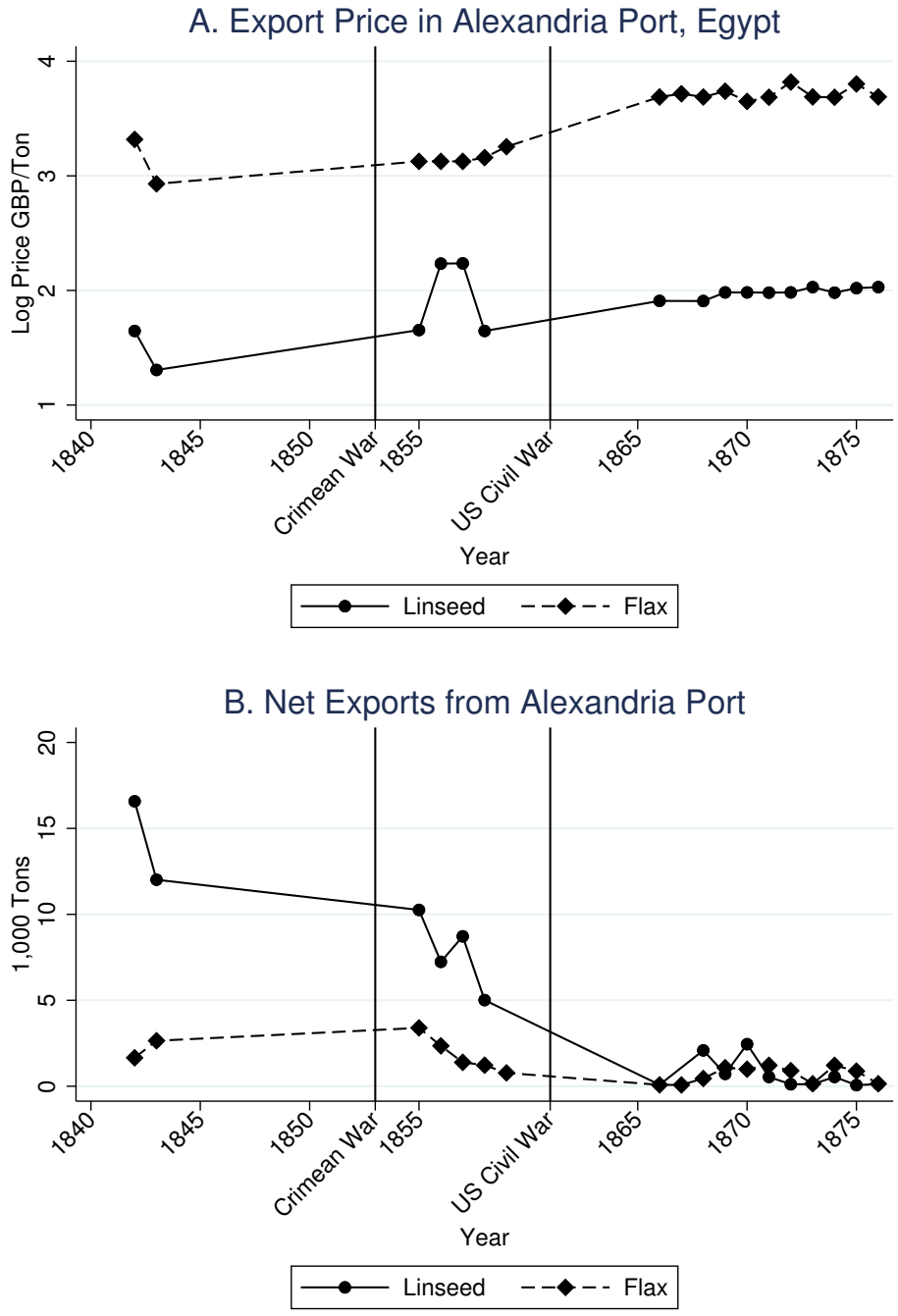


Figure A.3 – Export price and quantity exported of linseed and flax in Egypt in 1842–1876

Notes: Original quantities are reported in *ardabbs* for linseed and in *cantars*/*quintals* for flax. I converted *ardabbs* into tons according to the conversion rate (1 *ardabb* = 197.7 kilograms) in Ministère de l'Intérieur (1873, p. 2). I converted *cantars*/*quintals* into tons according to the conversion rate in Owen (1969, pp. 381-385). Original prices are reported in Egyptian piasters, which I converted into British pounds (GBP) according to the conversion rates in Owen (1969, pp. 381-385) and Officer (2016).
Sources: 1842–1843: U.K. Parliamentary Papers, Vol. 53 (1849, pp. 359-367); 1855–1858 (no information on imports): U.S. House of Representatives (1860, p. 358); 1859 (flax only): Fowler (1861, p. 12); 1866–1876: U.S. House of Representatives (1877, pp. 918-933).

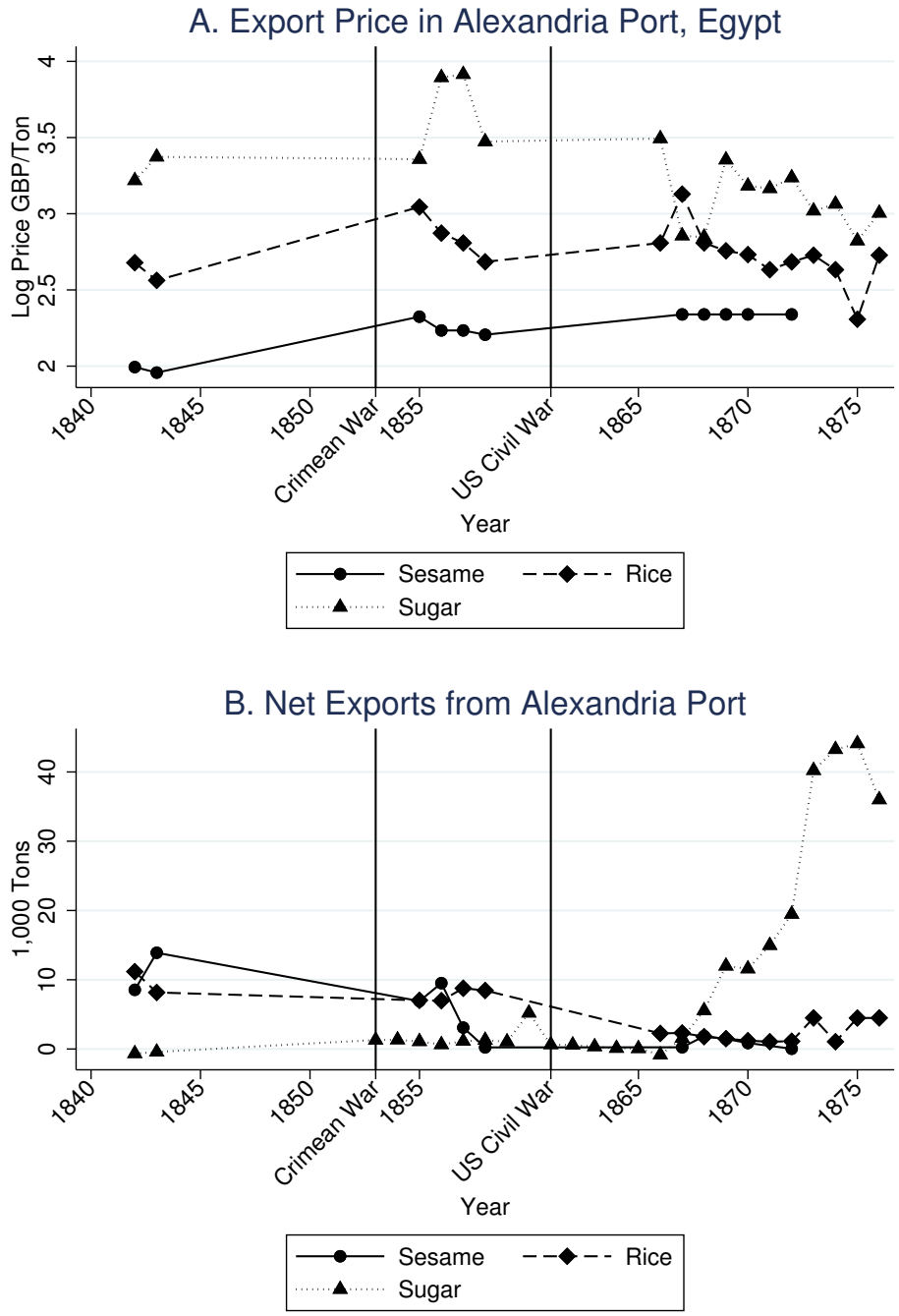


Figure A.4 – Export price and quantity exported of sesame, rice, and sugar in Egypt in 1842–1876

Notes: Original quantities are reported in *ardabbs*, which I converted into tons according to the conversion rate (1 *ardabb* = 197.7 kilograms; 1 *ardabb* = 185.6 kilograms of rice) in Ministère de l'Intérieur (1873, p. 2). Original prices are reported in Egyptian piasters, which I converted into British pounds (GBP) according to the conversion rates in Owen (1969, pp. 381-385) and Officer (2016).
Sources: 1842–1843: U.K. Parliamentary Papers, Vol. 53 (1849, pp. 359-367); 1855–1858 (no information on imports): U.S. House of Representatives (1860, p. 358); 1859–1865 (sugar exports only): Ministère de l'Intérieur (1873, pp. LXXV-LXXVI); 1866–1876: U.S. House of Representatives (1877, pp. 918-933).

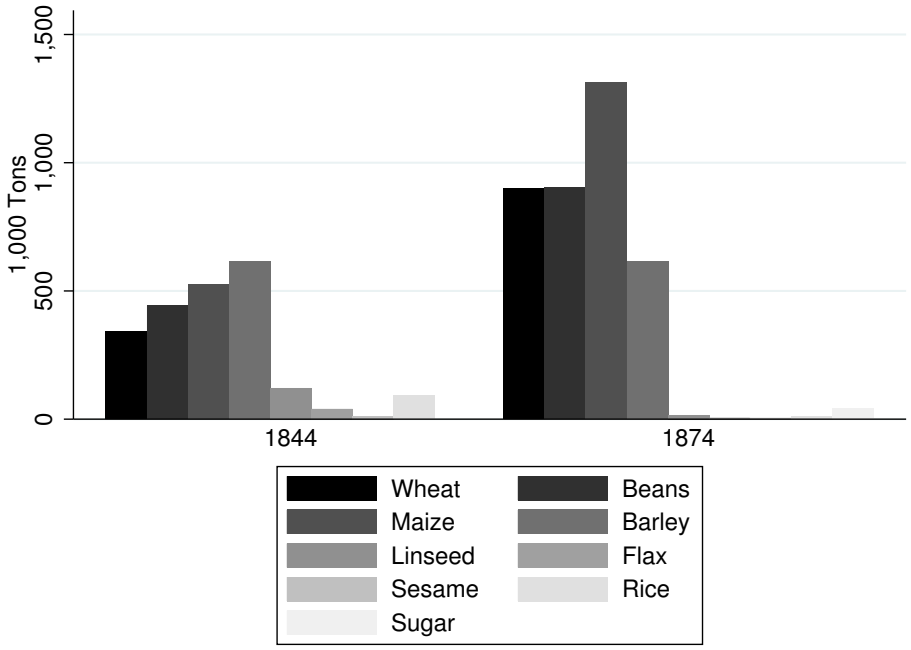


Figure A.5 – Total output of major export crops (except cotton and cotton seed) in Egypt in 1844 and 1874

Sources: 1844: Barnett (1844); 1874: U.S. House of Representatives (1877, pp. 918-933).

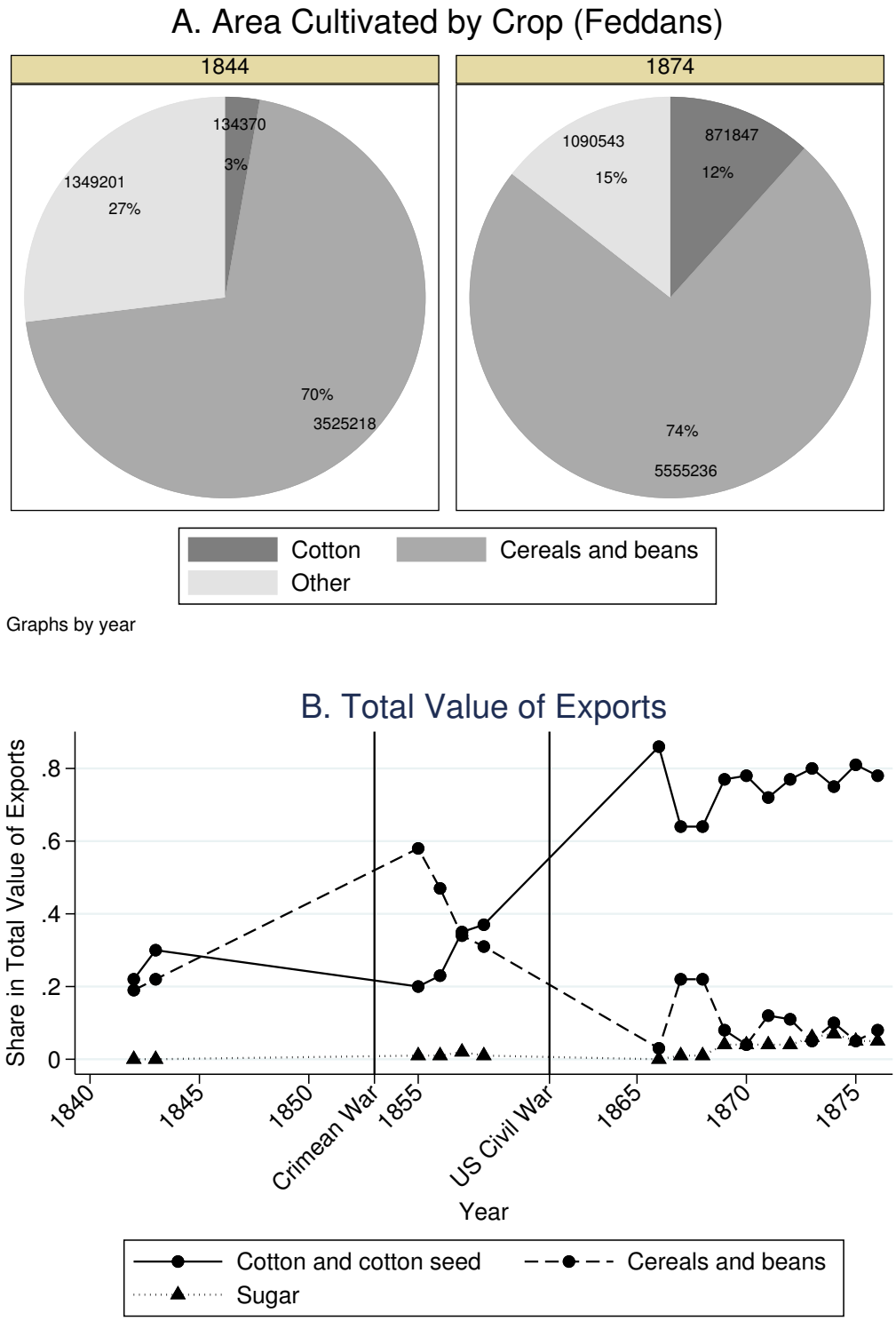


Figure A.6 – Relative shares of major export crops out of cropped area in 1844 and 1874 and of the total value of exports in 1842–1876

Notes: One *feddan* is equal to 4,200 square meters.
Sources: Cropped area: 1844: Barnett (1844); 1874: U.S. House of Representatives (1877, p. 905). Total value of exports: 1842–1843: U.K. Parliamentary Papers, Vol. 53 (1849, pp. 359-367); 1855–1858 (no information on imports): U.S. House of Representatives (1860, p. 358); 1866–1876: U.S. House of Representatives (1877, pp. 918-933).

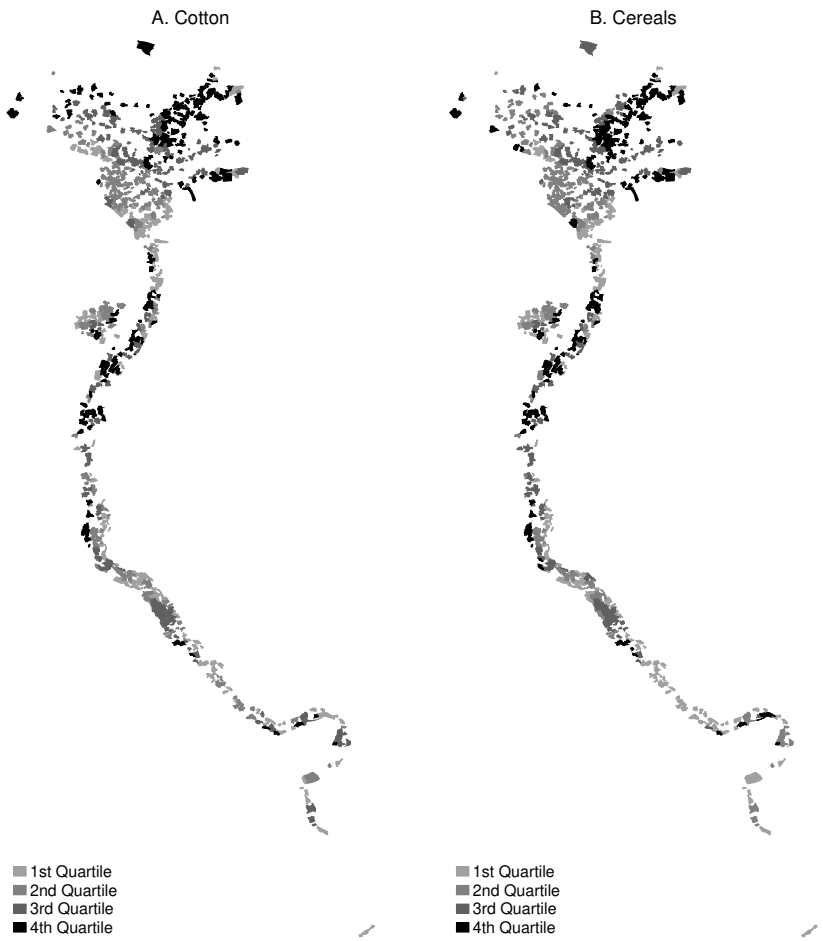


Figure A.7 – Cotton and cereals suitability indices of villages in the full rural sample

Notes: Crop suitability indices range from 0 (lowest value in the sample) to 1 (highest value). Cereals suitability index is the maximum value of the suitability indices of wheat, barley, beans, and maize. The maps show the crop suitability indices at the village level (1,046 villages) in all rural districts (70 districts).
Sources: FAO-GAEZ crop suitability index under irrigation and intermediate input level in 1961–1990.

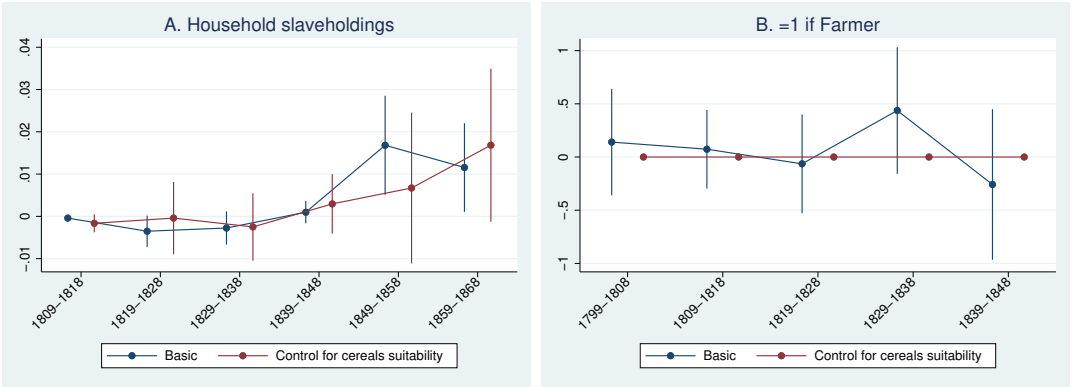


Figure A.8 – Evolution of household slaveholdings and of the proportion of local farmers

Notes: 95% confidence intervals are shown. See text for description of how the coefficients are estimated.
Sources: The 1848 and 1868 population census samples. Data on crop suitability are from FAO-GAEZ.

Table B.1 – Baseline differences in observables across matched and non-matched districts in 1848

| | Non-matched | | | Matched | | | |
|---|---|---|---|---|---|---|---|
| | N | Mean | SD | N | Mean | SD | Diff |
| Number of slaves and blacks in HH | 4860 | 0.04 | 0.42 | 2469 | 0.06 | 0.64 | 0.019 |
| =1 if slave-owning free-headed HH | 4853 | 0.01 | 0.12 | 2459 | 0.01 | 0.11 | -0.001 |
| Number of slaves and blacks in free-headed HH | 4853 | 0.03 | 0.40 | 2459 | 0.05 | 0.62 | 0.015 |
| =1 if slave-headed HH | 4860 | 0.00 | 0.04 | 2469 | 0.00 | 0.06 | 0.003** |
| =1 if HH head farmer | 3700 | 0.72 | 0.45 | 1661 | 0.67 | 0.47 | -0.053 |
| =1 if HH head white-collar worker | 3700 | 0.05 | 0.22 | 1661 | 0.06 | 0.23 | 0.003 |
| =1 if HH head artisan | 3700 | 0.07 | 0.26 | 1661 | 0.09 | 0.29 | 0.019 |
| =1 if HH head unskilled non-farmer | 3700 | 0.15 | 0.36 | 1661 | 0.18 | 0.39 | 0.032 |
| Cotton suitability index | 4860 | 0.54 | 0.07 | 2469 | 0.54 | 0.14 | 0.004 |
| Cereals suitability index | 4860 | 0.70 | 0.08 | 2469 | 0.69 | 0.16 | 0.001 |
| =1 if HH head non-Muslim | 4803 | 0.04 | 0.20 | 2454 | 0.08 | 0.28 | 0.044** |
| =1 if HH head Bedouin | 4860 | 0.05 | 0.22 | 2469 | 0.01 | 0.08 | -0.052*** |
| Number of free males 0-5 in HH | 4860 | 0.73 | 1.04 | 2469 | 0.68 | 1.04 | -0.055 |
| Number of free males 6-10 in HH | 4860 | 0.38 | 0.67 | 2469 | 0.38 | 0.66 | -0.006 |
| Number of free males 11-20 in HH | 4860 | 0.34 | 0.62 | 2469 | 0.34 | 0.62 | 0.001 |
| Number of free males 21-30 in HH | 4860 | 0.36 | 0.60 | 2469 | 0.36 | 0.67 | -0.006 |
| Number of free males 31-40 in HH | 4860 | 0.31 | 0.53 | 2469 | 0.31 | 0.57 | 0.003 |
| Number of free males 41-50 in HH | 4860 | 0.24 | 0.46 | 2469 | 0.22 | 0.43 | -0.015 |
| Number of free males 50+ in HH | 4860 | 0.36 | 0.54 | 2469 | 0.32 | 0.51 | -0.044** |
| Number of free females 0-5 in HH | 4860 | 0.71 | 1.01 | 2469 | 0.67 | 0.97 | -0.040 |
| Number of free females 6-10 in HH | 4860 | 0.29 | 0.59 | 2469 | 0.26 | 0.53 | -0.025 |
| Number of free females 11-20 in HH | 4860 | 0.34 | 0.65 | 2469 | 0.33 | 0.62 | -0.013 |
| Number of free females 21-30 in HH | 4860 | 0.49 | 0.73 | 2469 | 0.49 | 0.66 | 0.005 |
| Number of free females 31-40 in HH | 4860 | 0.36 | 0.57 | 2469 | 0.33 | 0.54 | -0.026 |
| Number of free females 41-50 in HH | 4860 | 0.22 | 0.45 | 2469 | 0.20 | 0.42 | -0.023 |
| Number of free females 50+ in HH | 4860 | 0.34 | 0.54 | 2469 | 0.33 | 0.55 | -0.012 |

Notes: The "Diff" column reports the coefficient of the following household-level regression in 1848: $y_{hd} = \alpha_1 + \alpha_2 DistMatched_d + \epsilon_{hd}$, where $y_{hd}$ is the outcome of household $h$ residing in district $d$ in 1848, and $DistMatched_d$ is a dummy variable =1 if a household's district of residence is observed in both 1848 and 1868, and =0 if district of residence is observed in 1848 only. Each regression is weighted by household inverse sampling probability. Standard errors are clustered at the district of residence level. $*p < 0.10, **p < 0.05, ***p < 0.01$.
Sources: The 1848 population census sample restricted to individuals residing in rural provinces and aggregated to the household level. Data on crop suitability are from FAO-GAEZ.

Table B.2 – Baseline differences in observables by cotton suitability level in 1848

| | Low cotton | | | High cotton | | | |
|---|---|---|---|---|---|---|---|
| | N | Mean | SD | N | Mean | SD | Diff |
| Number of slaves and blacks in HH | 1235 | 0.07 | 0.77 | 1234 | 0.04 | 0.47 | -0.031 |
| =1 if slave-owning free-headed HH | 1228 | 0.01 | 0.12 | 1231 | 0.01 | 0.11 | -0.003 |
| Number of slaves and blacks in free-headed HH | 1228 | 0.06 | 0.75 | 1231 | 0.04 | 0.45 | -0.025 |
| =1 if slave-headed HH | 1235 | 0.01 | 0.08 | 1234 | 0.00 | 0.05 | -0.003 |
| =1 if HH head farmer | 912 | 0.66 | 0.48 | 749 | 0.69 | 0.46 | 0.026 |
| =1 if HH head white-collar worker | 912 | 0.06 | 0.24 | 749 | 0.05 | 0.22 | -0.012 |
| =1 if HH head artisan | 912 | 0.10 | 0.30 | 749 | 0.09 | 0.28 | -0.014 |
| =1 if HH head unskilled non-farmer | 912 | 0.19 | 0.39 | 749 | 0.17 | 0.38 | -0.000 |
| Cotton suitability index | 1235 | 0.45 | 0.11 | 1234 | 0.64 | 0.10 | 0.203*** |
| Cereals suitability index | 1235 | 0.60 | 0.16 | 1234 | 0.79 | 0.09 | 0.193*** |
| =1 if HH head non-Muslim | 1227 | 0.11 | 0.32 | 1227 | 0.05 | 0.23 | -0.063** |
| =1 if HH head Bedouin | 1235 | 0.01 | 0.09 | 1234 | 0.00 | 0.07 | -0.003 |
| Number of free males 0-5 in HH | 1235 | 0.64 | 0.95 | 1234 | 0.72 | 1.13 | 0.072 |
| Number of free males 6-10 in HH | 1235 | 0.37 | 0.65 | 1234 | 0.38 | 0.66 | 0.009 |
| Number of free males 11-20 in HH | 1235 | 0.35 | 0.65 | 1234 | 0.33 | 0.59 | -0.021 |
| Number of free males 21-30 in HH | 1235 | 0.34 | 0.76 | 1234 | 0.37 | 0.58 | 0.016 |
| Number of free males 31-40 in HH | 1235 | 0.32 | 0.60 | 1234 | 0.31 | 0.53 | -0.020 |
| Number of free males 41-50 in HH | 1235 | 0.21 | 0.43 | 1234 | 0.23 | 0.44 | 0.007 |
| Number of free males 50+ in HH | 1235 | 0.32 | 0.51 | 1234 | 0.32 | 0.51 | 0.018 |
| Number of free females 0-5 in HH | 1235 | 0.63 | 0.92 | 1234 | 0.70 | 1.02 | 0.078 |
| Number of free females 6-10 in HH | 1235 | 0.27 | 0.53 | 1234 | 0.25 | 0.53 | -0.020 |
| Number of free females 11-20 in HH | 1235 | 0.31 | 0.61 | 1234 | 0.35 | 0.63 | 0.024 |
| Number of free females 21-30 in HH | 1235 | 0.52 | 0.65 | 1234 | 0.47 | 0.67 | -0.066* |
| Number of free females 31-40 in HH | 1235 | 0.33 | 0.53 | 1234 | 0.33 | 0.55 | -0.008 |
| Number of free females 41-50 in HH | 1235 | 0.17 | 0.40 | 1234 | 0.22 | 0.44 | 0.066*** |
| Number of free females 50+ in HH | 1235 | 0.30 | 0.52 | 1234 | 0.36 | 0.57 | 0.059* |

Notes: The "Diff" column reports the coefficient of the following household-level regression in 1848: $y_{hv} = \alpha_1 + \alpha_2 HighCotton_v + \epsilon_{hv}$, where $y_{hv}$ is the outcome of household $h$ residing in village $v$, and $HighCotton_v$ =1 if a household's village of residence is above the median cotton suitability. Each regression is weighted by household inverse sampling probability. Standard errors are clustered at the village level. $*p < 0.10, **p < 0.05, ***p < 0.01$.
Sources: The 1848 population census sample restricted to individuals residing in matched districts in rural provinces and aggregated to the household level. Data on crop suitability are from FAO-GAEZ.

Table B.3 – The Lancashire cotton famine and summer irrigation in 1840–1873

| | (1) Δ Length of summer canals (meters per *feddan*) | (2) Δ Number of waterwheels per 1,000 *feddan* | (3) Δ Number of steam engines per 1,000 *feddan* |
|---|---|---|---|
| Cotton | 65.638 | 1138.755 | 19.853* |
| | (179.332) | (591.879) | (5.331) |
| Cereals | -261.889 | -977.350 | -17.939* |
| | (235.369) | (600.033) | (5.362) |
| Obs (districts/provinces) | 19 | 5 | 5 |
| $R^2$ | 0.315 | 0.861 | 0.922 |
| Mean dep. var. in 1848 | 0.155 | 8.979 | 0.000 |

Notes: Sample is restricted to districts/provinces that are observed in both 1848 and 1868. Robust standard errors are in parentheses. $*p < 0.10, **p < 0.05, ***p < 0.01$.
Sources: Rivlin (1961, p. 281) for 1840, and Ministère de l'Intérieur (1873, pp. 270-272) for 1873. Data on summer canals are at the province level for 1840, and at the district-level for 1873. Data on waterwheels and steam engines are at the province level for 1844 and 1873. There were no steam engines (thus, all provinces are assigned 0) in 1844.

Table B.4 – The Lancashire cotton famine and the occupational distribution of farmers

| | (1) =1 if HH head landholding farmer | (2) =1 if HH head sharecropper | (3) =1 if HH head cash wage agr. worker | (4) =1 if HH head area headman |
|---|---|---|---|---|
| Cotton × 1868 | 0.790*** | -0.004 | -0.110 | 0.081* |
| | (0.225) | (0.037) | (0.131) | (0.041) |
| Cotton | 0.039 | -0.046 | -0.057 | -0.016 |
| | (0.176) | (0.055) | (0.161) | (0.027) |
| 1868 | -0.444*** | -0.022 | -0.011 | -0.035 |
| | (0.125) | (0.024) | (0.062) | (0.022) |
| District FE? | Yes | Yes | Yes | Yes |
| Clusters (villages) | 574 | 574 | 574 | 574 |
| Obs (households) | 4032 | 4032 | 4032 | 4032 |
| $R^2$ | 0.049 | 0.059 | 0.124 | 0.009 |
| Av. dep. var. in 1848 | 0.567 | 0.018 | 0.058 | 0.029 |

Notes: Sample is restricted to free household heads with a non-missing occupational title. Standard errors clustered at the village level are in parentheses. $*p < 0.10, **p < 0.05, ***p < 0.01$. Each regression is weighted by household inverse sampling probability.
Sources: The 1848 and 1868 population census samples. Data on cotton suitability are from FAO-GAEZ under irrigation and intermediate input in the baseline period 1961–1990.

Table B.5 – The Lancashire cotton famine and migration

| | =1 if HH head immigrant | Prop. emigrant | Immigrants | | Village natives | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | | | =1 if farmer | =1 if landholding farmer | =1 if farmer | =1 if landholding farmer |
| Cotton × 1868 | 0.130 | 0.102 | 1.760** | 0.544 | 0.723*** | 0.766*** |
| | (0.186) | (0.171) | (0.822) | (0.711) | (0.189) | (0.214) |
| Cotton | -0.204** | -0.086 | -1.249 | 0.541 | -0.153 | -0.090 |
| | (0.100) | (0.113) | (0.985) | (0.800) | (0.135) | (0.169) |
| 1868 | -0.042 | -0.072 | -0.702 | 0.032 | -0.543*** | -0.490*** |
| | (0.101) | (0.093) | (0.448) | (0.385) | (0.109) | (0.120) |
| District FE? | Yes | Yes | Yes | Yes | Yes | Yes |
| Clusters (villages) | 608 | 478 | 98 | 98 | 516 | 516 |
| Obs (households/villages) | 5693 | 574 | 531 | 531 | 3453 | 3453 |
| $R^2$ | 0.068 | 0.081 | 0.179 | 0.219 | 0.076 | 0.054 |
| Mean dep. var. in 1848 | 0.120 | 0.166 | 0.048 | 0.032 | 0.624 | 0.535 |

Notes: Standard errors clustered at the village level are in parentheses. $*p < 0.10, **p < 0.05, ***p < 0.01$. Immigrants are those who are born outside village of residence. The proportion of emigrants of village $v$ is the number of people born in village $v$ and reside elsewhere, divided by the number of people born in village $v$. Each regression (except in column (2)) is weighted by household inverse sampling probability.
Sources: The 1848 and 1868 population census samples. Data on cotton suitability are from FAO-GAEZ under irrigation and intermediate input in the baseline period 1961–1990.

Table B.6 – The Lancashire cotton famine, slavery, and the occupational distribution of local labor - Using distance to Damietta branch

| | (1) N. slaves & blacks in HH | (2) =1 if HH head free & slave-owning | (3) N. slaves & blacks in free-headed HH | (4) =1 if HH head slave | (5) =1 if HH head farmer | (6) =1 if HH head white-collar | (7) =1 if HH head artisan | (8) =1 if HH head non-agr. unskilled |
|---|---|---|---|---|---|---|---|---|
| Dist. Damietta × 1868 | -0.647*** | -0.305*** | -0.709*** | 0.021** | -0.534** | 0.135 | 0.131 | 0.268 |
| | (0.214) | (0.045) | (0.213) | (0.011) | (0.264) | (0.099) | (0.133) | (0.176) |
| Cereals × 1868 | 0.096 | 0.053 | 0.121 | -0.005 | 0.456** | -0.151 | -0.028 | -0.277** |
| | (0.126) | (0.036) | (0.117) | (0.009) | (0.180) | (0.100) | (0.081) | (0.141) |
| Dist. Damietta | 0.471 | 0.470 | 0.630 | -0.010 | 2.363 | -0.124 | -0.191 | -2.048* |
| | (1.301) | (0.286) | (1.275) | (0.077) | (1.475) | (0.686) | (0.614) | (1.095) |
| Cereals | -0.034 | 0.001 | -0.042 | 0.004 | -0.090 | 0.042 | 0.022 | 0.025 |
| | (0.108) | (0.020) | (0.097) | (0.008) | (0.122) | (0.045) | (0.047) | (0.117) |
| 1868 | 0.112 | 0.043 | 0.098 | 0.001 | -0.363*** | 0.147** | -0.026 | 0.242** |
| | (0.092) | (0.026) | (0.086) | (0.007) | (0.139) | (0.071) | (0.069) | (0.108) |
| HH controls? | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| District FE? | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Clusters (villages) | 609 | 609 | 609 | 609 | 574 | 574 | 574 | 574 |
| Obs (households) | 5736 | 5723 | 5723 | 5736 | 4027 | 4027 | 4027 | 4027 |
| $R^2$ | 0.092 | 0.133 | 0.101 | 0.011 | 0.099 | 0.044 | 0.080 | 0.072 |
| Av. dep. var. in 1848 | 0.058 | 0.013 | 0.049 | 0.004 | 0.669 | 0.055 | 0.094 | 0.181 |

Notes: Standard errors clustered at the village level are in parentheses. $*p < 0.10, **p < 0.05, ***p < 0.01$. Distance to the Damietta branch is in 1,000 kilometers. Each regression is weighted by household inverse sampling probability.
Sources: The 1848 and 1868 population census samples. Data on cereals suitability are from FAO-GAEZ under irrigation and intermediate input in the baseline period 1961–1990.

Table B.7 – The Lancashire cotton famine, slavery, and the occupational distribution of local labor - Adding village fixed effects

| | (1) N. slaves & blacks in HH | (2) =1 if HH head free & slave-owning | (3) N. slaves & blacks in free-headed HH | (4) =1 if HH head slave | (5) =1 if HH head farmer | (6) =1 if HH head white-collar | (7) =1 if HH head artisan | (8) =1 if HH head non-agr. unskilled |
|---|---|---|---|---|---|---|---|---|
| Cotton × 1868 | 0.891 | 0.505** | 0.984 | 0.005 | 1.613* | -0.463 | -0.017 | -1.133 |
| | (0.669) | (0.251) | (0.672) | (0.044) | (0.897) | (0.410) | (0.489) | (0.758) |
| Cereals × 1868 | -0.459 | -0.259 | -0.637 | 0.012 | -0.983 | 0.173 | 0.244 | 0.566 |
| | (0.614) | (0.204) | (0.588) | (0.056) | (0.828) | (0.471) | (0.439) | (0.632) |
| 1868 | -0.042 | -0.047 | 0.034 | -0.013 | -0.393 | 0.182 | -0.148 | 0.359** |
| | (0.195) | (0.062) | (0.179) | (0.019) | (0.240) | (0.174) | (0.142) | (0.155) |
| HH controls? | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Village FE? | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Clusters (villages) | 105 | 105 | 105 | 105 | 105 | 105 | 105 | 105 |
| Obs (households) | 2102 | 2097 | 2097 | 2102 | 1461 | 1461 | 1461 | 1461 |
| $R^2$ | 0.160 | 0.172 | 0.167 | 0.061 | 0.333 | 0.163 | 0.221 | 0.261 |
| Av. dep. var. in 1848 | 0.060 | 0.011 | 0.051 | 0.005 | 0.668 | 0.057 | 0.107 | 0.169 |

Notes: Standard errors clustered at the village level are in parentheses. $*p < 0.10, **p < 0.05, ***p < 0.01$. Each regression is weighted by household inverse sampling probability.
Sources: The 1848 and 1868 population census samples. Data on crop suitability are from FAO-GAEZ under irrigation and intermediate input in the baseline period 1961–1990.

Table B.8 – The Lancashire cotton famine, slavery, and the occupational distribution of local labor - District-level analysis

| | (1) Prop. slaves & blacks | (2) Prop. HH head free & slave-owning | (3) Prop. slaves & blacks in free-headed HH | (4) Prop. HH head slave | (5) Prop. HH head farmer | (6) Prop. HH head white-collar | (7) Prop. HH head artisan | (8) Prop. HH head non-agr. unskilled |
|---|---|---|---|---|---|---|---|---|
| Cotton × 1868 | 0.459** | 0.917** | 0.465** | 0.019 | 2.853 | -0.458 | -1.010 | -1.385 |
| | (0.182) | (0.359) | (0.202) | (0.074) | (2.572) | (0.846) | (0.606) | (1.559) |
| Cereals × 1868 | -0.244 | -0.272 | -0.248 | -0.015 | -1.951 | 0.552 | 0.690 | 0.710 |
| | (0.186) | (0.350) | (0.204) | (0.069) | (2.327) | (1.118) | (0.477) | (1.328) |
| 1868 | -0.040 | -0.215 | -0.042 | 0.002 | -0.206 | -0.047 | -0.015 | 0.269 |
| | (0.060) | (0.149) | (0.060) | (0.024) | (0.656) | (0.450) | (0.122) | (0.308) |
| District FE? | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Clusters (districts) | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| Obs (district-year) | 50 | 50 | 50 | 50 | 49 | 49 | 49 | 49 |
| $R^2$ | 0.648 | 0.672 | 0.600 | 0.428 | 0.652 | 0.570 | 0.786 | 0.737 |
| Av. dep. var. in 1848 | 0.011 | 0.014 | 0.010 | 0.004 | 0.682 | 0.058 | 0.091 | 0.169 |

Notes: Standard errors clustered at the district level are in parentheses. $*p < 0.10, **p < 0.05, ***p < 0.01$.
Sources: The 1848 and 1868 population census samples. Data on crop suitability are from FAO-GAEZ under irrigation and intermediate input in the baseline period 1961–1990.

Table B.9 – Labor-to-land ratio by crop in 1939

*Dependent variable: labor-to-land ratio = number of cultivators/area cultivated*

| | (1) 0-1 | (2) 1-2 | (3) 2-3 | (4) 3-4 | (5) 4-5 | (6) 5-10 | (7) 10-20 | (8) 20-50 | (9) 50-100 | (10) 100-200 | (11) 200-500 | (12) 500+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wheat | -0.620 | -0.350 | -0.226 | -0.131 | -0.115 | -0.115 | -0.026 | -0.011 | -0.005 | -0.002 | -0.016 | -0.000 |
| | (1.338) | (0.255) | (0.174) | (0.170) | (0.142) | (0.142) | (0.096) | (0.045) | (0.044) | (0.039) | (0.020) | (0.028) |
| Beans | 9.384 | 0.354 | 0.528*** | 0.569*** | 0.527*** | 0.527*** | 0.323*** | 0.182*** | 0.090** | 0.051 | 0.012 | 0.012 |
| | (9.471) | (0.265) | (0.188) | (0.152) | (0.123) | (0.123) | (0.086) | (0.042) | (0.039) | (0.035) | (0.020) | (0.028) |
| Barley | 0.583 | 0.527* | 0.671*** | 0.756*** | 0.660*** | 0.660*** | 0.399*** | 0.248*** | 0.134*** | 0.077* | 0.027 | 0.017 |
| | (1.302) | (0.302) | (0.179) | (0.148) | (0.127) | (0.127) | (0.099) | (0.045) | (0.046) | (0.040) | (0.022) | (0.028) |
| Lentils | 1.240 | 1.493* | 1.528* | 1.010*** | 0.862** | 0.862** | 1.378** | 0.699*** | 0.477*** | 0.624*** | 0.065** | 0.017 |
| | (1.705) | (0.824) | (0.824) | (0.359) | (0.356) | (0.356) | (0.591) | (0.163) | (0.123) | (0.218) | (0.028) | (0.042) |
| Onions | 3.054** | 3.286*** | 3.369*** | 3.076*** | 2.700*** | 2.700*** | 1.419*** | 0.795*** | 0.521*** | 0.382*** | 0.191*** | 0.133*** |
| | (1.528) | (1.042) | (0.919) | (0.916) | (0.577) | (0.577) | (0.318) | (0.170) | (0.127) | (0.125) | (0.054) | (0.044) |
| Rice | -1.508 | -0.493 | -0.038 | -0.089 | -0.068 | -0.068 | -0.035 | -0.006 | -0.011 | -0.024 | -0.010 | 0.008 |
| | (1.669) | (0.344) | (0.270) | (0.208) | (0.170) | (0.170) | (0.117) | (0.054) | (0.053) | (0.044) | (0.024) | (0.044) |
| Sugar | 0.356 | 0.357 | 0.603*** | 0.591*** | 0.559*** | 0.559*** | 0.426*** | 0.293*** | 0.214*** | 0.192*** | 0.128*** | 0.337* |
| | (1.301) | (0.348) | (0.205) | (0.183) | (0.161) | (0.161) | (0.097) | (0.052) | (0.064) | (0.056) | (0.042) | (0.188) |
| Peanuts | 0.443 | 0.650 | 0.262 | 0.411* | 0.330 | 0.330 | 0.201 | 0.233* | 0.342 | 0.112 | 0.064 | 0.222* |
| | (1.273) | (0.973) | (0.317) | (0.247) | (0.239) | (0.239) | (0.139) | (0.123) | (0.226) | (0.085) | (0.053) | (0.131) |
| Maize | -0.779 | 1.314 | -0.264 | -0.157 | -0.110 | -0.110 | -0.004 | 0.010 | 0.012 | 0.007 | -0.007 | 0.001 |
| | (1.379) | (1.751) | (0.208) | (0.201) | (0.170) | (0.170) | (0.111) | (0.054) | (0.050) | (0.042) | (0.021) | (0.028) |
| S. Sorghum | -0.191 | 0.035 | -0.074 | 0.253 | 0.238 | 0.238 | 0.169* | 0.091** | 0.034 | 0.109 | 0.001 | 0.012 |
| | (1.389) | (0.251) | (0.177) | (0.206) | (0.153) | (0.153) | (0.099) | (0.045) | (0.046) | (0.078) | (0.021) | (0.031) |
| N. Sorghum | -0.527 | -0.009 | -0.018 | 0.132 | 0.121 | 0.121 | 0.071 | 0.108* | 0.066 | 0.062 | 0.034 | 0.027 |
| | (1.410) | (0.305) | (0.192) | (0.178) | (0.157) | (0.157) | (0.108) | (0.057) | (0.044) | (0.045) | (0.021) | (0.043) |
| Fenugreek | 0.484 | 0.933** | 1.061*** | 0.977*** | 0.911*** | 0.911*** | 0.527*** | 0.332*** | 0.181*** | 0.116*** | 0.054** | 0.045 |
| | (1.420) | (0.367) | (0.245) | (0.252) | (0.189) | (0.189) | (0.108) | (0.056) | (0.052) | (0.040) | (0.022) | (0.030) |
| Province FE? | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | |
| Obs (Crop-province) | 164 | 167 | 165 | 169 | 165 | 165 | 170 | 171 | 166 | 163 | 157 | 147 |
| $R^2$ | 0.156 | 0.211 | 0.473 | 0.447 | 0.572 | 0.572 | 0.437 | 0.523 | 0.405 | 0.375 | 0.437 | 0.263 |
| Mean dep. var. | 4.410 | 2.457 | 1.772 | 1.470 | 1.240 | 1.240 | 0.619 | 0.347 | 0.205 | 0.156 | 0.070 | 0.068 |

Notes: Each column shows the results of an OLS regression of labor-to-land ratio on a full set of crop and province fixed effects, at each landholding size, where cotton is the omitted category. White-Huber heteroskedasticity robust standard errors are in parentheses. $*p < 0.10, **p < 0.05, ***p < 0.01$. Rice refers to summer and Nolitic rice. S. Sorghum is summer sorghum, N. Sorghum is Nolitic sorghum.

Sources: The 1939 agricultural census (Ministry of Agriculture 1939, pp. 60-69).

Table B.10 – Returns to scale by crop in 1877
*Dependent variable: Crop revenue per feddan*

| | (1) Large estate 1 | (2) Large estate 2 |
|---|---|---|
| Cotton × Large estate | -0.076 | -0.369 |
| | (0.215) | (0.236) |
| Wheat × Large estate | 0.566 | 0.617** |
| | (0.429) | (0.297) |
| Beans × Large estate | 0.552** | 1.074*** |
| | (0.252) | (0.301) |
| Barley × Large estate | 0.218 | 0.767** |
| | (0.315) | (0.364) |
| District FE? | Yes | Yes |
| Crop FE? | Yes | Yes |
| Clusters (districts) | 67 | 61 |
| Obs (area-crop) | 366 | 329 |
| $R^2$ | 0.514 | 0.579 |
| Mean dep. var. | 0.839 | 0.755 |

Notes: Crop revenue is standardized with mean 0 and variance 1. Clustered standard errors at the district level are in parentheses. $*p < 0.10, **p < 0.05, ***p < 0.01$. Large estate 1 =1 if an area is designated as a large estate, or if an area includes both a large estate and a non-large estate. Large estate 2 =1 if an area is designated as a large estate, and treats as missing areas that include both a large estate and a non-large estate.
Sources: Area-level data on the revenue and area of each crop from Ministère de l'Intérieur (1877).