DOI: 10.1111/ehr.13242

THE ECONOMIC HISTORY REVIEW

ORIGINAL ARTICLE

The Middle-Eastern marriage pattern? Malthusian dynamics in nineteenth-century Egypt

Yuzuru Kumon[1] | **Mohamed Saleh**[2]

[1]Department of Economics, Norwegian School of Economics

[2]London School of Economics and Political Science

Correspondence
Mohamed Saleh
Email: m.saleh@lse.ac.uk

Funding information
Agence Nationale de la Recherche (ANR), Grant/Award Number: ANR-17-EURE-0010

Abstract

Malthus predicted that fertility rises with income and that people regulate fertility via regulating marriage. However, evidence on the Malthusian equilibrium has been mostly confined to Europe and East Asia. We employ Egypt's population censuses of 1848 and 1868 to provide the first evidence on the preindustrial Malthusian dynamics in the Middle East and North Africa. At the aggregate level, we document rural Egyptian women having a high fertility rate that is close to the Western European level, combined with low age at marriage and low celibacy rate, that are closer to the East Asian levels. This resulted in a uniquely high fertility regime that was probably offset by the high child mortality. Next, we provide individual-level evidence on the positive correlation between fertility and income (occupation). We find that the higher fertility of rural white-collar men is attributed to their marriage behaviour, and not to marital fertility. Specifically, white-collar men's higher polygyny explains 45 per cent of their fertility advantage, whereas their higher marriage rate and lower wife's age at marriage explains 55 per cent. Therefore, polygyny was an additional factor that led to a steeper income–fertility curve than in Western Europe by enabling the rural middle class to out-breed the poor.

KEYWORDS
fertility, Malthusian model, marriage, Middle East, polygamy

JEL CLASSIFICATION
J13, N35

The Malthusian model implies that fertility rises with income, and that people regulate fertility at the extensive margin via regulating marriage.[1] Most famously, Hajnal documented a (Western) European marriage pattern (EMP) of late marriage and high celibacy that restricted fertility at the extensive margin.[2] The reduction of fertility, and therefore population pressure, via the EMP has been used to explain the rise of Western Europe during the early modern period, generating much debate.[3] By contrast, scholars have also documented an East Asian pattern using data that predominantly comes from the eighteenth and nineteenth centuries. They show a region of low marital fertility (via longer breastfeeding and infanticide), early marriage, and low celibacy, suggesting fertility regulation within marriage, although its effect on living standards remains contested.[4]

In comparison, while societies in the Middle East and North Africa (MENA) had stagnant incomes, we know little about the existence (or lack thereof) of Malthusian demographic patterns prior to MENA's demographic transition during the second half of the twentieth century.[5] However, it is important to study these Malthusian dynamics, because of their implications for MENA's stagnant incomes, and because of its peculiar demographic institutions, among which are polygyny and slavery.[6] While under monogamy, male fertility is concave in income due to the biological limit to childbearing, polygyny, and female slave ownership enable richer men to significantly out-breed the poor, leading to a steeper income–fertility relationship. This could, in turn, lead to higher population, and lower income per capita, if women married in polygynous marriages, or female slaves, had more children than monogamous women.[7]

This paper introduces the first evidence from the MENA region on the existence of Malthusian dynamics prior to the demographic transition. We draw on a unique and novel data source: two nationally representative individual-level samples of Egypt's population censuses of 1848 and 1868 that were digitized by Saleh from the original Arabic manuscripts at the National Archives of Egypt.[8] These are among the earliest precolonial individual-level population censuses from any

[1] Malthus, *An essay*; Guinnane, 'Historical fertility transition'. Consequently, the Malthusian model implies that any rise in income due to technological progress is offset by higher fertility and population growth, which keeps income per capita stable over the long run. This contrasts with the modern fertility regime, brought about via the demographic transition, with negative (or zero) income elasticity of fertility, and marital fertility control.

[2] Hajnal, 'European marriage'.

[3] Greif, 'Family structure'; Greif and Tabellini, 'Cultural and institutional'; De Moor and Van Zanden, 'Girl power'; Foreman-Peck, 'Western european' and Voigtländer and Voth, 'How the West'. For papers that debate the importance of the EMP, see Guinanne, 'Historical fertility transition'; Dennison and Ogilvie, 'Does the European'.

[4] Tomobe, 'Kinsei Nihon'; Lee and Feng, 'Malthusian models' and Kurosu, Tsuya and Hayano, 'Regional differentials'.

[5] Ozmucur and Pamuk, 'Real wages'; Yousef, 'Egypt's growth' and Pamuk and Shatzmiller, 'Plagues, wages'. Data from the United Nations reveal that the birth rate declined in most MENA countries from 40–50 per 1000 in 1950–1955 to 20–25 per 1000 in 2005–2010. Data on the total fertility rate (TFR) show a similar decline. The death rate witnessed an earlier decline.

[6] Polygyny is the marriage of one man to multiple wives.

[7] This could hold if marriage was partially a result of women choosing husbands to maximize reproductive success. See Becker, 'A theory'.

[8] Saleh, 'A pre-colonial'.

non-Western country – and the earliest in MENA – to include information on every household member, including females, children, and slaves. Although the censuses do not record the marital status or the number of children ever born, a common limitation of historical censuses, they do record the relationship to the household head, which we use to infer both marriage and fertility. Furthermore, they record the age of women in rural provinces – where 90 per cent of the population resided – to which we restrict our analysis. Due to the absence of vital records before 1902, these censuses are a unique micro-data source for examining Egypt's pre-industrial demographic patterns.

We address two questions. First, at the aggregate level, what were the nuptiality and fertility patterns in rural Egypt? Did they (not) resemble that in Europe or East Asia? Second, at the individual level, was there a Malthusian relationship of higher fertility among men in higher-income occupations, and if so, what was generating this positive relationship? Was it higher marriage probability and lower age at marriage, as predicted by Malthus, and what role did polygyny and slavery play?

At the aggregate level, we find that nineteenth-century rural Egypt combined the early and near-universal marriage of East Asia with the high marital fertility of Western Europe. The female total marital fertility rate (TFMR) at ages 21–45 years was 7.2 in Egypt, which is comparable to the 7–9 found in Western Europe, and much higher than the TFMR of 5.7 in Japan, 1665–1871, and 3.8–4.76 in northeast China, 1789–1907.[9] However, Egypt was comparable to East Asia in marriage patterns, with all but 6 per cent of women marrying at the mean age of 18 years. This resulted in a uniquely high fertility regime that was probably offset by Egypt's higher mortality rates at ages 0–15 years.

At the individual level, we find rural white-collar men – mainly village headmen – had significantly higher fertility than men in other occupations, as has been found for other populations.[10] Furthermore, white-collar workers' higher fertility was not driven by their higher marital fertility, which is similar to the findings from pre-industrial Western societies showing the lack of targeting in marital fertility.[11] Instead, we show that they had higher marriage rate, lower wife's age at marriage, higher polygyny rate, and higher probability of owning female slaves. This is partially consistent with the timing of marriage being used to regulate fertility in Western Europe.[12]

However, unlike Western societies, we find that polygyny – and, less so, ownership of female slaves, who had much lower fertility than free wives – functioned as an additional mechanism generating the occupational differentials in male fertility in Egypt. First, 12 per cent of white-collar men were polygynous, as opposed to 5 per cent among the whole male population. Second, while polygynous men had significantly more children than monogamous men, polygynous families had slightly fewer children per wife than monogamous couples, which was potentially due to the lower fertility of the first wife, as has been argued for China.[13] Third, we evaluate the relative contributions of polygyny versus the age-specific marriage rates in driving the occupational differences in male fertility. We find that over 45 per cent of the fertility differences across

[9] Tomobe. 'Kinsei Nihon'; Lee and Campbell, *Fate and fortune*, and Chen, Lee, and Campbell, 'Wealth stratification'.

[10] Clark and Hamilton, 'Survival of the richest'; Boberg-Fazlic, Sharp, and Weisdorf, 'Survival of the richest?'; Dribe and Scalone, 'Socioeconomic class'; Clark and Cummins, 'Intergenerational wealth'; Lee and Park, 'Quality over quantity', and Hu, 'Survival of the Confucians'. Egypt's upper class, the Ottoman-Egyptian aristocracy, lived in cities and were the largest (absentee) landholders. Because we restrict the analysis to rural provinces – since we do not observe urban women's age – we do not include the upper class. Rural white-collar workers constituted a rural middle class.

[11] Clark, Cummins, and Curtis, 'Twins support'.

[12] De la Croix, Schneider, and Weisdorf, 'Childlessness, celibacy' and Cummins, 'The micro-evidence'.

[13] Feng and Wang, *One quarter*.

occupations is due to polygyny. However, because polygyny was practised by only 5 per cent of the male population, our estimates suggest that it had little effect on female total fertility and hence on population.

Finally, we test whether Muslims and Coptic Christians had different fertility and marriage patterns, conditional on occupational class. Rural Egypt provides a rare context in which we are able to compare people of different religions living within the same environment. We find no statistically significant difference in fertility or marriage among the two groups. The only exception was in polygyny, which was practised by Muslims but not by Copts, as the Coptic Church prohibited the practice. Ownership of female slaves was practised by both groups, though.

The main contribution of this paper is to show whether and how the Malthusian mechanism functioned in a MENA population before the demographic transition. The literature on this region had mainly focused on wages, GDP per capita, and industrialization and deindustrialization.[14] This literature found that Egypt, and the Ottoman Empire in general, had lower wages than Western Europe by 1500. Further, in our interpretation, the wage and GDP per capita trends suggest a region in stagnation – despite episodes of growth – as would be predicted by the Malthusian model. Saleh employs the GDP per capita figures in Pamuk and Yousef to argue that Egypt did not achieve modern economic growth before 1950.[15]

We extend this literature by providing novel evidence on marriage and fertility in nineteenth-century Egypt. To be clear, we do not claim that our results would necessarily generalize to the whole of MENA, given the high heterogeneity across its countries and populations. Nevertheless, our paper sheds light on MENA demographic history and may have implications for other parts of MENA for three reasons. First, Egypt was the third most populous country in MENA in 1870 – after Turkey and Iran – and constituted 28 per cent of MENA's population excluding these two countries. Studying Egypt's demographic history is thus an important addition to our knowledge about the demographic history of the region. Second, both polygyny and slavery were common across MENA, although there was considerable cross-country heterogeneity in their prevalence.[16] Third, although tribalism was much less prevalent in Egypt than in the Levant, North Africa, and the Arab Peninsula, there was a significant Bedouin Arab tribal population in rural Egypt that we observe in the 1848 and 1868 censuses, and that is controlled for in our regression analysis. Although analysing the demographics of this Bedouin population goes beyond the scope of this paper, this does suggest that tribalism also existed in Egypt.

This paper also shows, both theoretically and empirically, how polygyny and female slavery may alter the Malthusian equilibrium. Polygyny was the most common marriage system in pre-industrial times. The ethnographic atlas shows 84 per cent of societies allowed some form of polygyny, which is in line with other studies.[17] Therefore, monogamy in marriage was a peculiar institution, that had become common in early modern Europe and may have originated in ancient Greece/Rome.[18] Our finding that polygynous men had higher fertility is consistent with

[14] Ozmucur and Pamuk, 'Real wages'; Yousef, 'Egypt's growth' and Pamuk and Shatzmiller, 'Plagues, wages'; Pamuk, 'Estimating economic', and Pamuk and Williamson, 'Ottoman de-industrialization'.

[15] Saleh, 'The Middle East'; Yousef, 'Egypt's growth', and Pamuk, 'Estimating economic'. Modern economic growth is defined as sustaining an average growth of real GDP per capita of 1 per cent per annum for a sufficiently long period of time so as to quadruple the standard of living.

[16] For further details, see Egypt's Demographic Institutions section.

[17] Gray, 'Ethnographic atlas', and Henrich, Boyd, and Richerson, 'The puzzle'.

[18] Scheidel, 'A peculiar', and Henrich, Boyd and Richerson, 'The puzzle'. This is not to suggest that polygyny in mating did not occur in Europe, as illegitimate children existed, although their social status declined in later periods. See De La Croix and Mariani, 'From polygyny'.

empirical findings from China, 1400–1900, although polygyny was less prevalent in China (less than 2 per cent) than in Egypt (about 5 per cent), and hence its demographic impact was probably smaller.[19] We further show that polygyny was an additional channel by which the rural middle class could out-breed the poor to a greater extent than the monogamous rich in the West, resulting in a steeper income–fertility curve in Egypt.

Our finding that female slaves had low fertility is consistent with recent studies on slavery in Egypt, and with observations made by nineteenth-century Europeans.[20] However, it contrasts with earlier studies on the Ottoman Empire that emphasized the high fertility of female slaves, using evidence from white female slaves (Harem) in Ottoman palaces.[21] Yet, white slaves constituted only 5 per cent of slaves in Egypt in 1848 and resided in cities only. The vast majority of slaves were black Sudanese (93 per cent) and Ethiopians (2 per cent). Almost all slaves in rural Egypt were black Sudanese or Ethiopians.

This paper belongs to a group of descriptive studies that document differences in fertility by income level (e.g. wealth, occupational status), possibly over time, finding that higher income is associated with greater fertility, as theorized by Malthus.[22] The primary mechanism in these studies is through the extensive margin of fertility via an earlier age of marriage, and not via marital fertility control.[23] This Malthusian regime continued up to the nineteenth century in much of Europe, according to the most recent study.[24] It was only in later stages of development that fertility and income lost their (positive) correlation.[25]

I | EGYPT'S DEMOGRAPHIC INSTITUTIONS

Egypt was an autonomous Ottoman vassal state during the nineteenth century, ruled by the Ottoman viceroy Muhammad Ali Pasha (1805–48) and his descendants. Following the British occupation in 1882, Egypt remained under the nominal Ottoman sovereignty, represented by Ali's dynasty, although it was de facto ruled by Britain. After the Ottoman Empire joined the Central Powers in 1914, Britain declared Egypt a protectorate independent of the Ottoman Empire, under the nominal rule of Ali's dynasty. From 1922 to 1952, Egypt became nominally independent from Britain, as a constitutional monarchy ruled by Ali's dynasty, yet de facto ruled by Britain.[26]

---

19 Hu, 'Survival of the Confucians'.

20 See Walz and Cuno, 'Introduction' pp. 12–3, and Lane, *An account*, p. 179.

21 Peirce, *The imperial harem*.

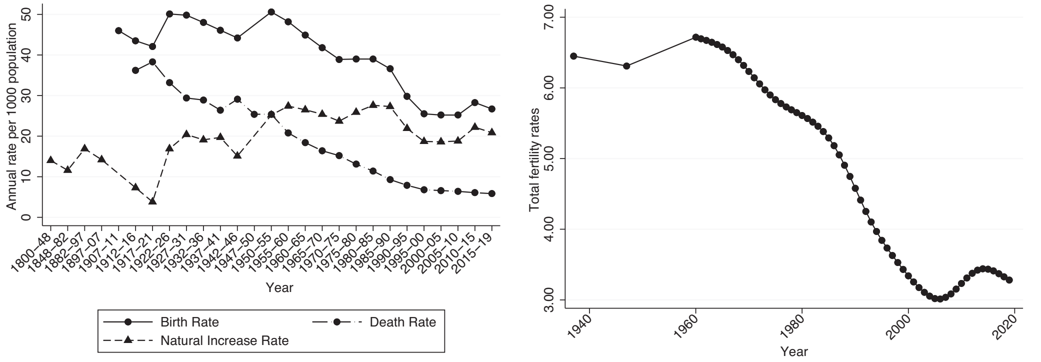
22 Clark and Hamilton, 'Survival of the richest'; Boberg-Fazlic, Sharp, and Weisdorf, 'Survival of the richest?'; Clark and Cummins, 'Intergenerational wealth'; Lee and Park, 'Quality over quantity', and Hu, 'Survival of the Confucians'.

23 Clark, Cummins and Curtis, 'Twins support', and Cummins, 'The micro-evidence'. Another line of this literature attempts to provide causal evidence on the income–fertility gradient by exploiting food price changes as exogenous shocks to real income, finding a negative effect of food prices on fertility– that operates via marriage – implying a positive relationship between income and fertility. See Weir, 'Life under pressure'; Galloway, 'Basic patterns'; Guinnane and Ogilvie, 'Institutions and demographic', and Lagerlöf, 'Malthus in Sweden'.

24 Madsen, Robertson, and Ye, 'Malthus was right'. Although an initial finding was little or no Malthusian effect by the eighteenth century, Madsen et. al. showed that this was likely due to omitted variable bias and strong Malthusian forces were in fact active. For the earlier literature, see Nicolini, 'Was Malthus'; Kelly and O'Grada, 'The preventative', and Fochesato, 'Origins of Europe's'.

25 Hacker, 'Rethinking the early'; Ruggles, 'Marriage, family'; Ager, Herz, and Brueckner, 'Structural change', and Chatterjee and Vogl, 'Escaping Malthus'.

26 See Daly, Daly, and Petry, *The Cambridge history*, for a background about the modern political history of Egypt.



(a) Birth and death rates, 1800–2019 (b) Total fertility rates, 1800–2019

FIGURE 1 Egypt's demographic transition, 1800–2019. *Notes*: The natural increase rate in 1800–1907 is the intercensal growth rate (per 1000 population) per year, based on the population censuses of 1800 (total estimate by the French occupation), 1848, 1882, 1897, and 1907. For the subsequent period 1907–2010, the natural increase rate is the difference between the birth and death rates. *Sources*: (a): 1800–1950: Fargues, 'Une siecle' p. 210; 1950–2019: World Development Indicators. (b): 1937, 1947: Fargues, 'Une siecle' p. 223; 1960–2019: World Development Indicators.

Figure 1a shows Egypt's birth, death, and natural increase (= birth – death) rates per 1000 population from 1800 to 2019. Prior to the establishment of the universal vital registration system in Egypt in 1902, we plot the intercensal growth rates based on the population censuses of 1800 (total estimate by the French occupation), 1848 (total estimate by Fargues), 1882, 1897, and 1907.[27] The figure shows that the death rate started to decline in the 1920s, which is consistent with Riley's estimates, whereas the birth rate started to decline in 1955–60.[28] Figure 1b plots the total fertility rate from 1937 to 2019. We do not have estimates of the TFR prior to 1937, because the 1937 census is the first published census to tabulate the number of births by mother's age. The figure shows that the TFR started to decline after 1960, which coincides with the timing of the birth rate decline, suggesting the fertility transition occurred in the 1960s. Therefore, our period of study long predates the mortality and fertility transitions.

Egypt and the Ottoman Empire at large, had two distinct demographic institutions: polygyny and slavery. Polygyny was allowed for Muslim males by Islamic jurisprudence; a Muslim male may marry up to four wives simultaneously. Polygyny was not unique to MENA, as it was a common institution in the non-Western world. The best-studied polygyny cases from pre-industrial times are East Asian societies that allowed for polygyny via concubines. However, polygyny rates in early modern China were low and could not have exceeded 1–2 per cent.[29] By contrast, levels of polygyny were higher in MENA, with significant cross-country variation. In Egypt, 5 per cent of rural adult men were polygynous in the 1848 and 1868 censuses, and about 6 per cent of all men were polygynous according to the 1907 census.[30] Elsewhere, the percentage of men married

[27] Fargues, 'Une siecle'.

[28] Riley, 'The timing'.

[29] Accurate statistics do not exist for early modern East Asia. However, polygyny among peasants would have been extremely rare in both Japan and China at this time. For further details, see Feng and Wang, *One quarter*.

[30] Fargues, 'Terminating marriage'.

polygynously was 15 per cent in Algeria in 1886, 6.6 per cent in Morocco in 1951, 4.5 per cent in Tunisia in 1946, 4.3 per cent in Syria in 1960, and 3.2 per cent in Libya in 1954.[31]

Slavery was also a long-standing institution until Egypt's abolition of slavery in 1877, as the enslavement of foreign non-Muslims via 'holy' raids (*ghazwas*) was permitted by Islamic law. Slavery was self-perpetuating by law, as the offspring of a male slave were automatically slaves. Slaves constituted 1.2 per cent of Egypt's population in 1848 and rose to 3 per cent in 1868 following the cotton boom in 1861–5.[32] Around 93 per cent of slaves in 1848 were blacks (*aswad*, *sudani*) from the Nilotic Sudan, 2 per cent were Abyssinians (*habashi*) from Ethiopia, and 5 per cent were whites (*abyad*) from Circassia and Georgia. Egypt was the largest importer of slaves in North Africa, followed by Libya (abolition in 1857), Morocco (abolition in 1922), Tunisia (abolition in 1841), and Algeria (abolition in 1848).[33]

Most slaves in 1848 were employed as domestic servants. Female slaves could also be concubines of their male masters, and their offspring were considered free and legitimate. The two other sectors of slave employment were agriculture and the military: employing slaves in agriculture increased after the cotton boom in 1861–5, whereas employing slaves in the military declined during the nineteenth century.

We knew relatively little about family structures in nineteenth-century Egypt prior to the discovery of the 1848 and 1868 censuses. Lane made a number of anecdotal observations about family structures in Cairo in the 1820s and 1830s, where he noted the women's early age at marriage.[34] Using an unpublished sample for Cairo from the 1848 census, Fargues employed a demographic model to document family structures in nineteenth-century Cairo. He describes several demographic facts.[35] First, infant and child mortality rate was very high, ranging around 50 per cent. Second, adult mortality was also very high, resulting in parents and children overlapping for a very short period of time. Surviving grandparents were extremely rare. This resulted in male children becoming heads of households at a young age long before marriage. Third, marriage was almost universal for both men and women, with mean age at marriage around 20 for men and 14 for women.[36] Fourth, the average fertility for a couple was around 6–10 children. However, the average household size was 3.54, probably because this high fertility was offset by the high infant and child mortality. As we will show in this paper, our findings for rural Egypt are broadly consistent with Fargues.[37] One key difference is that rural Egypt had more complex households, with multiple nuclear families, especially among village headmen.

II | THE MALTHUSIAN MODEL WITH POLYGYNY AND SLAVERY

The Malthusian model is based on three assumptions as shown in figure 2.[38] First, birth rates – shown by the birth rate curve b(y) – are increasing in income (A1). Second, death rates – shown by

[31] Ibid and Chamie, 'Polygyny among Arabs'.

[32] Saleh, 'Trade, slavery'

[33] Austen, 'The Mediterranean'.

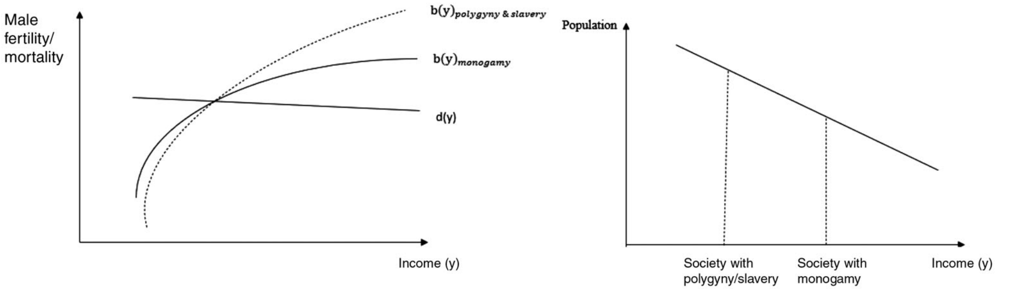
[34] Lane, *An account*.

[35] Fargues, 'Family and household'.

[36] Because women's age is not observed in 1848 Cairo, it is likely that Fargues used a curve to estimate women's age.

[37] Ibid.

[38] Malthus, *An essay*.



(a) Fertility/mortality and income (b) Income and population

FIGURE 2 A Malthusian model with polygyny and female slavery. *Notes*: b(y) refers to the birth rate and d(y) refers to the death rate. *Sources*: Authors' own creation.

the death rate curve d(y) – are decreasing in income (A2). Third, decreasing returns to labour due to limited land results in decreasing average income per person as population increases (A3) as shown in figure 2b. If we define the income where birth rate equals death rate as the subsistence income, any income above this level will result in population growth. As population increases over the long run, the income per capita decreases due to A3 until it reaches equilibrium at the subsistence level.

The equilibrium income can be shifted upwards in this model. This occurs if either the birth rate curve is shifted downwards or the death rate curve is shifted upwards in figure 2a. In either case, the mechanism works through the equilibrium population level. However, any technological growth has no effect on equilibrium income because any short-term gains are eventually eaten away by population growth.

Polygyny and female slavery may both affect the Malthusian equilibrium. Under monogamy and no slavery, there is an increase in the birth rate function as income increases, as in assumption A1. However, due to biological limits in childbearing under monogamy, the rate of increase slows down rapidly as incomes increase as shown in figure 2a. The institutions of polygyny and female slavery can partially loosen this constraint by allowing richer men to significantly outbreed the poor by having multiple wives, or owning female slaves. This may be accompanied by a decrease in fertility among the poor who have to compete for wives with the rich. Therefore, these institutions could affect the curvature of the fertility curve. It could also increase fertility for society as a whole if women in polygynous marriages or female slaves have more children than monogamous women. This could result in higher population and lower average income per person in equilibrium (figure 2b).

Furthermore, because polygyny was practised by Muslims only, and not by non-Muslim minorities, it can alter the inter-religious differences in fertility (if any) in favour of Muslims. Specifically, it may partially offset the fertility advantage of non-Muslims, who were better off than the Muslim majority (appendix figure A4).

III | DATA

Egypt's 1848 and 1868 population census samples are two nationally representative cross-sectional samples of approximately 80 000 individuals in each year.[39] Each sample is selected via a random

[39] The sampling rate is 8–10 per cent in Cairo and Alexandria and 1 per cent in rural provinces.

draw of pages within the census registers of each province, where all households on a selected page are included in the sample.[40] Because we do not observe women's ages in cities, we restrict the analysis to free Muslim and Coptic men and women in rural provinces who are 15–64 years of age.[41] In the analysis of fertility, we restrict the sample of women further to those in the reproductive age who are 15–54 years old. Throughout the analysis, we weight the observations by the inverse of the sampling probability, to account for inter-province differences in the sampling rate. While the 1848 census enumerated all 14 rural provinces, only 6 rural provinces have extant census registers in 1868. This can be due to either the non-survival of the 1868 census registers of these provinces and/or their non-enumeration. We take this issue into account by assigning higher personal weights to the individuals in the neighbouring provinces.[42]

The Egyptian censuses record neither the marital status nor the number of children ever born. However, the censuses record each individual's relationship to the household (HH) head. We thus follow the historical demography literature that employs the relationship to the HH head to infer marriage and fertility.[43] The availability of the relationship to the HH head in the Egyptian censuses is actually remarkable from an international perspective. For example, the US censuses did not record this information before 1880, and so, US historical demographers relied instead on the age and sex structure of the HH members. The Egyptian censuses have the further advantage of recording other demographic and socioeconomic characteristics that are typically not available in vital records, and that we use to explain the variation in fertility and marriage.

Below we briefly explain how we measure fertility and marriage. We relegate the detailed technical description of these variables to appendices A.1 and A.2.

The first outcome variable is fertility, which we measure at the individual level by the number of surviving children aged between 0 and 1.5 years old who co-resided with their parent(s) at the time of the census. We use the 1.5 age threshold due to age heaping around the ages of 1 and 2 years. We also confirm that this threshold is most consistent with the expected age structure due to infant mortality at the time in appendix A.2. In the case of multiple potential fathers or mothers, we assign the child to the parent with the smallest parent–child age difference. When we measure fertility at the aggregate level, we correct for unobserved children due to both child death and unmatched children who did not co-reside with their parent(s).

The second outcome variable is marriage. We measure the marital status at the individual level (never married, in a monogamous marriage, in a polygynous marriage, separated) by the number of surviving marital partners who co-resided with the individual at the time of the census. In the case of multiple potential partners (e.g. multiple brothers of HH head and multiple wives of brothers of HH head), we assign to the individual the partner with the smallest couple age differential.

[40] Within the census registers of each province, one page is selected every *x* number of pages until the end of the province's census registers. The range (*x*) is decided based on (1) the average number of individuals in a page in the province's census registers and (2) the target sample size in each province. If a household begins on a selected page, it is included in its entirety, regardless of the page in which the household ends. For more detail, see Saleh, 'A pre-colonial'.

[41] This means excluding urban provinces: Cairo, Alexandria, Rosetta, Qusayr, 'Arish, and Damietta. Women's age in these urban provinces is recorded as binary: adult or juvenile.

[42] Specifically, individuals in the two Lower Egypt provinces that we observe in 1868, al-Sharqiya and al-Daqahliya, are assigned higher personal weights to account for the population of the other four missing provinces of Lower Egypt (al-Buhayra, al-Menoufiya, al-Gharbiya, and al-Qalyubiya). Similarly, the four observed Upper Egypt provinces (Giza, Fayyum, Beni Soueif, and Asyut), are assigned higher weights to account for the population of the other four missing provinces of Upper Egypt (Minya, Girga, Qena, and Aswan).

[43] Hacker, 'Rethinking the early', and Ruggles, 'Marriage, family'.

An important variable in the empirical analysis is age. We use the 10-year age bin because of the age heaping around ages ending in 0s (appendix figure A1).

IV | EGYPT'S DEMOGRAPHICS IN INTERNATIONAL PERSPECTIVE

One way of studying the Malthusian dynamics is to think of the society as a whole in equilibrium. In this case, the population is mostly stable, due to birth control (the preventative check) or high mortality (the positive check). We focus on the preventative check, for which our data is best suited (censuses enumerate the survivors). In this section, we construct Egypt-level measures of fertility, mean age at marriage, and the celibacy rate, using the censuses of 1848 and 1868, and we compare them with the demographics of other regions. These aggregate statistics demonstrate how pre-industrial societies prevented overpopulation. The literature has shown that Western Europe achieved this objective via late marriage and a high celibacy rate despite high marital fertility, whereas East Asia had low fertility within marriage despite early and universal marriage.[44]

We follow Hajnal's method to estimate the singulate mean age at marriage using our marital status variable.[45] To measure fertility, we use the number of surviving children aged 0–1.5 years to estimate the age-specific number of births, where we correct for unobserved and unmatched children as documented in appendix A.4. We present the results for marriage and fertility by sex, age, and census year in table 1. We additionally show that the standard errors of our estimates are small and that these estimates are precise in appendix figure A3.

We find that the marriage rate generally increases up to the age of 44 years for both sexes. The share of separated individuals increases thereafter, which is due to both the death of spouses and divorce. While the share of individuals never married increases after the age of 44 years, this is likely due to the misassignment of widows and divorcees as never married due to our matching procedure.[46] We, therefore, assume that the share never married is non-increasing over age when estimating the singulate mean age at marriage.[47] We find that the mean age at marriage was 18 years for women and 27 years for men, resulting in a large age gap among couples. Reassuringly, the median age at marriage is also very similar.

To estimate fertility, we construct three measures. The total marital fertility rate (TMFR) is the number of children among married couples aged 21–45 years, assuming that they survive for the entire age bracket.[48] The total fertility rate (TFR) is the number of children among all women aged 21–45 years, assuming they survive for the entire age bracket. Both the TMFR and TFR do not account for female mortality. Our third measure, the general fertility rate (GFR), adjusts the TFR by accounting for female mortality at each age bracket

[44] Hajnal, 'European marriage'; Clark, 'A farewell'; Lee and Feng, 'Malthusian models', and Feng and Wang, *One quarter*.

[45] Hajnal, 'European marriage'.

[46] Specifically, an individual who does not have a co-residing marital partner or children in the household and whose relationship to the HH head does not imply a (past) marriage is considered never married in our procedure. But this individual might have been married in the past.

[47] Specifically, as the share never married increases after the age of 35–44 years, we assign the celibacy rate at the age of 35–44 years to the higher age bracket, 45–54 years. However, using the celibacy rate at the age of 45–54 years only increases the estimated celibacy rate to 7 per cent.

[48] We use the age bracket 21–45 years because it is comparable to the international literature.

TABLE 1 Marriage and fertility by sex, age, and census year

Panel A: Marriage by age

	15–24 years	25–34 years	35–44 years	45–54 years	55–64 years
Women, 1848					
Monogamous	0.47	0.62	0.61	0.51	0.33
Polygamous	0.11	0.17	0.18	0.15	0.12
Separated	0.11	0.12	0.14	0.25	0.41
Never married	0.30	0.09	0.07	0.10	0.14
Women, 1868					
Monogamous	0.52	0.67	0.66	0.54	0.37
Polygamous	0.08	0.16	0.16	0.11	0.09
Separated	0.07	0.10	0.14	0.30	0.44
Never married	0.33	0.07	0.04	0.05	0.10
Men, 1848					
Monogamous	0.16	0.52	0.67	0.73	0.73
Polygamous	0.01	0.06	0.08	0.10	0.13
Separated	0.01	0.02	0.03	0.04	0.04
Never married	0.82	0.41	0.22	0.13	0.10
Men, 1868					
Monogamous	0.23	0.60	0.77	0.80	0.78
Polygamous	0.01	0.03	0.07	0.11	0.12
Separated	0.00	0.02	0.02	0.03	0.04
Never married	0.75	0.35	0.15	0.06	0.06

Panel B: Age at marriage

	Women		Men	
	1848	1868	1848	1868
Mean	17.6	18.0	27.6	26.4
Median	18.3	18.6	29.0	27.1

Panel C: Female fertility by age

	15–24 years	25–34 years	35–44 years	45–54 years	Total 21–45 years
Total marital fertility			Rate		
1848	249	326	238	128	6.8
1868	294	352	259	141	7.4
Total fertility rate					
1848	184	292	203	94	5.8
1868	200	318	223	93	6.3
General fertility rate					
1848	181	260	155	64	4.9
1868	196	283	169	63	5.4

(Continues)

TABLE 1 (Continued)

Panel D: Male fertility by age

	15–24 years	25–34 years	35–44 years	45–54 years	55–64 years	Total 21–64 years
Total marital fertility rate						
1848	117	288	331	304	237	12.1
1868	266	339	339	322	241	13.5
Total fertility rate						
1848	22	168	255	256	208	9.0
1868	66	214	286	295	218	10.4
General fertility rate						
1848	21	146	184	141	81	5.6
1868	65	186	206	162	85	6.7

Source: The 1848 and 1868 population census samples.

using Egypt's first life table that was constructed by El-Shanawany based on the 1917 and 1927 censuses.[49] Notice that, while the TMFR measures the intensive margin of fertility within marriage, the TFR and GFR account for the extensive margin of fertility.

We find that male and female fertility both increased slightly between 1848 and 1868. Across the three measures, the female TMFR is 7.2 on average across 1848 and 1868, and is 20 per cent higher than the average TFR of 6.1. This difference is due to the existence of unmarried women who drive down the TFR. However, the effect of unmarried women is relatively small due to the high marriage rate among women who are in fertility age. The average female GFR of 5.2 is 17 per cent lower than the average female TFR due to the effect of female mortality. Male fertility rates differ from females in having a fertility peak at the age 35–44 years due to men's later age at marriage. The male TMFR and TFR both appear high, but once we account for mortality, the GFR is much lower, at an average of 6.1. The GFR remains higher for men than women because we compute women's GFR at the age 21–45 years, to be comparable with the estimates for other regions in table 2, which leads us to miss a number of fertile years for women at the age 15–20 years. If we compute women's GFR at age 15–45 years instead, the GFR estimates become similar across men and women. Despite the assumptions that are required for our calculations, it is reassuring that the estimated female TFR in both 1848 and 1868 are actually very close to the first available TFR estimate for Egypt from the 1937 census (figure 1b) which preceded the Egyptian demographic transition.

Next, we compare our findings with other pre-industrial populations in table 2. We find that rural Egypt was a high-fertility society, with almost universal marriage among women, low female age at marriage, and high marital fertility. Egypt's TMFR of 7.2 was comparable to the 7–9 that we observe in Western Europe. However, it was much higher than the East Asian levels of fertility,

[49] El-Shanawany, 'The first'. These are the first published censuses in Egypt to report the detailed age distribution, which is necessary to estimate mortality, by comparing the age distribution across the two censuses. Notice that the 1848 and 1868 censuses were never published, and were thus unknown to demographic scholars before they were discovered in the 1980s.

TABLE 2 International comparisons of pre-industrial fertility and marriage

Country	Period	Female total marital fertility rate (21-45 years)	Female mean age at marriage	Female celibacy (%)	Total mortality rate	
					0–1	0–15
Western Europe						
England	1740–90	7.7	25.3	11.3	16.8	30.3
France	1740–90	9.0	26.0	12.0	28.1	52.5
Scandinavia	1740–90	7.1	25.5	14.1	20.8	39.8
Middle East						
Egypt	1848, 1868	7.2	18.0	6.0	19.3	41.3
East Asia						
China (Liaoning)	1774–1873	3.8	18.3	0.2	–	–
Japan	1665–1871	5.7	21.4	3.7	17.8	33.8

Notes: Due to different measures in the literature, the proportion of women who never married is measured at age 46–50 years for China, age 45–49 years for Japan, lifetime celibacy for Western European countries, and age 35–44 years for Egypt. We use the figures for lifetime celibacy from Dennison and Ogilvie (2014) for Western Europe. In the case of Japan, we use the average mean age at marriage and the share of women never married measured in various regions.
For mortality rate, we use averages from the period 1750–99 for England, 1740–89 for France, the 1751–90 mortality rates for Sweden in the case of Scandinavia, the 1877 statistical yearbook for Egypt, and estimates from Mino region in Japan.
Sources: Ministère de l'intérieur, *Essai de statistique*; Blayo, 'La mortalité'; Flinn, *The European*; Tomobe, 'Kinsei nihon'; Saito, 'Jinkō tenkan'; Feng, Lee, and Campbell, 'Marital fertility'; Lee and Campbell, *Fate and fortune*; Wrigley, Davies, Oeppen, and Schofield, *English population*, Statistics Sweden, *Population development*; Kurosu, Tsuya, and Hamano, 'Regional differentials'; Feng and Wang, *One quarter*; Ochiai, 'Rekishi teki', and Dennison and Ogilvie, 'Does the European'.

which generally ranged from 4 to 6.[50] Importantly, this is not due to unobserved births in the censuses, due to infant mortality before the census enumeration, as we account for this in our measure using the infant mortality rate in the Egyptian 1877 statistical yearbook (appendix A.4).[51] It is also not due to our use of 10-year age brackets, as we obtain very similar results if we instead employ the 5-year age brackets (appendix figure A2). Further, the shape of the fertility–age curve is similar to that which we observe in other societies.

These results suggest that birth spacing amounted to slightly below 3 years in Egypt. This could be possibly due to a relatively short breastfeeding period, which may have contributed to Egypt's high marital fertility. Recent archaeological evidence from skeletal remains has shown the breastfeeding period was a key factor in determining fertility in other pre-industrial societies. For example, the literature has found declining periods of breastfeeding in England over two millenia, from 4 years in Roman Britain to less than 2 years by the nineteenth century.[52] In contrast, similar studies from Eastern Europe and East Asia suggest longer breastfeeding periods. They find 3.1 years in seventeenth-century Japan, 3–4 years in fourth- to fifth-century Korea, 4 years in eleventh- to eighteenth-century rural Romania, and 3–4 years in the sixth- to fifteenth-century

[50] Although not included in the table, Shuangcheng, 1866–1907, in China also had a total marital fertility rate of 4.76. It is not included in the table because we lack most other statistics from this region. See Chen, Lee, and Campbell, 'Wealth stratification'.

[51] Ministère de l'intérieur, *Essai de statistique*.

[52] Haydock et al., 'Weaning at Anglo-Saxon'.

Greek Byzantine population.[53] Although there are no archaeological studies for Egypt or the Middle East during this period, the Islamic law recommended a 2-year period of breastfeeding.[54] This would be similar to Western European standards and may have resulted in the similarly high marital fertility rates.

Marital fertility rates only matter insofar as women are married. Regarding the extensive margin, we find that the female mean age at marriage and the female celibacy rate were both low in rural Egypt, which probably contributed to increasing fertility. Rural Egyptian women typically married at the mean age of 18 years (or median age of 18.4 years). Assuming that women can typically have children between ages of 15 and 45 years, Egyptian women would only avoid 10 per cent of their childbearing years. Moreover, Egyptian women also had a low celibacy rate, as almost all women married by the age of 45 years. In comparison, Western European women typically married at the age of 25–6 years, meaning that they avoided 33 per cent of their childbearing years, many of which were their most fertile years. In addition, 11–4 per cent of Western European women never married. Hence, Egypt is more similar to East Asian societies with respect to the extensive margin with fertility being close to natural fertility levels. One small difference was in the celibacy rate, which was close to zero in East Asia but 6 per cent in Egypt, although this result may be due to misassigning widows and divorcees as never married in our matching procedure, as we mentioned earlier. However, infanticide and the skewed sex ratio in China implied that there were fewer women relative to men, which in itself lowered potential fertility.[55]

To conclude, Egypt had a marriage and fertility pattern that differed from both East Asian and Western European societies. It was a very high fertility regime unlike other societies that limited fertility by some means. However, this can be partially explained by two factors. First, high child mortality rates in Egypt may have necessitated the high birth rates. As shown in the mortality rate for age 0–15 years, Egypt had lower probability of child survival to adulthood than Western Europe with the exception of France, whose mortality rates may be vastly overestimated.[56] Second, we are only looking at rural fertility. In urban areas, we would expect the 'urban graveyard effect' due to higher densities, which lead to greater transmission of disease and higher mortality rates. Consequently, cities typically experienced population decrease that was only counterbalanced by in-migration from rural areas. Therefore, we would expect rural areas to have higher fertility than urban areas.

One interesting implication of these aggregate findings is that fertility was high despite Egypt having low wages.[57] This suggests the fertility curve for Egypt was to the left of the fertility curve in Western Europe. Therefore, the Malthusian logic (figure 2a) implies that the low wages can be partially explained by the demographic pressure generated by Egypt's high fertility regime.

[53] Tsutaya et al., 'Stable isotopic'; Choy, Jeon, Fuller, and Richards, 'Isotopic evidence'; Voas et al., 'Childhood in the Carpathians' and Bourbou, Fuller, Garvie-Lok, and Richards, 'Nursing mothers'.

[54] Giladi, 'Breastfeeding'.

[55] Feng and Wang, *One quarter*.

[56] French infant mortality rates in the early nineteenth century are about 20 per cent which are much lower. See Mesle and Vallin, 'Reconstitution of annual'.

[57] Ozmucur and Pamuk, 'Real wages'; Yousef, 'Egypt's growth' and Pamuk and Shatzmiller, 'Plagues, wages'.

V | INDIVIDUAL-LEVEL ANALYSIS OF INCOME AND FERTILITY

We next examine the Malthusian prediction of the positive correlation between income and fertility, and whether people regulated fertility via marriage. To this end, we pool the 1848 and 1868 census samples. As we lack income data, we use occupation as a proxy for income. We examine both the extensive margin of fertility via marriage patterns, and the intensive margin of fertility via births within marriage, by estimating the following regression:

$$Y_{i,q,t} = \alpha_q + \theta_t + \sum_{o} \beta_{1,o} occupation_o + \gamma X + \epsilon_i \quad (1)$$

where $Y_{i,q,t}$ is the outcome of individual i residing in village q in census year $t \in \{1848{,}1868\}$. We examine the following dependent variables: (1) the number of surviving children aged 0–1.5 years; (2) a dummy variable (defined for the whole sample) that takes the value 1 if the person was married at the time and equals 0 if they were never married or were separated; (3) age at marriage (defined for individuals who were married at the time with at least one child less than 8 years), which we estimate by the difference in years between the parent's age and the age of the oldest observed child, minus 1, assuming that the oldest child was born 1 year after marriage;[58] (4) a dummy variable (defined for men married at the time) that takes the value 1 if polygynous and equals 0 if monogamous; and (5) a dummy variable (defined for male HH heads) that takes the value 1 if the HH head owns at least one female slave.

Our main explanatory variable is occupation status, where we classify the occupational titles into four categories:[59] (1) white-collar workers (11 per cent), which include professionals (e.g. physicians, engineers, and teachers), bureaucrats, military, police, judiciary, clergy, rural elites (e.g. village headmen), and merchants; (2) artisans (8 per cent; e.g. weavers and carpenters), (3) farmers (64 per cent), which include small landholders (peasantry), sharecroppers, and agricultural laborers; and (4) unskilled non-farmer workers (17 per cent; e.g. porters). We observe the occupational title for men but not for women (except those working in low-status occupations such as servants and slaves). We thus impute the occupational title for married women by assigning to them the husband's occupation. We do not impute the occupational status for non-married women. Small changes in our occupational categories do not change our result (appendix E.9).

While occupations are not a perfect measure of income, they are increasingly used in the economic history literature due to the absence of information on income in historical censuses.[60] We lack an independent source on income by occupation for Ottoman and nineteenth-century Egypt. However, two pieces of evidence boost our confidence that our occupational categories are correlated with income, with white-collar workers being the richest and unskilled non-farmer workers the poorest. First, evidence on income by occupation from medieval Egypt by Ashtor – which is available for a subset of occupations – suggests that bureaucrats and merchants earned more than

[58] This estimate is subject to certain shortcomings, as we discuss in appendix A.1. These concerns are mitigated in Equation (1), though, because we are interested in the occupational differences in— rather than the levels of—age at marriage. For robustness, we also created alternative measures of age at marriage, and we present the results in appendix E.

[59] In appendix A.3, we list the top occupational titles under each category.

[60] A large body of literature in US economic history employs occupations as a measure of income by assigning the average income for each occupation title to all individuals observed with this occupation (e.g. Abramitzky, Boustan, and Eriksson, 'Europe's tired'). The average income by occupation is either based on an independent contemporaneous survey on wages by occupation or estimated from the 1940 census, the first US census to include information on income.

artisans, who earned more than farmers and unskilled workers.[61] Second, our categorization is based on HISCLASS, a standard classification of occupations that is widely used in the economic history literature, based on the skill content of each occupation (e.g. manual vs. non-manual) among other criteria.[62]

We control for a full set of village fixed effects (α_q)[63] to account for the spatial differences in fertility and marriage as shown in appendix figure A5, and a dummy variable for the 1868 census (β_t) to account for the aggregate changes in outcomes between 1848 and 1868. The control vector X includes: age measured by a full set of 10-year age bin indicators, spouse's age (for married individuals) measured by a full set of 10-year age bin indicators,[64] and dummies for Coptic Christians,[65] migrants (born outside village of residence), foreigners (e.g. Turkish), and belonging to a Bedouin Arab tribe. The standard errors are White–Huber heteroskedasticity-robust, although the results are robust to using standard errors clustered at the village level as shown in appendix E.4, and to spatial correlation across villages as shown in appendix E.8.

Tables 3 and A3 show our findings for fertility. Column 1 reports the fertility differences across occupations using the sample of all men, both married and unmarried. Consistent with the Malthusian prediction on the positive correlation between income and fertility, we find that white-collar men, presumably the richest on average, had higher fertility than men in any other occupation: They have 0.07 more children aged 0–1.5 years than unskilled men, amounting to 32 per cent of the sample average. We also find that artisans, farmers, and unskilled workers exhibited similar fertility rates. While this null finding is not surprising for unskilled workers and farmers, who likely had similar income levels, the fact that artisans did not have a higher fertility rate is surprising.

The positive correlation between income and fertility incorporates the effects from both the intensive margin, via marital fertility, and the extensive margin, via regulating marriage. To investigate the relative contribution of the intensive margin, we study marital fertility among married individuals in columns 2–4. Again, consistent with the Malthusian prediction, we find no statistically significant difference in marital fertility across occupations. This suggests that the higher fertility of white-collar men in column 1 is not driven by the intensive margin. This is also consistent with the finding that European couples were not aiming for certain family sizes, which suggests the lack of control over fertility once people married.[66]

Finally, we fail to detect differences across Muslims and Coptic Christians with respect to men's overall fertility or marital fertility. This suggests that religious affiliation, as a system of beliefs, played little role in driving fertility decisions.

If marital fertility played less of a role in driving the higher fertility of white-collar men, can we explain the latter by differences in marriage patterns across occupations? We present the results for marriage outcomes, the extensive margin of fertility, in tables 4 and A4.[67] Column 1 shows

[61] Ashtor, *Histoire des prix*.

[62] See the online appendix of Saleh, 'The reluctant', for further details on the manual assignment process of HISCO occupational codes to the Arabic occupational titles that are observed in the 1848 and 1868 census samples, and the subsequent HISCLASS classification.

[63] This is Egypt's third administrative level in rural provinces, below the province and the district.

[64] We do not measure spouse's age for polygynous men, because they have more than one wife.

[65] Almost all non-Coptic Christians and Jews lived in Cairo and Alexandria – Egypt's two largest cities – and are thus excluded from our analysis.

[66] Clark, Cummins, and Curtis, 'Twins support'.

[67] For the binary variables, we find similar results using a logit regression in appendix E.7.

TABLE 3 Occupational differences in fertility

	(1) All men	(2) Monogamous women	(3) Polygamous men	(4) Polygamous women
= 1 if a farmer	−0.016	−0.013	0.253	0.058
	(0.018)	(0.026)	(0.319)	(0.099)
= 1 if an artisan	0.012	−0.010	0.270	−0.007
	(0.026)	(0.035)	(0.384)	(0.177)
= 1 if white collar	0.068***	0.003	0.209	0.092
	(0.025)	(0.033)	(0.344)	(0.119)
= 1 if Coptic Christian	0.005	0.030	−0.409	−0.327
	(0.026)	(0.037)	(0.473)	(0.285)
Census year FE	Yes	Yes	Yes	Yes
Age FE	Yes	Yes	Yes	Yes
Spouse age FE	No	Yes	No	Yes
Other controls	Yes	Yes	Yes	Yes
Village FE	Yes	Yes	Yes	Yes
Observations	11 391	6930	531	1210
Adj-R^2	0.080	0.057	0.112	0.063
Average dependent variable	0.218	0.319	0.567	0.274
p-value artisan–farmer	0.231	0.930	0.961	0.688
p-value white collar–farmer	0.000	0.567	0.832	0.677
p-value white collar–artisan	0.048	0.716	0.855	0.555

Notes: The dependent variable is the number of surviving children aged 0–1.5 years who co-resided with their parent(s) at the time of the census. White–Huber robust standard errors are in parentheses.
The sample is restricted to free Muslim and Coptic men (resp. women) aged 15–64 (resp. 15–54) years who resided in rural Egypt. The omitted category for occupation is unskilled non-farmer workers. The omitted category for religion is Muslim. Other controls are dummies for migrants, foreigners, and Bedouins. In column 1, the sample includes all men, whether married or not. In column 2, the sample is restricted to women in monogamous marriages. In column 3, the sample is restricted to men in polygynous marriages. In column 4, the sample is restricted to women in polygynous marriages. All regressions are weighted by the inverse probability of sampling. The full table is available in appendix D.
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.
Source: The 1848 and 1868 population census samples.

that white-collar men had the highest probability of being married, followed by artisans, farmers, and unskilled non-farmer workers. In terms of magnitude, the proportion married among white-collar men is 5.6 percentage points higher than among unskilled workers, which amounts to 9 per cent of the proportion married in the population.

Column 3 demonstrates that white-collar couples had the lowest female age at marriage: women married to white-collar workers 1.3 years younger than women married to unskilled non-farmer men. The coefficient for white-collar men in column 2 is also negative in sign but statistically insignificant. Appendix table A6 shows that the results for both sexes are robust to changes in the way we define the age at marriage. Furthermore, when we compute in appendix table A7 the singulate age at marriage by occupation using the methodology by Hajnal, we find

TABLE 4 Occupational differences in marriage

	= 1 if married at the time	Age at marriage		= 1 if polygamous	= 1 if owns a female slave
	(1)	(2)	(3)	(4)	(5)
	Men	**Men**	**Women**	**Married men**	**Male HH head**
= 1 if a farmer	−0.022	−0.953	−0.482	−0.004	0.000
	(0.014)	(0.877)	(0.540)	(0.011)	(0.005)
= 1 if an artisan	0.033	1.865	0.347	0.014	0.006
	(0.022)	(1.555)	(0.869)	(0.016)	(0.007)
= 1 if white collar	0.056***	−0.061	−1.317**	0.103***	0.060***
	(0.017)	(1.069)	(0.629)	(0.018)	(0.012)
= 1 if Coptic Christian	0.035	−0.734	−0.750	−0.055***	
	(0.026)	(1.434)	(0.828)	(0.012)	(0.015)
Age FE	Yes	No	No	Yes	Yes
Census year FE	Yes	Yes	Yes	Yes	Yes
Other controls	Yes	Yes	Yes	Yes	Yes
Village FE	Yes	Yes	Yes	Yes	Yes
Observations	11 391	2893	2906	7232	6271
Adj-R^2	0.317	0.115	0.140	0.069	0.274
Average dependent variable	0.625	34.874	24.937	0.074	0.012
p-value artisan–farmer	0.007	0.062	0.321	0.253	0.435
p-value white collar–farmer	0.000	0.341	0.123	0.000	0.000
p-value white collar–artisan	0.302	0.221	0.056	0.000	0.000

Notes: White–Huber robust standard errors are in parentheses.
The sample is restricted to free Muslim and Coptic women and men aged 15–64 years who resided in rural Egypt. The omitted category for occupation is unskilled non-farmer workers. The omitted category for religion is Muslim. Other controls are dummies for migrants, foreigners, and Bedouins. In column 1, the sample includes all men. In columns 2–3, the sample is restricted to men and women in monogamous marriages with at least one child ≤7 years, respectively. In column 4, the sample is restricted to married men. In column 5, the sample is restricted to male HH heads. All regressions are weighted by the inverse probability of sampling. The full table is available in appendix D.
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.
Source: The 1848 and 1868 population census samples.

that women married to white-collar men have the lowest age at marriage in both 1848 and 1868, in comparison to women married to artisans, farmers, and unskilled workers.[68]

These results suggest that the higher fertility of white-collar men relative to other occupations is partially attributable to their higher probability of marriage, and to the lower age at marriage of their wives. By contrast, both farmers and artisans did not have significantly different fertility from unskilled workers, probably because their marriage patterns did not significantly differ from the latter.

Next, we investigate whether polygyny and female slave ownership were more widespread among white-collar men. Column 4 reveals that, among married men, white-collar men were

[68] Hajnal, 'European marriage'.

(unsurprisingly) far more likely to be polygynous than unskilled non-farmer workers by 10 percentage points (the sample average polygyny rate is 7 per cent). Examining the occupational titles of polygynous white-collar men reveals that they were mostly village headmen. However, we fail to detect differences in the polygyny rate across artisans, farmers, and unskilled workers, which suggests that only white-collar men could afford to have multiple wives.[69] However, we issue a cautionary note in interpreting the polygyny results because we only observe polygyny if the polygynous wives are co-residing within the same HH of their husband. This can either overestimate or underestimate the differences in the polygyny rate across occupations, depending on the inter-occupation differences in the residence norm of the second (and subsequent) wife.[70]

We find similar results for the ownership of female slaves in column 5: White-collar male HH heads were far more likely to own female slaves than male HH heads in other occupations. These female slaves were mostly domestic servants, and could be legitimate concubines to their male masters, by Islamic law. Similar to our findings for polygyny, we detect no differences in female slave ownership across the other occupations, suggesting that it was mostly confined to white-collar workers.

Similar to our null finding on religious affiliation and fertility in table A3, we fail to find statistically significant differences across Muslims and Copts with respect to the probability of marriage, the age at marriage, and female slave ownership. However, Coptic Christians had a lower polygyny rate, which is not surprising given that, like the Catholic Church, the Coptic Church prohibited polygyny but not slavery. Overall, these null results suggest that religious affiliation did not affect the individual decision-making of fertility and marriage conditional on the available demographic institutions. However, religious affiliation did affect the available demographic institutions themselves – in Egypt's case the institution of polygyny.

We conducted a number of robustness checks that we describe in appendix E. We first allowed for heterogeneity in the occupation–fertility relationship, by age group and by polygyny status in appendix E.1. Second, we employed alternative measures for age at marriage in appendix E.2 and for fertility – using number of surviving children below 5 – in appendix E.3. Third, we clustered the standard errors at the village level in appendix E.4. Fourth, we removed the location fixed effects (FE) to capture the overall correlation between occupation and fertility – both within and across villages – in appendix E.5. Fifth, we dropped all observations with ambiguous matchings to partners or to children in appendix E.6. Sixth, we estimated a Logit regression for the binary outcomes in appendix E.7. Seventh, to account for the potential spatial correlation across villages in our data, we report the Conley standard errors in appendix E.8. We also estimated a spatial autoregressive model with spatial autoregressive standard errors (SARAR) at the village level. Finally, we broke down the farmers category in our data into small landholders, agricultural workers, and sharecroppers in appendix E.9.

Having shown that white-collar men were more likely to be polygynous and to purchase female slaves, we turn to investigating whether polygyny and female slave ownership contributed to the higher fertility of white-collar men. Conceptually, both institutions could differentially increase the fertility of rich men, unlike in Western Europe, where the rich had no access to such institutions. Furthermore, polygyny may reduce the marriage rate among poorer men who may not be able to marry due to the lower supply of women. The opposite is true for slavery. While female

[69] The positive correlation between resources and polygyny is consistent with evidence from preindustrial China (Feng and Wang, *One quarter*) and small scale societies (Mulder, 'Kipsigis women's'; Hames, 'Costs and benefits').

[70] For example, white-collar men could afford to have big enough houses that could accommodate all their wives. But they could also afford to have a separate house for each wife.

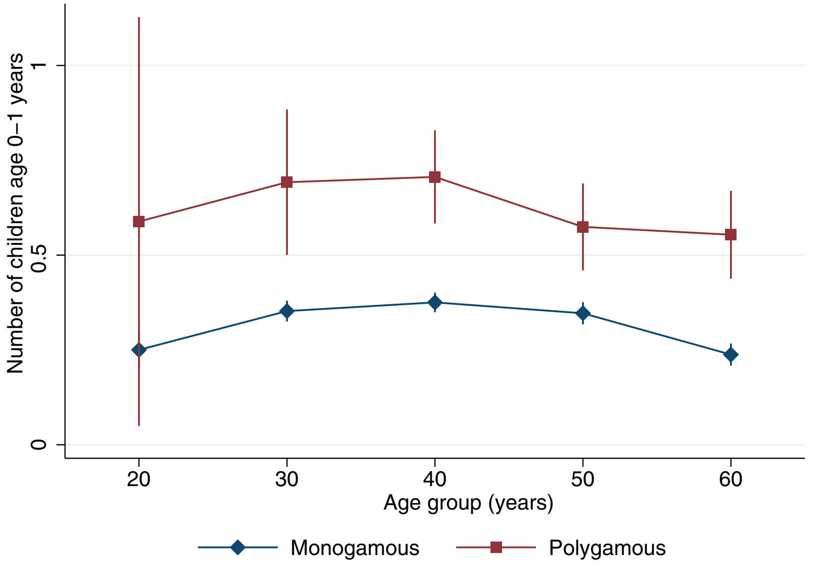


FIGURE 3 Male marital fertility by marriage type. *Notes*: The plotted numbers are based on the regression of the number of children aged 0–1.5 years on a full set of interactions of the 10-year age bracket fixed effects with a dummy variable that takes the value 1 for polygynous men and 0 for monogamous men. We control for the 1868 census year fixed effect, village fixed effects, a dummy variable for being Coptic Christian, a dummy variable for being an immigrant, a dummy variable for being a foreigner, and a dummy variable for being Bedouin. The 95 per cent confidence intervals are based on White–Huber heteroskedasticity-robust standard errors. The sample is restricted to married free rural Coptic and Muslim men aged 15–64 years. All regressions are weighted by the inverse probability of sampling. *Source:* The 1848 and 1868 population census samples. [Colour figure can be viewed at wileyonlinelibrary.com]

slaves were imported from the Nilotic Sudan, meaning that slavery did not mechanically alter the supply of Egyptian women, female slave ownership could increase the marriage rate among poorer men if it acted as a substitute for marriage among the rich.

We first show that female slave ownership did not increase the fertility of white-collar men, and hence it did not act as a (perfect) substitute for marriage. Female slaves had a total fertility rate of 2.8, which is much lower than the total fertility in the non-slave female population of 6.1. This suggests that, contrary to marital relationships, male slave owners controlled their fertility within the master–slave sexual relationship. While this may speak to the low rates of illegitimate children seen in Western Europe, at roughly 2–4 per cent of all live births before 1800, we emphasize that the master–slave sexual relationship in Egypt was considered legitimate from the Islamic law viewpoint, and the resulting offspring were free.[71] Hence, unlike Western Europe, the fertility control within the master–slave relationship in Egypt may have been driven by racism – the social stigmatization of the offspring of black female slaves – rather than illegitimacy concerns. This probably triggered owners of female slaves to prefer to have (male) heirs from their free wives rather than their female slaves.

Next, we examine whether polygyny contributed to the higher fertility of white-collar men. We plot the average male fertility by age bracket for monogamous and polygynous men in figure 3. Polygynous men consistently had more children than monogamous men at all age brackets.

[71] Flinn, *The European*.

Because white-collar men were over-represented among polygynous men, this figure suggests that polygyny contributed to the higher fertility of white-collar men.

As figure 3 includes men with more than two wives, it shows that the fertility per wife among polygynous men was lower than that of monogamous men. This is similar to findings from China, where polygynous men out-bred monogamous men by only 20–30 per cent, although fertility among polygynous men was higher in Egypt.[72]

There are two potential reasons for the lower fertility per woman under polygyny. First, the first wife may have been less fertile, and polygyny was thus (at least partially) motivated by the husband's attempt to secure an heir by marrying a second wife. This explanation has been hypothesized in the cases of Istanbul and Albania in the nineteenth and twentieth centuries.[73] The second explanation is that polygynous men did not simultaneously engage in sexual relationships with all of their wives, leading to lower fertility per woman. This explanation has been hypothesized in the case of China.[74] Unfortunately, the data do not enable us to distinguish between these two mechanisms, because we observe neither the timing of marriage nor the existence of sexual relationships in marriages.[75]

We next estimate the relative contributions of polygyny and the age-specific marriage rate in driving the higher fertility of white-collar men. Our approach is to compare the male general fertility rate (GFR) by occupation for all men, married men (monogamous and polygynous), and monogamous men. Then, we can attribute the difference in GFR between monogamous men and all married men to the effect of polygyny. The difference between married men and all men can be attributed to the age-specific marriage rates.

To estimate the male GFR by occupation, we use the predicted male fertility rate using an individual-level regression, where we allow the coefficient of each occupational indicator in Equation (1) to vary by age:

$$Y_{i,q,t} = \alpha_q + \theta_t + \sum_{o,a} \beta_{1,o,a} occupation_o \times agegroup_a + \gamma Z + \epsilon_i \tag{2}$$

where $Y_{i,q,t}$ is the number of children aged 0–1.5 years, and $agegroup_a$ is a full set of 10-year age brackets fixed effects. The control vector Z includes dummies for Coptic Christians, migrants, foreigners, and Bedouins includes = 1 if Coptic Christian, = 1 if a migrant, = 1 if a foreigner, and = 1 if Bedouin. The other variables are defined as in Equation (1).

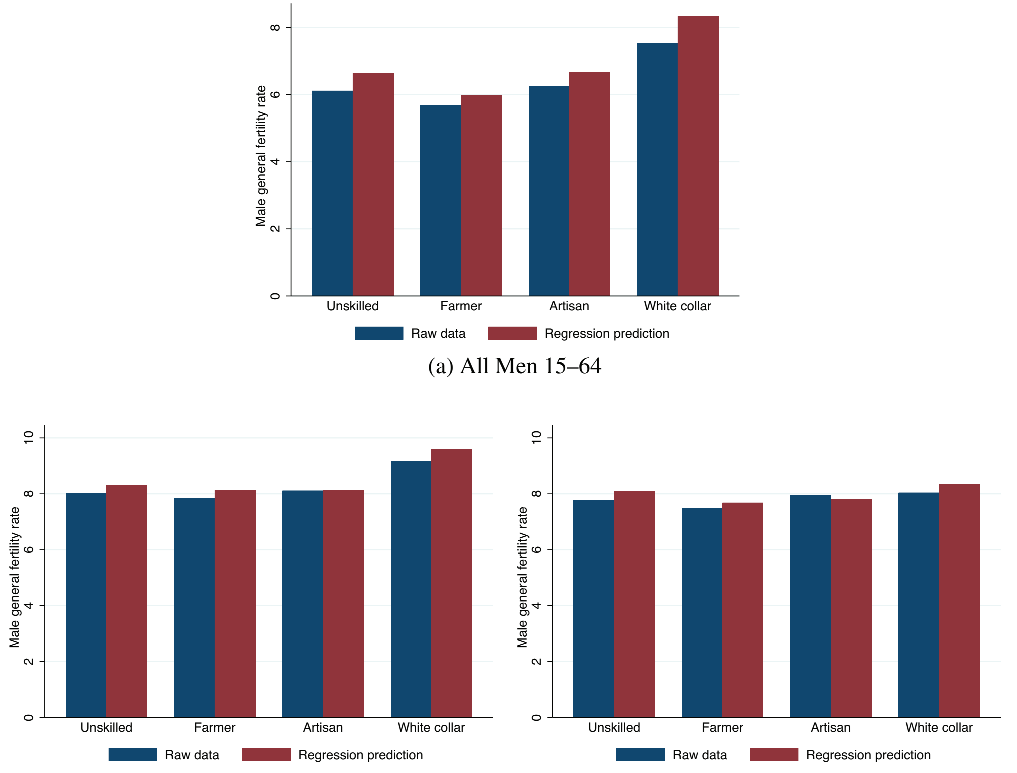
We first estimate Equation (2) for all men. We then use the regression estimates to predict the male fertility by occupation and age group, holding the other controls at the average value. Similar to the aggregate-level GFR estimation, we adjust the predicted age-specific fertility by accounting for male mortality using El-Shanawany's life table, the unobserved births, and the unmatched

[72] Feng and Wang, *One quarter*.

[73] Behar, 'Polygyny in Istanbul', and Nicholson, 'Women who shared'.

[74] Feng and Wang, *One quarter*.

[75] Table A2 in appendix C shows the results of estimating Equation (1) for female fertility, when controlling for a dummy variable that takes the value 1 if the woman is the oldest wife in a polygynous marriage (as a proxy for the first wife) and a dummy variable that takes the value 1 for younger wives; the omitted group consists of monogamous women. We find that the oldest wife in polygynous marriages had 0.24 fewer births than monogamous wives, whereas younger wives had 0.11 more births, which is consistent with both mechanisms. However, these results can be mechanically driven by our procedure of assigning children of polygamous marriages to the mother with the smallest mother–child age difference.



(a) All Men 15–64

(b) Married men 27–64 years

(c) Monogamous men 27–64 years

FIGURE 4 Male general fertility rate by occupation. The sample is restricted to free Muslim and Coptic men aged 15–64 years (27–64 years in (b) and (c)) who resided in rural Egypt. The regression predictions are based on Equation (2). The numbers underlying this figure are shown in appendix table A1. [Colour figure can be viewed at wileyonlinelibrary.com]

children.[76] We compare the regression-based male GFR with the male GFR that is based on the observed sample mean fertility by occupation and age group.

Figure 4a, which replicates the results in column 1 in table 3, shows that white-collar men significantly out-bred men in all the other occupations; they had approximately 2.1 more children – or 33 per cent higher fertility – on average than men in other occupations. Next, we measure the relative contributions of the age-specific marriage rate and the age-specific polygyny rate in driving the higher fertility of white-collar men. To this end, we re-estimate Equation (2) for the sample of monogamous men, as well as for the sample of married men, whether polygynous or monogamous. Two remarks are in order. First, we are not able to estimate Equation (2) for polygynous men separately, due to the small number of observations in each occupation and age cell. Second, we limit the sample to men aged 27–64 years, because the male singulate mean age at marriage in 1848 and 1868 is about 27 years.

Figure 4c shows that the GFR is 8 children among monogamous men, and that it is largely similar across occupations. This confirms our findings in table 3 that marital fertility within monogamous marriages is not driving the higher fertility of white-collar men. However, when

[76] El-Shanawany, 'The first'.

we limit our sample to all married men in figure 4b, we find that the GFR of white-collar men is 9.2 children, whereas men in all the other occupations remain at close to 8 children. This implies that white-collar men had 15 per cent higher fertility than men in other social classes. These findings are in line with the finding that 17 per cent of married white-collar men were polygynous, compared with only 7 per cent among married men in other occupations. Since the difference in overall fertility between white-collar men and men in other occupations in figure 4a was 33 per cent, this suggests that 45 per cent of the overall difference can be explained by polygyny, whereas the remaining 55 per cent can be explained by age-specific marriage rates.

These findings show that fertility was positively correlated with occupational status, but the latter does not capture the income heterogeneity within each class. Some white-collar men may have earned higher incomes than others within the same occupation. Some village headmen's incomes may have been too low for leading a polygynous lifestyle, while others had this option. If this is true, our measure may underestimate the steepness of the income–fertility curve. Overall, the analysis shows the effect of polygyny – which was only available among the rural middle class – meant the male income–fertility curve was flat for a large share of the rural population, but there was a steep increase as we get to the richest among them.

Finally, could polygyny have increased the population in the Egyptian rural society as a whole, leading to lower average income? If so, the effect would be through the marriage rate of polygynous women and the degree to which they had outside options to marry.[77] As it is not possible to know the outside option, we instead look at the upper-bound and lower-bound cases of the effect of polygyny on fertility.

If we assume women in polygynous marriages would not have married – an upper-bound case – given that 8 per cent of married women were second (or subsequent) wives, the overall effect of polygyny would be to increase population by up to 8 per cent. A lower-bound case is to assume women would have married unskilled workers. As women married 1.3 years earlier to white-collar men relative to unskilled men, this would mean 0.4 fewer children over their lifetime. This is 7 per cent of the general fertility rate, and given that only 8 per cent of the population would have experienced this decline, the overall effect of polygyny is about a 0.6 per cent increase in population.

If we believe that a majority of women had an outside option to marry unskilled workers, the overall effect of polygyny would have been to increase population by a few percentage points. While not a trivial effect, this is unlikely to have significantly pushed down Egyptian wages via population pressure. Hence, the main factor that was increasing Malthusian pressure was the aggregate pattern of high marital fertility, low female age at marriage, and the high marriage rate among women. Within the Malthusian framework, the main effect of polygyny was in making the Malthusian fertility–income curve steeper via richer men significantly out-breeding the poor.

VI | CONCLUSION

This paper had two objectives. First, we introduced novel aggregate-level estimates of marriage and fertility for rural Egypt based on the individual-level population census samples of Egypt in 1848 and 1868 that were digitized by Saleh.[78] Our estimates precede the demographic estimates for Egypt that are available in the literature by almost a century and are the first for any pre-industrial

[77] Becker, 'A theory'.

[78] Saleh, 'A pre-colonial'.

population in the MENA region. We documented that rural Egypt women had a high total marital fertility rate that was similar to pre-industrial Western Europe, combined with a low age at marriage and almost universal marriage (whereby all but 6 per cent of women married by the age of 45 years) that was similar to pre-industrial East Asia.[79] Combining these characteristics, Egypt had a unique marriage pattern yielding the highest total fertility rate among societies studied in the literature. This was probably offset by an exceptionally high infant and child mortality in Egypt.

Second, we used the individual-level census data to test two implications of the Malthusian model: the positive elasticity of fertility with respect to income, and the hypothesis that people regulated their fertility via regulating marriage, rather than controlling births within marriage. Egypt, and MENA at large, had two distinct demographic institutions that differed from Western Europe: polygyny and female slave ownership. These institutions can alter the Malthusian equilibrium by enabling richer men to increase their fertility by having multiple wives or by owning female slaves. Consistent with the Malthusian predictions, we found that white-collar men had higher fertility than artisans, farmers, and unskilled workers and that marital fertility did not differ across occupations. Instead, the higher fertility of white-collar men emerged from their higher age-specific marriage rate and the lower age at marriage of their wives. Furthermore, we found that polygyny allowed males to almost double their fertility and that the substantial advantage in fertility given by polygyny explains more than 45 per cent of the fertility differentials between white-collar men and other social classes. This is surprising because fertility differentials by income in Western Europe were mostly generated by differences in age at marriage and in the marriage rate. Instead, we find the positive gradient in the Egyptian fertility–income curve was also generated by polygyny. However, we also found that female slavery did not play an important role in the Malthusian equilibrium, as female slaves, who could be concubines to their male masters, had lower fertility than free women. Therefore, this institution was not functioning as a substitute to marriage. We also found that religion did not affect fertility or marriage choices. The one exception was that Coptic Christians did not enter into polygynous marriages because polygyny was prohibited by the Coptic Church.

We believe that the findings in this paper may have important implications for the region as a whole. At the aggregate level, the region may have had a similarly high fertility pattern. The high fertility regime itself may have therefore played an important role in explaining the region's relatively low wages.[80] At the individual level, polygyny was practised widely in this region, ranging from 4 to 15 per cent among married man.[81] As polygyny was generally practised by the rich, it may have played an important role in driving the fertility differentials between the rich and the poor.

The paper opens two areas of future research. First, the differing demographic institutions between the MENA region, Western Europe, and East Asia, goes beyond what has been explored in this paper. One unexplored institution that may have affected fertility is divorce. Although we do not directly observe divorce in the census data, it was extremely common in the 1930s, when up to one third of marriages ended in divorce.[82] Divorce could have had two effects. First, it could reduce female fertility due to the early stopping of fertility. Second, if divorce was partially motivated by infertility, much like in Japan, divorce could affect the gradient of the fertility–income

[79] Hajnal, 'European marriage'; Lee and Campbell, 'Fate and fortune'; Kurosu, Tsuya, and Hamano, 'Regional differentials'; Feng and Wang, *One quarter*, and Ochiai, 'Rekishi teki'.

[80] Ozmucur and Pamuk, 'Real wages', and Pamuk and Shatzmiller, 'Plagues, wages'.

[81] Chamie, 'Polygyny among Arabs', and Fargues, 'Terminating marriage'.

[82] Fargues, 'State policies'.

curve: Richer men with infertile wives may have divorced and remarried to have children, whereas poorer men would find it harder to divorce and find a new marriage partner.[83] This could have been a further channel leading to the rich out-breeding the poor. Whether divorce led to a further difference in the Malthusian equilibrium remains a question for future study.

Second, we regard this paper as the first step in a research agenda aiming at documenting the historical demographic facts about the pre-industrial MENA region. For example, it is possible to construct a life table for Egypt using the two censuses of 1848 and 1868. It is also possible to document inter-racial differences in fertility, age at marriage, and mortality. We leave these exciting areas to future research.

ACKNOWLEDGEMENTS

We are grateful to David Hacker and Steven Ruggles for very useful comments. We benefitted from presenting earlier versions of this paper at the 19th Annual St. Shenouda-UCLA Conference, Association for the Study of Religion, Economics, and Culture (ASREC), Economic History Society, Toulouse Economics and Biology Workshop, Institut National d'Etudes Démographiques (INED), African Economic History Network, Social Science History Association (SSHA), Economic History Association, and Bocconi University. We acknowledge IAST funding from Agence Nationale de la Recherche (ANR) under grant ANR-17-EURE-0010 (Investissements d'Avenir Program). We are grateful to the excellent research assistance by Xinyan Lao.

REFERENCES

Abramitzky, R., Boustan, L. P., and Eriksson, K., 'Europe's tired, poor, huddled masses: self-selection and economic outcomes in the age of mass migration', *American Economic Review*, 102 (2012), pp. 1832–56.

Ager, P., Herz, B., and Brueckner, M., 'Structural change and the fertility transition', *Review of Economics and Statistics*, 102 (2020), pp. 806–22.

Ashtor, E., *Histoire des prix et des salaires dans l'orient médiéval* (Paris, 1969).

Austen, R., 'The Mediterranean Islamic slave trade out of Africa: a tentative census', in E. Savage, ed., *The human commodity: Perspectives on the trans-Saharan slave trade* (1992), pp. 214–48.

Becker, G. S., 'A theory of marriage: part II', *Journal of Political Economy*, 82 (2, Part 2) (1974), pp. S11–S26.

Behar, C., 'Polygyny in Istanbul, 1885–1926', *Middle Eastern Studies*, 27 (1991), pp. 477–86.

Blayo, Y., 'La mortalité en France de 1740 à 1829', *Population*, 30(1) (1975), pp. 123–42.

Boberg-Fazlic, N., Sharp, P., and Weisdorf, J., 'Survival of the richest? Social status, fertility and social mobility in England 1541–1824', *European Review of Economic History*, 15(3) (2011), pp. 365–92.

Bourbou, C., Fuller, B. T., Garvie-Lok, S. J., and Richards, M. P., 'Nursing mothers and feeding bottles: reconstructing breastfeeding and weaning patterns in Greek Byzantine populations (6th–15th centuries AD) using carbon and nitrogen stable isotope ratios', *Journal of Archaeological Science*, 40 (2013), pp. 3903–13.

Chamie, J., 'Polygyny among Arabs', *Population Studies*, 40(1) (1986), pp. 55–66.

Chatterjee, S. and Vogl, T., 'Escaping Malthus: Economic growth and fertility change in the developing world', *American Economic Review*, 108 (2018), pp. 1440–67.

Chen, S., Lee, J., and Campbell, C., 'Wealth stratification and reproduction in Northeast China, 1866–1907', *History of the Family*, 15(4) (2010), pp. 386–412.

Choy, K., Jeon, O.-R., Fuller, B. T., and Richards, M. P., 'Isotopic evidence of dietary variations and weaning practices in the Gaya cemetery at Yeanri, Gimhae, South Korea', *American Journal of Physical Anthropology*, 142(1):7, (2010), pp. 4–84.

Clark, G., *A farewell to alms: a brief economic history of the world* (Princeton, 2008).

Clark, G. and Cummins, N., 'Intergenerational wealth mobility in England, 1858–2012: Surnames and social mobility', *Economic Journal*, 125(582) (2015), pp. 61–85.

[83] Fuess, *Divorce in Japan*.

Clark, G., Cummins, N., and Curtis, M., ‘Twins support the absence of parity dependent fertility control in pretransition populations’, *Demography*, 57(4) (2020), pp. 1571–95.

Clark, G. and Hamilton, G., ‘Survival of the richest: the Malthusian mechanism in pre-industrial England’, *Journal of Economic History*, 66 (2006), pp. 707–36.

Cummins, N., ‘The micro-evidence for the Malthusian system. France, 1670–1840’, *European Economic Review*, 129 (2020), pp. 1–22.

Daly, M. W., Daly, M., and Petry, C. F. E., *The Cambridge history of Egypt*, volume 2 (Cambridge, 1998).

De La Croix, D. and Mariani, F., ‘From polygyny to serial monogamy: a unified theory of marriage institutions’, *Review of Economic Studies*, 82(2) (2015), pp. 565–607.

De La Croix, D., Schneider, E. B., and Weisdorf, J., ‘Childlessness, celibacy and net fertility in pre-industrial England: the middle-class evolutionary advantage’, *Journal of Economic Growth*, 24(3) (2019), pp. 223–56.

De Moor, T. and Van Zanden, J. L., ‘Girl power: the European marriage pattern and labour markets in the North Sea region in the late medieval and early modern period’, *Economic History Review*, 63 (2010), pp. 1–33.

Dennison, T. and Ogilvie, S., ‘Does the European marriage pattern explain economic growth?’, *Journal of Economic History*, 74 (2014), pp. 651–93.

Dribe, M. and Scalone, F., ‘Socioeconomic class and net fertility before, during, and after the demographic transition: a micro-level analysis of Sweden 1880–1970’, *Demographic Research*, 30 (2014), pp. 429–64.

El-Shanawany, M., ‘The first national life tables for Egypt’, *L’Egypte Contemporaine*, 162 (1936), pp. 209–69.

Fargues, P., ‘Un siecle de transition démographique en Afrique Méditerranéenne 1885–1985’, *Population (French edition)*, 41(2) (1986), pp. 205–32.

Fargues, P., ‘State policies and the birth rate in Egypt: from socialism to liberalism’, *Population and Development Review*, 23(1) (1997), pp. 115–38.

Fargues, P., ‘Terminating marriage’, in N. S. Hopkins, ed., *The new Arab family* (Cairo, 2001), pp. 247–73.

Fargues, P., ‘Family and household in mid-nineteenth-century Cairo’, in B. Doumani, ed., *Family history in the Middle East* (New York, 2003), pp. 23–50.

Feng, W., Lee, J., and Campbell, C., ‘Marital fertility control among the Qing nobility: implications for two types of preventive check’, *Population Studies*, 49(3) (1995), pp. 383–400.

Feng, W., and Wang, F., *One quarter of humanity: Malthusian mythology and Chinese realities, 1700–2000* (Cambridge, MA, 2001).

Flinn, M. W. *The European demographic system, 1500–1820* (Baltimore, MD, 1985).

Fochesato, M., ‘Origins of Europe’s north-south divide: population changes, real wages and the ‘little divergence’ in early modern Europe’, *Explorations in Economic History*, 70 (2018), pp. 91–131.

Foreman-Peck, J., ‘The western European marriage pattern and economic development’, *Explorations in Economic History*, 48 (2011), pp. 292–309.

Fuess, H., *Divorce in Japan: family, gender, and the state, 1600–2000* (Stanford University Press, 2004).

Galloway, P. R., ‘Basic patterns in annual variations in fertility, nuptiality, mortality, and prices in pre-Industrial Europe’, *Population Studies*, 42(2) (1988), pp. 275–303.

Giladi, A., ‘Breast-feeding in medieval Islamic thought: a preliminary study of legal and medical writings’, *Journal of Family History*, 23(2) (1998), pp. 107–23.

Gray, J. P., ‘Ethnographic atlas codebook’, *World Cultures*, 10(1) (1998), pp. 86–136.

Greif, A., ‘Family structure, institutions, and growth: the origins and implications of western corporations’, *American Economic Review Papers & Proceedings*, 96 (2006), pp. 308–12.

Greif, A. and Tabellini, G., ‘Cultural and institutional bifurcation: China and Europe compared’, *American Economic Review Papers & Proceedings*, 100 (2010), pp. 135–40.

Guinnane, T. W., ‘The historical fertility transition: a guide for economists’, *Journal of Economic Literature*, 49 (2011), pp. 589–614.

Guinnane, T. W. and Ogilvie, S., ‘Institutions and demographic responses to shocks: Württemberg, 1634–1870’, Yale University Economic Growth Center Discussion Paper No. 962 (2008).

Hacker, J. D., ‘Rethinking the “early” decline of marital fertility in the United States’, *Demography*, 40 (2003), pp. 605–20.

Hajnal, J., ‘European marriage patterns in perspective’, in D. V. Glass, ed., *Population in history* (1965), pp. 101–44.

Hames, R., 'Costs and benefits of monogamy and polygyny for Yanomamo women', *Ethology and Sociobiology*, 17(3) (1996), pp. 181–99.

Haydock, H., Clarke, L., Craig-Atkins, E., Howcroft, R., and Buckberry, J., 'Weaning at Anglo-Saxon Raunds: implications for changing breastfeeding practice in Britain over two millennia', *American Journal of Physical Anthropology*, 151(4) (2013), pp. 604–12.

Henrich, J., Boyd, R., and Richerson, P. J., 'The puzzle of monogamous marriage', *Philosophical Transactions of the Royal Society B: Biological Sciences*, 367(1589) (2012), pp. 657–69.

Hu, S., 'Survival of the Confucians: marital fertility by status in China, 1400–1900', *Economic History Working Papers*, no. 307 (2020).

Kelly, M. and O'Grada, C., 'The preventive check in medieval and preindustrial England', *Journal of Economic History*, 72 (2012), pp. 1015–35.

Kurosu, S., Tsuya, N., and Hamano, K., 'Regional differentials in the patterns of first marriage in the latter half of Tokugawa Japan', *Keio Economic Studies*, 36(1) (1999), pp. 13–38.

Lagerlöf, N.-P., 'Malthus in Sweden', *Scandinavian Journal of Economics*, 117 (2015), pp. 1091–133.

Lane, E. W., *An account of the manners and customs of the modern Egyptians* (1846).

Lee, J. and Feng, W., 'Malthusian models and Chinese realities: Chinese demographic system 1700–2000', *Population and Development Review*, 25(1) (1999), pp. 33–65.

Lee, J. Z. and Campbell, C. D., *Fate and fortune in rural China: Social organization and population behavior in Liaoning 1774–1873* (Cambridge, 1997).

Lee, S. and Park, J. H., 'Quality over quantity: a lineage-survival strategy of elite families in premodern Korea', *Social Science History*, 43(1) (2019), pp. 31–61.

Madsen, J. B., Robertson, P. E., and Ye, L., 'Malthus was right: Explaining a millennium of stagnation', *European Economic Review*, 118 (2019), pp. 51–68.

Malthus, T. R., *An essay on the principle of population* (edition used = Cambridge, 1826).

Mesle, F. and Vallin, J, 'Reconstitution of annual life tables for nineteenth century France', *Population an English Selection*, 3 (1991), pp. 33–62.

Ministère de l'intérieur. Essai de statistique générale de l'Egypte: ann*é*es 1873, 1874, 1875, 1876, 1877 (Deux Volumes) (Typographie de l'Etat-Major Généralé Egyptien, Le Caire, Egypté, 1877).

Mulder, M. B., 'Kipsigis women's preferences for wealthy men: evidence for female choice in mammals?', *Behavioral Ecology and Sociobiology*, 27(4) (1990), pp. 255–64.

Nicholson, B., 'Women who shared a husband: Polygyny in southern Albania in the early 20th century', *History of the Family*, 11(1) (2006), pp. 45–57.

Nicolini, E. A., 'Was Malthus right? A VAR analysis of economic and demographic interactions in pre-industrial England', *European Review of Economic History*, 11(1) (2007), pp. 99–121.

Ochiai, E., 'Rekishi teki ni mita nihon no kekkon', *Kazoku shakaigaku kenkyu*, 15(2) (2004), pp. 39–51.

Ozmucur, S. and Pamuk, S., 'Real wages and standards of living in the Ottoman empire, 1489–1914', *Journal of Economic History*, 62 (2002), pp. 293–321.

Pamuk, S., 'Estimating economic growth in the Middle East since 1820', *Journal of Economic History*, 66 (2006), pp. 809–28.

Pamuk, Sÿ. and Shatzmiller, M., 'Plagues, wages, and economic change in the Islamic Middle East, 700–1500', *Journal of Economic History*, 74(1) (2014), pp. 196–229.

Pamuk, S., and Williamson, J. G., 'Ottoman de-industrialization, 1800–1913: assessing the magnitude, impact, and response', *Economic History Review*, 64 (2011), pp. 159–84.

Peirce, L. P., *The imperial harem: women and sovereignty in the Ottoman empire* (New York and Oxford, 1993).

Riley, J. C., 'The timing and pace of health transitions around the world', *Population and Development Review*, 31 (2005), pp. 741–64.

Ruggles, S., 'Marriage, family systems, and economic opportunity in the USA since 1850', in S. M. McHale, V. King, J. Van Hook, and A. Booth, eds., *Gender and couple relationships* (Cham, 2016), pp. 3–41.

Saito, O., 'Jinkō tenkan izen no nihon ni okeru mortality', *Keizai Kenkyu*, 43(3) (1992), pp. 248–67.

Saleh, M., 'A pre-colonial population brought to light: digitization of the nineteenth-century Egyptian censuses', *Historical Methods: A Journal of Quantitative and Interdisciplinary History*, 46(1) (2013), pp. 5–18.

Saleh, M., 'The reluctant transformation: state industrialization, religion, and human capital in nineteenth-century Egypt', *Journal of Economic History*, 75(1) (2015), pp. 65–94.

Saleh, M., 'The Middle East: decline and resurgence in West Asia', in S. Broadberry and K. Fukao, eds., *The Cambridge economic history of the modern world*, vol. 2, *1870–2010* (Cambridge, 2021), pp. 213–50.

Saleh, M., 'Trade, slavery, and state coercion of labor: Egypt during the first globalization era', Centre for Economic Policy Research Discussion Paper No. 14542 (2022).

Scheidel, W., 'A peculiar institution? Greco–Roman monogamy in global context', *History of the Family*, 14(3) (2009), pp. 280–91.

Statistics Sweden, *Population development in Sweden in a 250-year perspective* (1999).

Tomobe, K., 'Kinsei nihon nōson ni okeru shizen shusshōryoku suikei no kokoromi', *Jinkōgaku kenkyu*, 14 (1991), pp. 35–47.

Tsutaya, T., Nagaoka, T., Sawada, J., Hirata, K., and Yoneda, M., 'Stable isotopic reconstructions of adult diets and infant feeding practices during urbanization of the city of Edo in 17th century Japan', *American Journal of Physical Anthropology*, 153(4) (2014), pp. 559–69.

Voas, M. R., Killgrove, K., Tykot, R. H., Nyárádi, Z., Gonciar, A., and Bethard, J. D., 'Childhood in the Carpathians: an isotopic analysis of childhood diet and weaning in a medieval and early modern Transylvanian village', *Journal of Archaeological Science: Reports*, 38 (2021), 103046.

Voigtländer, N. and Voth, H.-J., 'How the West "invented" fertility restriction', *American Economic Review*, 103 (2013), pp. 2227–64.

Walz, T. and Cuno, K., 'Introduction: the study of slavery in nineteenth-century Egypt, Sudan, and the Ottoman Mediterranean', in T. Walz and K. M. Cuno, eds., *Race and slavery in the Middle East: Histories of Trans-Saharan Africans in nineteenth-century Egypt, Sudan, and the Ottoman Mediterranean* (Cairo, 2010), pp. 1–16.

Weir, D. R., 'Life under pressure: France and England, 1670–1870', *Journal of Economic History*, 44(1) (1984), pp. 27–47.

Wrigley, E. A., Davies, R. S., Oeppen, J. E., and Schofield, R. S., *English population history from family reconstitution 1580–1837* (Cambridge, 1997).

Yousef, T. M., 'Egypt's growth performance under economic liberalism: a reassessment with new GDP estimates, 1886–1945', *Review of Income and Wealth*, 48(4) (2002), pp. 561–79.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Kumon, Y. and Saleh, M., 'The Middle-Eastern marriage pattern? Malthusian dynamics in nineteenth-century Egypt', *Economic History Review*, (2023), pp. 1–28. https://doi.org/10.1111/ehr.13242