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ABSTRACT

Little Divergence in America — Market Access and Demographic Transition in the United States*

This paper assesses the causal impact of greater market access on demographic transition during the latter half of the 19th century in the United States. We construct new measures of fertility changes and measures of railroad access at the county level from 1850 – 1890. We are able to document market-access-induced changes in fertility due to both extensive margins (shifts in occupations with different average fertility rates) and intensive margins (changes in fertility within each occupation class). Both our theoretical model and empirical results suggest that declining fertility in counties mainly occurred through extensive margins. We further discover that fertility changes occurred mainly through strengthening patterns of specialization, rather than through greater industrialization or urbanization, suggesting that demographics diverged within the United States during this period.

JEL Classification: J11, J13, N11, N31

Keywords: demographic transition, market access, railroads, fertility, agricultural production, manufacturing production

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* All comments welcome.

1. Introduction

Societies undergoing development tend to experience a demographic transition, where households dramatically lower rates of fertility from pre-Industrial levels. The United States underwent its transition over the "long" nineteenth century (Haines 2000). The causes for this transition are still debated and continue to be an area of inquiry for economists and demographers (Guinnane 2011). Demographers posit changes in child mortality or the role of contraception as important, but many economists have placed more focus on the role of income and opportunity costs (direct or indirect) as key factors underlying the first demographic transition (Guinnane 2011). A related puzzle is why there was a widening of birth rates between regions and groups during the 19th century, with compression occurring only in the 20th century (Jones and Tertilt 2008). Any explanation regarding fertility declines over time would do well to also explain diverging fertility rates within the United States early on and converging fertility rates later on.

This paper attempts a more unified approach at understanding demographic transition in the United States by analyzing the fertility effects of greater market access. Specifically we measure access to markets by exposure to railway lines that were constructed throughout the latter half of the 19th century. Railroads could conceivably influence local demographic characteristics in a number of ways. One major force is greater industrialization – railroads can increase economic activity in marginally productive regions by attracting capital and people, fostering modernization and concomitant demographic changes (Hornbeck and Rotemberg 2019). One can imagine that this form of transition would generate compression in rates of fertility, as rural and marginally productive regions "catch up" with more urban and developed regions.

But there may be another major force at work — greater market access can increase the scope for trade and specialization. This would conceivably foster a divergence in fertility, as rural areas specialize in agriculture and other unskilled and child-intensive work.[1] Urban areas on the other hand would produce manufactured goods and other more skill-intensive products that could hasten demographic transition in those areas. Our paper seeks to explore if this feature of specialization outweighed the industrialization effects of greater market access, to account for BOTH the aggregate decline AND divergence of birth rates across the United States.

While there are many studies on the theoretical underpinnings of demographic

[1] As a more recent example, greater connectivity and access to information has been demonstrated to enhance agricultural productivity in erstwhile remote areas — see Jensen (2007), Aker (2010), and Goyal (2010).

transition (see for example Becker and Lewis 1973; Galor and Weil 2000; Doepke 2004; O'Rourke et al. 2013; Cervellati and Sunde 2015), and a fair number of empirical studies documenting the transition in Europe or around the world (see for example Easterlin 1975; Klemp and Weisdorf 2012; Guinnane 2011; Murtin 2013), there are surprisingly few studies focused specifically on the United States. Greenwood and Seshadri (2002) develop a model and calibrate it using U.S. data to assess the role of technological progress in fertility reductions. Jones and Tertilt (2008) is the first study to use U.S. census data on fertility and occupations, finding a robust and stable negative cross-sectional relationship between husband's income and fertility. This contrasts with earlier work that shows a positive relationship during the first stages of transition for England (Wrigley 1988). More recently we have Hansen et al. (2017) which discovers a robust negative relationship between schooling and fertility in late 19th and 20th century America. And Ager et al. (2018) documents the negative association between kindergarten adoption and fertility across U.S. cities.

Many of these studies establish correlations without firmly identifying a direct causal channel through which fertility adjusts. The transition from high to low fertility typically accompanies the development process that transforms an agricultural society into an industrial one. But pinpointing which precise feature of modernization generates such a transition remains elusive. Schultz (1985) uses fluctuations in agricultural prices to instrument for women's wages and shows that this can explain about a quarter of the decline in Swedish fertility.[2] For the U.S. case, Wanamaker (2012) establishes a causal link between industrial production and fertility reductions, but the work is necessarily limited to South Carolinian households.

In this work we exploit the valuable efforts of Donaldson and Hornbeck (2016), who construct measures of county-level market access by developing a network database of railroads and waterways and calculating lowest-cost county-to-county freight routes. We use these bilateral cost measures to construct weighted-measures of overall transportation costs for each county decade by decade. The benefit of using these measures is that much of the variation in a county's market access is not determined solely by that county's own railroad track or even nearby railroad track. Thus once we control for local (county-level) railroad access, such market access measures that utilize information on the entire network can be considered exogenous to local economic conditions.

The approach also allows us to separate two distinct forces influencing fertility that come from greater market access. The first of these is the greater urbanization and

[2]Kitchens and Rogers (2020) come to similar conclusions during the WWI era, finding that a sharp increase in the agricultural price index led to a reduction in fertility.

modernization that typically accompanies greater access to capital and ideas. This channel may suggest that greater market access would incite forces leading to both lower and more compressed fertility. The second channel is the possibility of increasing the comparative advantages of regions' commercial productions. Greater market access can increase the scale of existing production and change relative demand for factors. Greater scale for labor-intensive production can raise the demand for children (as those under 16 years of age were often economically active), while greater scale for more capital-intensive production can lower it. This work endeavors to uncover which of these was the dominant demographic force arising from greater connectivity from railroad network improvements. To our knowledge this is the first study to produce such a test for the United States during its demographic transition of the latter 19th century.

To clarify concepts we first build a simple theoretical model with over-lapping generations that endogenizes fertility, adapting the demographic framework of O'Rourke et al. (2018). In the model children positively impact both utility and labor-intensive production. The model demonstrates both the modernizing effects of greater market-access that can lower fertility, and the production-expansion effects in agricultural-intensive regions that can have the reverse effect.

Theoretically market-access induced fertility changes come about through either an extensive margin (households switch towards lower-fertility occupations) or an intensive margin (households within an occupation class lowers fertility). The model suggests (and the empirical results which are discussed below verify) that fertility adjustments mainly occur through the former channel. A simple numerical exercise demonstrates that, depending on initial conditions, a uniform rise in market access across regions has the potential to create a great deal of divergence in regional fertility rates.

To test some of the implications of the theory we turn to county-level production and demographic data spanning from 1850 to 1890. More specifically, we measure changes in different kinds of market access by interacting transportation costs estimated in Donaldson and Hornbeck (2016) with initial regional conditions related to industrial employment. The Donaldson and Hornbeck (2016) measures utilize the entire railroad network, so that the variation in any specific county's market access is not determined solely by that county's own railroad track or even nearby railroad track. This allows us to make causal inferences regarding greater access and fertility changes.

To this data we merge county-level measures of fertility. Because each census generates different demographic information each decade, total fertility rates in each county must be inferred from county-level measures of births, infant mortality, and adult populations. This work is to our knowledge the first to construct county-level fertility rates that are comparable across this many counties and decades over the latter half of the 19th century. Using the full count census records we also construct measures of changes in fertility of farm households versus non-farm households.

There is a great deal of variation in rates of fertility across counties, ranging from eight births per average household to near replacement fertility, and there is also a great deal of geographic variation in these measures. Further, there exists much variation in rates of fertility change across counties.

Finally, we capture county-level measures of population, male literacy rates, local railroad access and other controls from decennial census records. We also record occupation shares using individual-level full count data for 1850 and 1880 from IPUMS (Ruggles et al. 2021). The final merged dataset allows us to link industrial composition and demographic features of over 1700 counties with changes in different measures of market access.

We estimate the impact on the long differences of fertility across three distinct periods: 1850 – 1870, 1870 – 1890, and 1850 – 1880. We produce a number of interesting results that are fairly consistent across these different periods.

First, regions which receive greater ma rket access tend to experience falling fertility. Because measured changes in market access have little to do with local economic conditions (especially after we control for local railroad development) this result can be interpreted causally. However, the effect is far more pronounced in areas with higher initial intensity in manufacturing production compared with more farm-intensive areas. This points to market access inducing shifts in comparative advantage, thus potentially creating diverging demographic trends in the U.S.

We then use the full-count census records for 1850–1880 to measure whether greater market access leads to changes in occupational composition, as predicted by the theory. Using the 1950 occupational classification codes provided in IPUMS, we split occupations between high-skilled, medium-skilled, low-skilled, wage earning farmers, and non-wage earning farmers. Greater market access results in more high- and mid-skilled employment and reductions in non-wage farming employment. This finding is consistent with our model which suggests that market access should shift occupational employment. It further suggests that greater market access on average shifts employment away from farming and towards higher-skilled occupations, thus generating fertility reductions on the extensive margin.

We can also use the full-count census records to look at the effects of greater market access on changes in farm and non-farm fertility rates in areas with different initial mixes of occupations. What we first find is that fertility rates in farming households are basically unaffected by these changes – market-access induced declines in fertility mostly occur within non-farming sectors of the economy.

Peering more deeply into non-farming fertility, we see that it does not appear to be differentially affected by greater market access for those regions with high levels of skills (admittedly a small segment of the population). However, greater market access appears to lower non-farming fertility more in those regions with greater shares of mid-skilled workers or greater shares of manufacturing workers, again suggesting trade-induced shifts.

Finally, greater market access actually increases non-farm fertility more in those regions with greater shares of farmers. These results also make sense in the context of shifts of trade and specialization, as more manufacturing-oriented regions shift towards low-fertility occupations in non-farming, while more agricultural-oriented regions shift towards higher-fertility occupations in non-farming.

To summarize, we see that greater accessibility to national and global markets had asymmetric local effects on fertility — lower-skilled and farm-intensive regions experienced far less fertility reductions given similar increases in market access. The results suggest that greater market access could produce both greater scope for industrialization (helping spur a demographic transition overall) and greater specialization (helping foster within-country divergence in that transition). The expansion of the railroad in the United States during the latter 19th century, and its impact on demographics, demonstrates one of the great enigmatic implications of globalization — that it can force regions to diverge from each other even as it binds them closer together.

The rest of the paper is organized as follows. Section 2 develops and numerically solves a simple model of endogenous fertility and trade. Section 3 describes our basic empirical strategy, and section 4 describes the basic measures of fertility, market access, and various controls. Section 5 shows and describes our key findings, and section 6 provide some parting thoughts.

2. A Model of Market Access and Fertility

In this section we present a simple model that endogenizes fertility in the context of a two-sector economy that exogenously switches from autarky to free trade. The objective here is twofold — we wish to qualitatively demonstrate the nature of fertility changes that come about from greater market access, and we wish to quantitatively observe the extent to which such access can potentially generate demographic divergence.

2.1. Production in Autarky

Suppose initially a small autarkic region that produces two goods: agricultural: Y_a, and manufacturing: Y_m. Aggregate productions are given by:

$$Y_a = pL_a^{\gamma} X^{1-\gamma} \tag{1}$$

$$Y_m = L_m^{\gamma} K^{1-\gamma} \tag{2}$$

where X is land, K is capital, and p is the price of agricultural goods (in terms of manufacturing goods — all values are in terms of manufacturing production). Land and capital are exogenously given. L_a is agricultural workers; L_m is manufacturing workers. These are endogenously determined.

Factors are paid their marginal products. In autarky factor prices (w_a, w_m, r) are determined by local supply. With free trade factor prices are determined by global conditions, and are thus exogenous to the local economy.

2.2. Individuals

Individuals can choose to be an unskilled farmer, an unskilled manufacturer, or a skilled manufacturer, whichever profession yields the highest utility.

There is a mass of workers lined up on a unitary number line. Worker L_i on this number line faces a resource cost τ_i to be a skilled worker (we will simply have $i = \tau_i$). Let $i = f$, u, or s if worker i chooses to be a farmer, an unskilled manufacturer, or a skilled manufacturer, respectively.

Individual i maximize $U_i = c_{a,i}^{\alpha} c_{m,i}^{\beta} n_i^{1-\alpha-\beta}$ subject to:

- $w_a(1 + \phi n_f) \geq c_{m,f} + p * c_{a,f} + w_a n_f$ if i chooses to be a farmer.
- $w_m \geq c_{m,u} + p * c_{a,u} + w_m n_u$ if i chooses to be an unskilled manufacturer.
- $hw_m - \tau_i \geq c_{m,s} + p * c_{a,s} + w_m n_s$ if i chooses to be a skilled manufacturer.

where $0 < \phi < 1$ is the productivity of children in agriculture, p is the price of agriculture produce (in terms of manufacturing product), and h is the human capital acquired by the skilled manufacturer. Notice that only farmers can employ their children in production. Also notice that only skilled workers have different amounts of income, since each person's resource cost of education varies.

Each individual can separately maximize the utility function for each constraint given wages, the price of agriculture goods and the productivity of children in farming. Then each decides which profession to join by judging which generates the highest utility. Optimization yields:

$$p = \left(\frac{\alpha}{\beta}\right)\frac{c_{a,f}}{c_{m,f}} = \left(\frac{\alpha}{\beta}\right)\frac{c_{a,u}}{c_{m,u}} = \left(\frac{\alpha}{\beta}\right)\frac{c_{a,s}}{c_{m,s}} \tag{3}$$

$$n_f = \frac{(1-\alpha-\beta)}{\beta}\frac{c_{m,f}^{\beta}}{(1-\phi)w_a} \tag{4}$$

$$n_u = \frac{(1-\alpha-\beta)}{\beta}\frac{c_{m,u}^{\beta}}{w_m} \tag{5}$$

$$n_s = \frac{(1-\alpha-\beta)}{\beta}\frac{c_{m,s}^{\beta}}{hw_m} \tag{6}$$

2.3. Economy-wide Values

Aggregate labor amounts determined by threshold values τ_1 and τ_2:

$$L_m = \tau_1 h + (\tau_2 - \tau_1) \tag{7}$$

$$L_a = (1 + n_f\phi)(1 - \tau_2) \tag{8}$$

where $\tau_1 = w_m(h-1)$ gives the individual who is indifferent between skilled and unskilled manufacturing, and τ_2 gives the individual who is indifferent between unskilled manufacturing and agriculture, which is such that $U_f = U_u$. Note that children in farming households contribute to agricultural labor, but are not as productive as adults ($\phi < 1$).

Wages equal marginal products (again measured in terms of the manufactured good):

$$w_a = p\gamma L_a^{\gamma-1}X^{1-\gamma} \tag{9}$$

$$w_m = \gamma L_m^{\gamma-1}K^{1-\gamma} \tag{10}$$

Finally, in this autarkic economy, the relative price of agricultural goods is pinned down by aggregate outputs:

$$p = \left(\frac{\alpha}{\beta}\right) \frac{Y_a}{Y_f} \tag{11}$$

A visualization of this equilibrium is provided in Figure 1. The cost of each household to be educated is shown on the left vertical axis, marginal utilities of households are shown on the right vertical axis, and the range of households is shown on the horizontal axis. The diagonal line shows the resource cost to education faced by each household. $1 - \tau_1$ is the group of people whose education costs are prohibitively high — this group splits itself among agricultural and manufacturing production so that the marginal utilities of each group are equal.

2.4. Simulating Greater Market Access

Given this simple autarkic solution to the model, we can model greater market access in a number of ways. One, we can suggest that greater market access produces greater access to capital, which induces the region towards greater industrialization. Two, we can suggest that greater market access produces greater opportunity for trade, which drives local economies towards factor price equalization. Here we look at each separately, with the understanding that in reality greater market access generated by railroad line construction likely involved both factors during the latter 19th century in the United States.

2.4.1 Greater industrialization

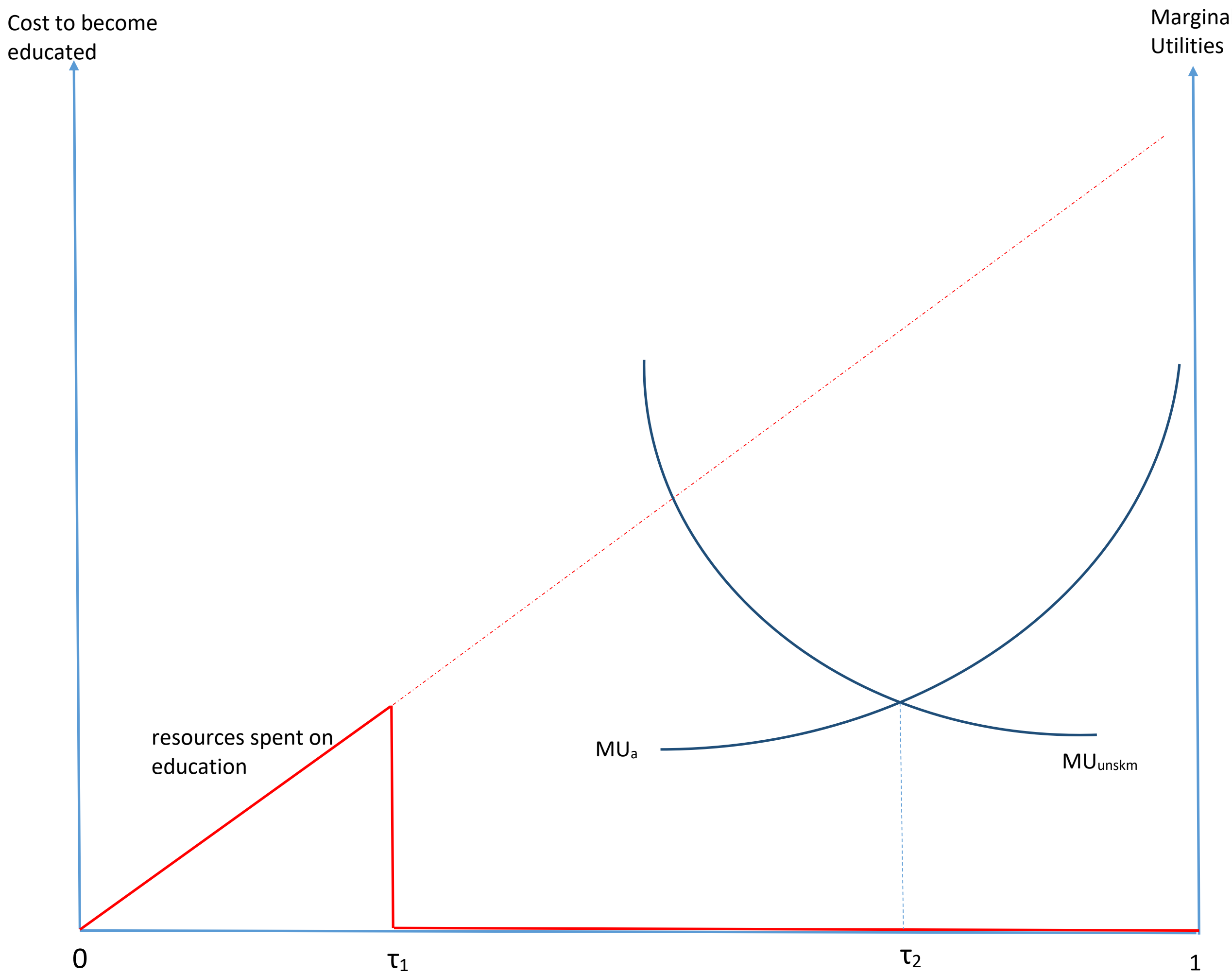
If greater market access produces greater inflows of capital, we can consider how such capital increases changes fertility patterns.

Proposition 1. $\partial n_f/\partial K = \partial n_u/\partial K = \partial n_s/\partial K = 0.$

Remark. Capital growth has no impact on the fertility level of each profession. The reason is that, given Cobb-Douglas preferences, the income and substitution effects that are associated with capital increase exactly cancel each other out. As one can observe in equations (4) - (6), increases in consumption, which would otherwise induce increases in fertility, are precisely offset by rising wages which increases the opportunity costs of children. □

Proposition 2. *Provided that $w_m > w_a$ and $h > 1$, $n_f > n_u > n_s$.*

Figure 1: Aggregate Labor Amounts — A Visualization



Note that the horizontal axis demonstrates that fraction τ_1 of workers will be skilled, fraction $\tau_2 - \tau_1$ of workers will be unskilled manufacturers, and fraction $1 - \tau_2$ of workers will be unskilled farmers.

Remark. This follows directly from equations (4) – (6). □

Proposition 3. $\partial\tau_1/\partial K > 0$, *and* $\partial\tau_2/\partial K > 0$.

Remark. Increases in manufacturing wages (both in absolute value and relative to agricultural wages) induced by capital increases provide some erstwhile unskilled manufacturers to be able to afford to become educated (increasing τ_1). At the same time manufacturing becomes more renumerative compared to agriculture, inducing some to switch from farming to unskilled manufacturing. □

Propositions 1–3 highlight the nature of fertility declines due to market-induced industrialization — capital inflows compel households to switch to occupations associated with lower levels of fertility. We can define the economy-wide level of fertility (n^*) as a population-weighted average of occupation-specific fertilities:

$$n^* = (n_s\tau_1) + (n_u(\tau_2 - \tau_1)) + (n_f(1 - \tau_2)) \tag{12}$$

The model stresses that fertility changes occur strictly though extensive margins (changes in τ_1 or τ_2, which are shifts in occupations) rather than intensive margins (changes of n_f, n_u, or n_s, which are shifts within each occupation). Of course a more general model would allow for both extensive and intensive margins. However elasticities of substitution between children and consumption, or more generally between "home" and "market" goods, would have to be implausiby different from unity in order for intensive margins to sizably matter (see for example Rupert et al. 1995 and Cordoba and Ripoll 2018). The point to make here is that given the countervailing forces of income and substitution effects associated with capital-induced income growth, we should expect fertility reductions due to greater industrialization to occur mainly through shifts in occupations.

2.4.2 Greater trade

Greater market access is also associated with a greater ability to exploit comparative advantages and trade with other regions. Suppose now that capital remains fixed, but market access transforms the region into a small open economy with respect to goods. In this case the price of agricultural goods is given by *global* supplies:

$$p = \left(\frac{\alpha}{\beta}\right)\frac{Y_a^*}{Y_f^*} \tag{13}$$

where now Y_a^* and Y_m^* are global outputs of agricultural and manufacturing goods. These outputs will be functions, among other things, of global capital (K^*) and global land (X^*). We can then motivate the trade effects of greater market access in the following way.

Proposition 4. *If $\frac{X}{X*}$ is sufficiently larger than $\frac{K}{K*}$, the economy's transition from autarky to free trade will produce a rise in n^*.*

Remark. In the case the local economy specializes in agricultural production since it has an abundance of land relative to capital in relation to the global economy. This will induce both τ_1 and τ_2 to fall. If trade is robust enough, fertility becomes $n^* = n_f$; that is, the local economy completely specializes in agriculture. □

Proposition 5. *If $\frac{K}{K*}$ is sufficiently larger than $\frac{X}{X*}$, the economy's transition from autarky to free trade will produce a fall in n^*.*

Remark. In the case where the economy specializes in manufacturing production, both τ_1 and τ_2 rise. If trade is robust enough, fertility becomes $n^* = (n_s\tau_1) + (n_u(1 - \tau_1))$; that is, the local economy completely specializes in manufacturing. □

2.5. Potential Implications

There are a number of testable ideas that may come from this model which we enumerate below:

1. Greater market access should not impact occupation-specific fertility rates.

2. Greater market access that generates higher levels of industrialization should lower fertility overall. This captures the role that access-induced industrialization plays in lowering rates of fertility by shifts towards lower-fertility occupations.

3. Greater market access that generates higher levels of industrialization will generate a *convergence* in fertility patterns around the country. Capital flowing to areas with sparse capital (so with high marginal productivities of capital) would generate dramatic demand for manufacturing employment. Furthermore, fertility would be predicted to decline more in areas with farms since capital inflows would impact two extensive margins in this case (urban areas would experience fertility reductions only through skill-upgrading).

4. Greater market access that creates opportunities to exploit comparative advantages will generate a *divergence* in fertility patterns around the country. Regions that are more agriculturally-based may experience rising fertility if specialization induces greater agricultural production. Regions that are more manufacturing-based should experience the reverse.

2.6. A Numerical Exercise

Before turning to our empirical work, we can use the model to quantitatively explore the potential extent of fertility changes from trade and specialization.

First, we target three starting values in the model that correspond to measures in 1850 — overall fertility, the share of workers in skilled occupations, and the share of workers in agriculture. First, crude birth rates were roughly 45 births per thousand in the middle of the 19th century (UN DESA and Gapminder 2019). Considering 27 years as a single generation, 1000 people of a generation would have 1215 births. So for our model this would translate to roughly $n = 1.2$.

For the share of workers in skilled occupations, we use the 1850 full count census to record high-skilled occupations (more details are provided in section 4). We find that 6 percent of workers are in this category, so $\tau_1 = 0.06$. Finally, in 1850 the share of the American labor force in agriculture was 55 percent (Mintz and McNeil 2018). This means that $\tau_2 = 0.45$.

Further, we normalize p, K and X to one, and we set $\gamma = 0.5$. We thus have three initial conditions to target, n, τ_1, τ_2, by choosing values for three "free" parameters — $\alpha = \beta$ (share of income to each consumption-type), ϕ (the fraction of child labor relative to adult labor), and h (the percentage increase skilled wages relative to unskilled wages).[3]

We can "shock" the economy in two ways, each evoking the effects of greater market access. One, we can give it more capital; two, we can have it become a small open economy that specializes in either agriculture or manufacturing. Numerical results for each type of trade specialization are provided in table 1.

First, we note that based on census-level measures of manufacturing capital, capital rose roughly 25 percent across the United States from 1850 to 1880 (we discuss U.S. data in subsequent sections). If we raise capital by 25 percent in the model, we see a modest decrease in fertility (dropping to 1.16).

[3] Specifically, we perform a grid search across this parameter space in order to minimize the loss function $(n - 1.2)^2 + (\tau_1 - 0.06)^2 + (\tau_2 - 0.45)^2$ (see O'Rourke et al. 2018 for an example of this approach). This gives us parameter values of $\alpha = \beta = 0.35$, $\phi = 0.85$, and $h = 1.08$.

Contrast this with the perfect specialization case. A region that specializes in agriculture would observe a fertility explosion; a region that specializes in manufacturing would observe a fertility depression. This is not to say of course that greater market access actually generated such dramatic trade patterns. The point is that greater trade had the *scope* to generate dramatic differences. Furthermore one can easily envision domestic trade generating local specialization more dramatically than international trade generating specialization at the country level (see for example Kim 1998).

3. Empirical Specification

Our basic empirical strategy is to regress changes in fertility on changes in market access and other controls. We do this in long-differences, across two or three decades. Our regressions take the basic form

$$\Delta fert_i = \beta_0 + \beta_1 \Delta P_{pw,i} + \gamma X_i + \epsilon_i \tag{14}$$

where $P_{pw,i}$ is a *population-weighted* measure of the cost of accessing external markets in county i. We discuss the construction of this measure in the next section. X_i includes county-level controls that are measured at the beginning of the time period.

We are also interested in estimating the different fertility impacts of greater market access for regions that conceivably are exporters of agricultural products, compared to regions that may be exporters of manufacturing products. To that end we estimate two types of regressions. The first of these uses measures of market access that are weighted by relative agricultural or manufacturing production:

$$\Delta fert_i = \beta_0 + \beta_1 \Delta P_{pw,i} + \beta_2 \Delta P_{aw,i} + \beta_3 \Delta P_{mw,i} + \gamma X_i + \epsilon_i \tag{15}$$

where $P_{aw,i}$ and $P_{mw,i}$ are market-access measures that are agricultural-production-weighted and manufacturing-production-weighted, respectively. We discuss the construction of this measure in the next section.

Our second approach is to include interactions between market access and proxies of local agricultural and manufacturing production:

$$\Delta fert_i = \beta_0 + \beta_1 \Delta P_{pw,i} + \beta_2 \Delta P_{pw,i} * farms_i + \beta_3 \Delta P_{pw,i} * manuf_i + \gamma X_i + \epsilon_i \tag{16}$$

where $farms_i$ and $manuf_i$ are measures of the number of farms and manufacturing output in county i.

We would like to implicitly test some of the implications of the theory described in section 2. Specifically, if greater market access primarily induces greater levels of urbanization and industrialization, we would expect that $\beta_1 > 0$ (overall decreases in the cost of access lowers fertility rates), and that $\beta_2 > \beta_3$ (greater market access for agricultural regions lowers fertility more than for industrial regions). On the other hand, if greater market access primarily induces greater opportunities to exploit comparative advantages, we would expect that $\beta_3 > 0$ (manufacturing-oriented regions experience greater reductions in fertility), and that $\beta_3 > \beta_2$ (greater market access for industrial regions lowers fertility more than for agricultural regions).

4. Data

4.1. Measures of Market Access

We define P_{pw} for a specific year as the following:

$$P_{pop-weighted,it} = \left(\sum_{j=1}^{N} \omega_{pop,j} cost_{ijt}^{-1} \right)^{-1} \tag{17}$$

where $\omega_{pop,j}$ is the share of population of county j relative to the U.S. in year t, and $cost_{ijt}$ is the measure of lowest cost of shipping freight from county j to county i as calculated by Donaldson and Hornbeck (2016).[4]

We will look at the change of this population-weighted cost index from two different census periods. That is, we will regress changes in fertility in county i on $\Delta P_{pop-weighed} = P_{pop-weighted,i,t+1} - P_{pop-weighted,i,t}$, keeping the population weights constant. This will serve as our empirical proxy for changes in the region's access for goods and capital.

Figures 2 and 3 demonstrate the regional variations in changes in this population-weighted cost index from 1850 to 1870 and from 1870 to 1890, respectively. Data for the earlier sample is concentrated in the East and Midwest. Here we see that trade costs fall most heavily in the Midwestern regions and in the Appalachian hinterlands. During the latter part of the sample on the other hand we observe that the more dramatic drops in trade costs had drifted westward, while the Eastern shore observed far more modest declines.

[4] The exponent used in the aggregation is consistent with a value of $\sigma = 0.5$ in a constant elasticity-of-substitution aggregator of products differentiated by region-of-origin, where this elasticity is $1/(1-\sigma)$. Results do not appear to be sensitive to this choice of elasticity, including the case where goods from different places are perfectly substitutable.

Figure 2: $\Delta P_{pop-weighed}$, 1850–1870

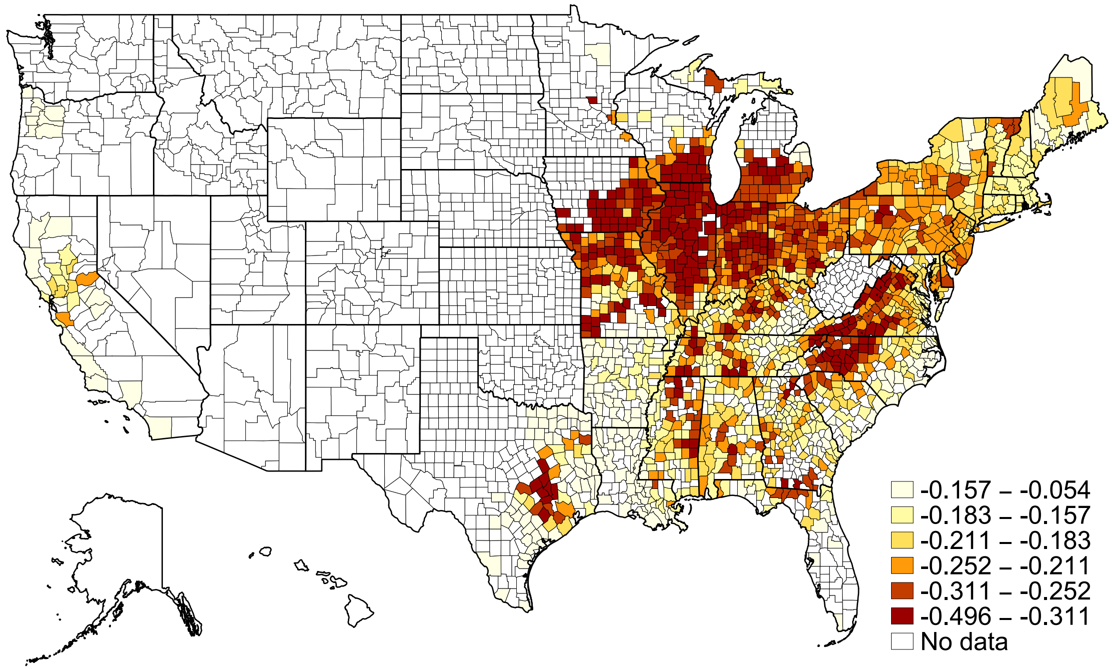
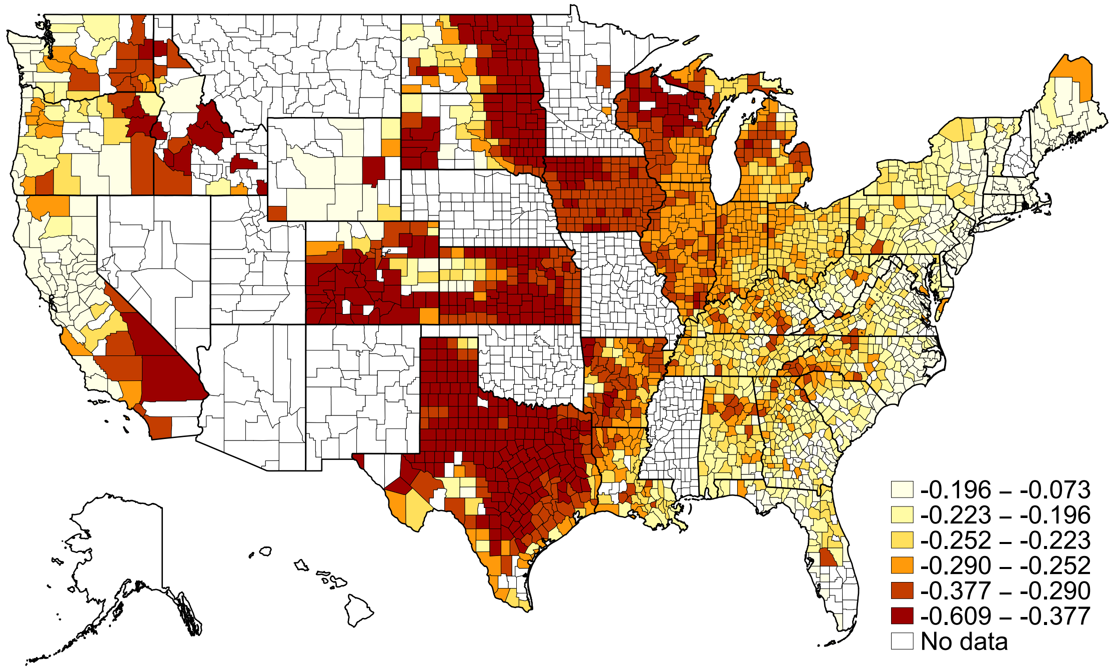


Figure 3: $\Delta P_{pop-weighed}$, 1870–1890



We also wish to separately measure changes in transportation costs among those counties which may alter specialization patterns for county i. Specifically, we create an agricultural-production-weighted cost measure, and a manufacturing-production-weighted cost measure:

$$P_{ag-weighted,it} = \left(\sum_{j=1}^{N} \omega_{ag,j} cost_{ijt}^{-1} \right)^{-1} \tag{18}$$

$$P_{manuf-weighted,it} = \left(\sum_{j=1}^{N} \omega_{manuf,j} cost_{ijt}^{-1} \right)^{-1} \tag{19}$$

where now

$$\omega_{ag,j} = \frac{ValueFarmProduction_i}{ValueFarmProduction_j} \tag{20}$$

$$\omega_{ag,j} = \frac{ValueManufacturingProduction_i}{ValueManufacturingProduction_j} \tag{21}$$

Drops in (18) would suggest an increase in county i's comparative advantage in agricultural production and exportation; drops in (19) would suggest an increase in county i's comparative advantage in manufacturing production and exportation. We will look at changes in these measures from one census-year to another to assess how shifts in comparative advantage could have impacted fertility rates across counties.

As discussed in Donaldson and Hornbeck (2016), one concern is that the expansion of the railroad is endogenous to economic factors in county i. This concern is mitigated by their construction of market access measures, where much of the variation in county i's market access is not determined by that county's own railroad track or even nearby railroad track. Nevertheless we also control for local access to railroads in all specifications (provided by Atack 2016).

4.2. Measures of Fertility

The construction of birth rates is complicated by differences in available data for each decade. Throughout we define birth rates as number of births in a year divided by total females aged 20–44.

For 1850 we are able to get actual number of births in each county for 1850. We infer births in each county each subsequent decade by observing children in subsequent decades and correcting for potential infant mortality (by using county-level deaths for those under one year old for 1850). We take subsets of this measure to proxy for number of births in a year, depending on the definition of children that census year (5–18 year olds in 1870, 5-17 year olds in 1880, 5–20 year olds in 1890 and 1900). Regional variations in fertility rate changes for our two sub-periods are displayed in figures 4 and 5.

4.3. Measures of Occupations

Finally, we use the full count census records to construct county-specific shares of laborers in different occupations. IPUMS uses the 1950 occupational classification to categorize these occupations. Only male laborers working in 1850 are considered in this classification. Occupations are broken into 6 broader categories — professional workers, clerical workers, craftsmen, laborers, wage farmers, and non-wage farmers. As a rough approximation to the theory, we consider professional workers as skilled, clerical workers and craftsmen as "semi-skilled," laborers as unskilled industry workers, and wage and non-wage farmers as workers in agriculture.[5]

[5]More specifically, the 1950 occupational classification has been summarized from the 1950 Census Bureau publication"1950 Census of Population: Classified Index of Occupations and Industries." There are over 450 occupations that are organized putatively by skill-intensity.

Figure 4: $\Delta fert$, 1850–1870

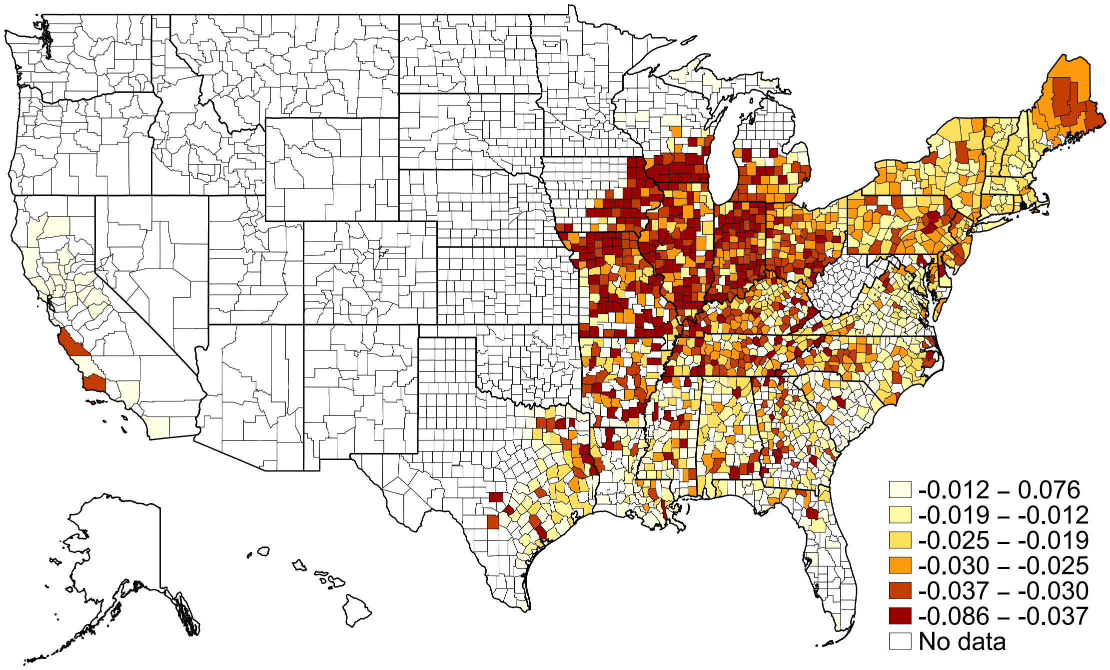
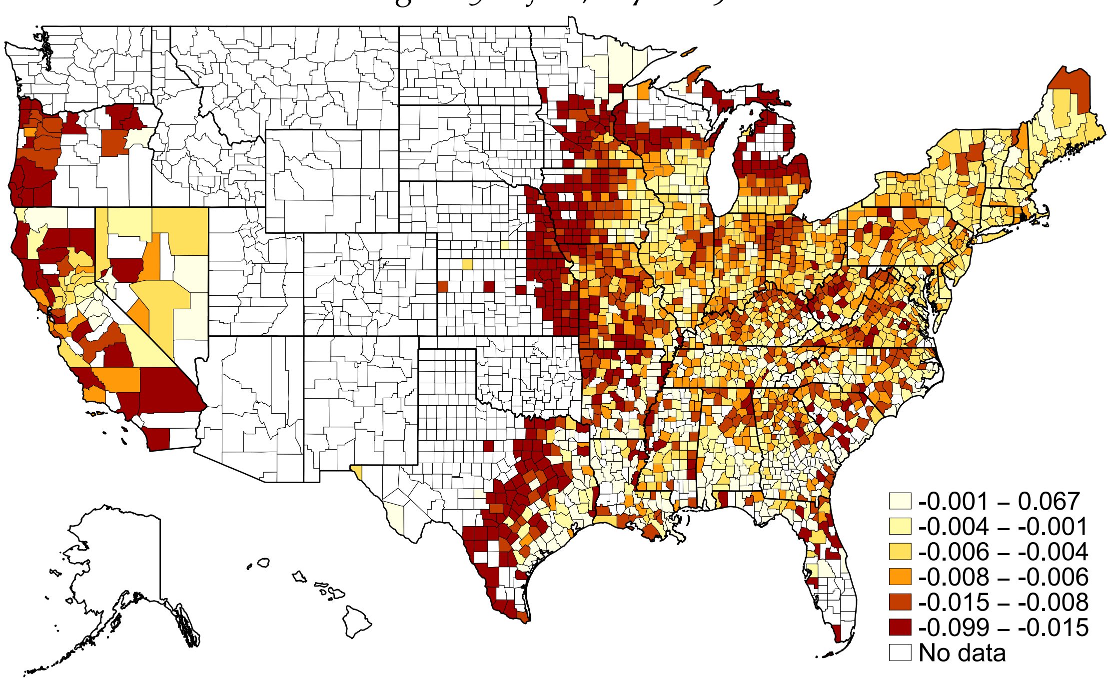


Figure 5: $\Delta fert$, 1870–1890



5. Empirical Findings

Our analysis consists of three periods — 1850–1870, 1870–1890, and 1850–1880 for the full-count census data. Summary statistics are provided in tables 2 and 7. In both tables, we see that on average fertility declines ($\Delta fertility$), but that the mean statistic masks the steep declines in some areas and outright increases in other areas. The percentage change in population-weighted transport cost of goods ($\%\Delta P_{pop-weighted}$) also declines, but the declines are more dramatic in some counties than in others. Table 2 shows for the base year of 1850 urban population in thousands, the average number of farms per county in thousands, school enrollment rate, manufacturing output and capital (in millions), as well as the fraction of counties with railroad access by 1870 and the fraction of time each county has railroad access between 1850 and 1870. Table 7 provides similar statistics but with 1870 as the base year and the fraction of counties with railroad access by 1890 and the fraction of time the county has railroad access between 1870 and 1890. Table 7 also includes the number of farm machines per capita (Haines 2010) and the number of banks per county in 1870 (Jaremski and Fishback 2018). All available controls are included in all specifications, including the extent of local rail access, which may be endogenous to local economic conditions.

5.1. 1850 – 1870

The first period we consider is 1850–1870. Results are displayed in Table 3. All regressions control for urban population, number of farms, manufacturing output in 1850, and local rail by 1870 as detailed in Table 2. Column 1 reports the estimated relationship between the long change in population-weighted transport cost of goods and the long change in fertility. The positive estimated coefficient suggests that as these costs rise, fertility would rise. Our summary statistic in Table 2 shows that costs dramatically fell from 1850 to 1870. Thus, our estimate suggests that those regions that experienced dramatic cost declines in transportation also experienced declining fertility. In column 2 we add controls for school enrollment, manufacturing capital, and number of farms. This slightly decreases the magnitude of the main coefficient estimate and school enrollment is, as expected, negatively related to fertility, while the number of farms is positively related to fertility. Once we additionally control for state fixed effects (column 3) the magnitude of our estimate is greatly reduced and any statistical significance disappears. When we decompose transport cost measure between bilateral connections where county j would conceivably export manufacturing goods ($\%\Delta \mathrm{P}_{manuf.ex}$) versus export agricultural goods

$\%\Delta P_{ag.ex}$) (column 4), we see that fertility declines in counties that are more manufacturing oriented while the opposite is true for agriculturally oriented counties. This result is robust to accounting for state fixed effects (column 5), while the estimated coefficient on population-weighted transport costs remains statistically insignificant. This constitutes our first piece of evidence supporting the idea that greater market access produced demographic divergence within the 19th century United States.

We further explore the relationship by interacting the long change in population-weighted transport cost of goods with the number of farms in a county and, separately, with the local manufacturing output. This provides us an alternative method to gauge the importance of specialization in demographic change. These results are displayed in Table 4. These regressions contain the most saturated specification of table 3. In column 1 we estimate that as costs decline, fertility declines with similar magnitude to our estimate in column 1 of table 2. From the estimates on our interactions, we see that the local economic specialization influences fertility in opposite ways. Declines in transportation costs are associated with an increase in fertility in areas with a stronger farming presence, and a *decrease* in areas with a stronger manufacturing presence. This result is robust to the inclusion of state fixed effects (column 2).

In general, regions with greater market access have lower fertility. But the effect is much more pronounced in manufacturing areas compared with farming areas, suggesting market-access induced shifts in comparative advantage. Next, we narrow the time period over which we estimate. Table 5 provides estimates for the 1850-1860 period while Table 6 provides them for the 1860-1870 period. Columns 1 and 2 of each table correspond to 2 and 3 of Table 3 while columns 3 and 4 correspond to columns 1 and 2 of Table 4. Our estimates are consistent with the pattern we observe over the 1850-1870 period, but show that the market-access induced fertility declines appear to be much more pronounced in the latter part of the sample.

5.2. 1870 – 1890

We perform similar analysis for the 1870–1890 period, a time when average transport cost declines somewhat more than in the 1850–1870 period. These results are displayed in Table 8 (compare to Table 3) and 9 (compare to Table 4). For the 1870–1890 period, in addition to the controls we use for the 1850–1870 period we are also able to control for the number of farm machines per capita in a county as well as the number of banks per county. We estimate fertility declines across counties during the 1870–1890 period of similar magnitude to the 1850–1870 period. The last two columns of Table 8 indicate that fertility reductions from greater market access are somewhat stronger during the 1870–1890 period than the earlier period, and that market access induced fertility declines are driven strictly by those areas that are more liable to export manufactured goods. In those areas likely to export agricultural goods, greater market access is associated with rising fertility (similar to earlier period).

When we turn to estimates with interactions between market access and economic structure (Table 9), we find that market access induced fertility declines are stronger overall during the 1870–1890 period than the earlier period. But similar to the earlier period, declines are more pronounced in manufacturing-heavy areas than in agricultural areas. From this we might conclude that while greater industrialization from the railroad network generated a more widely-shared demographic transition in the latter period, the network also continued to induce divergence from domestic trade specialization.

5.3. 1850 – 1880

Next we turn to the full-count census records where we have additional individual level data, which we have available for the 1850–1880 period. One benefit of using this data is that we are able to observe occupational distributions in each region, as well as distinguish between changes in fertility in farming and non-farming households.

For these estimates, crude birth rate adjustments are now in percent change (not percentage point change). We first use this data to construct changes in crude birth rates for farm and non-farm households. We report estimates of the relationship between transportation costs and fertility in Table 10. Columns 1 does not contain county level controls or state fixed effects. Columns 2 adds county level controls and Column 3 adds state fixed effects. We find that a one percent decline in trade costs appears to be associated with a 2 percent decline in crude birth rates.

Next, we examine whether the change in fertility occurs among farming or non-farming households. These are displayed in Table 11. Columns 1 and 2 contains county level controls but not state fixed effects. Columns 3 and 4 adds state fixed effects. Market access induced fertility declines appear to be far more pronounced for non-farm households (columns 2 and 4). If railroad access produced greater industrialization in those areas, we might expect the opposite.

We then use the full-count census records for 1850–1880 to measure whether greater market access leads to changes in occupational composition, as predicted by the theory. Using the 1950 occupational classification codes (provided in IPUMS) we split occupations between high-skilled, medium-skilled, low-skilled, wage earning farmers, and non-wage earning farmers. Columns 1 through 5 of Table 12 contain estimates for each of these skill categories, respectively. Greater market access ($\%\Delta P_{pop-weighted}$) results in more high- and mid-skilled employment and reductions in non-wage farming employment. This finding is consistent with our model which suggests that market access should shift occupational employment. It further suggests that greater market access on average shifts employment away from farming (increases in τ_2) and towards higher-skilled occupations (increases in τ_1).

Finally, using the full-count census records for 1850–1880 we look at the effects of greater market access on changes in fertility in areas with different initial mixes of occupations.

Results are displayed in Table 13 and 14. In separate regressions we interact changes in market-access costs with the percentage of those employed (in 1850) in high-skilled occupations, mid-skilled occupations, *any* manufacturing occupation (across all skill types), and farming occupations. We also distinguish between changes in fertility in farming households (Table 13) and non-farming households (Table 14).

Table 13 demonstrates that fertility in farming households are basically unaffected by changes in market access. Recall from the model that such changes are predicted to keep occupational-specific fertility rates constant (specifically in this case, n_f). Indeed, we find this result when we observe fertility only for farming occupations.

Table 14 on the other hand demonstrates a different story. Non-farming fertility appears not to be differentially affected by greater market access for those regions with high levels of skills (first specification). This is admittedly a relatively small portion of the population. However, greater market access appears to lower non-farming fertility more in those regions with greater shares of mid-skilled workers (second specification) or greater shares of manufacuturing workers overall (third specification).[6] Finally, greater market access actually increases non-farm fertility more in those regions with greater shares of farmers (fourth specification).[7] These results make sense in the context of shifts of trade and specialization, as more manufacturing-oriented regions shift towards low-fertility occupations in non-farming (increases in τ_1), while more agricultural-oriented regions shift towards higher-fertility occupations in non-farming (decreases in τ_1).

[6] Specifically, for mid-skilled the joint estimate for the coefficients on $\%\Delta P_{pop-weighted}$ and $\%\Delta P_{pop-weighted}$*$\%mid-skilled_{1850}$ is 46.8, with a p-value of 0.02. The same joint estimate for all manufacturing workers produces a value of 16.6 with a p-value of 0.024.

[7] Specifically, for farm workers the joint estimate for the coefficients on $\%\Delta P_{pop-weighted}$ and $\%\Delta P_{pop-weighted}$*$\% farm-workers_{1850}$ is -4.7 with a p-value of 0.026.

6. Conclusion

Between 1850 and 1890, the amount of railroad track in the United States roughly quintupled. We have demonstrated that this expansion helped to foster both a secular decline in fertility rates overall and a widening of fertility rates across the country. The compression of fertility observed during the first half of the 20th century may have come about only after the expansion of railroad track slowed down. Furthermore we take different slices of data and analyze different sub-periods, and continue to find similar patterns.

While studies have analyzed how greater market connectivity can spur demographic divergence across countries (Galor and Mountford 2008), there are few studies which attempt this within a country. Our study suggests that these patterns observed at a global scale could occur at smaller levels of aggregation. While our study stresses the role that trade specialization played, other channels that come about through greater market access may also be important. For example greater knowledge or cultural spillovers across regions could also help shape convergence or divergence in demographic patterns within a country (see for example Murphy 2015 in the context of 19th century France, and Delventhal 2021 for 186 countries across 250 years). And greater integration can spur technological diffusion that likewise can affect demography (Baldwin 2016; O'Rourke et al. 2018).

The relevance of these questions for today's economies should be clear. For example the EU project, which sought to integrate the various European countries, may have instead contributed to greater demographic disparities across its member countries.[8] This paper stresses the need to consider the role that greater trade and specialization can have in shaping demographic patterns both historically and contemporaneously.

[8] See "Demography could be yet another force for divergence within the EU." The Economist Jan 11, 2020 edition.

Table 1: *Simulated Figures from the Model*

Case	Fertility
Baseline	1.2
25 Percent ↑ in K with No Trade	1.16
Free Trade/Agricultural Specialization	2.0
Free Trade/Manufacturing Specialization	0.3

Table 2: *Summary Statistics, 1850–1870*

Variable	No. of Obs.	Mean	St. dev.	Min	Max
Δfertility	1,532	-.0235512	.0165313	-.0862418	.0764494
$\%\Delta P_{pop-weighted}$	2,797	-.2263014	.1073346	-.6251582	-.0246467
Urban Pop. (1000s)	1,564	2.247247	18.52629	0	515.547
No. of farms 1850 (1000s)	1,562	.9113387	.9285787	0	7.245
School enrollment 1850	1,564	.383051	.2270942	0	1.035211
Manuf. output 1850 (mil $)	1,564	.6499347	3.465884	0	90.38202
Manuf. capital 1850 (mil $)	1,564	.3347849	1.524695	0	31.4064
Local rail by 1870 (indicator)	3,332	0.320	0.466	0	1
Frac. of time from 1850-1870 with local rail	3,332	0.235	0.374	0	1

Table 3: *Effect of Market Access on Fertility, 1850–1870*

	Percentage Point Change in Fertility from 1850 to 1870				
	(1)	(2)	(3)	(4)	(5)
	Δfert	Δfert	Δfert	Δfert	Δfert
$\%\Delta P_{pop-weighted}$	0.0587***	0.0482***	0.00783	-0.0382	0.0451
	(9.47)	(7.26)	(1.15)	(-0.53)	(0.53)
$\%\Delta P_{ag.ex}$				-0.205**	-0.172*
				(-2.72)	(-2.11)
$\%\Delta P_{manuf.ex}$				0.285***	0.132*
				(4.75)	(2.23)
School enrollment		-0.0264***	-0.0251***	-0.0238***	-0.0230***
		(-10.63)	(-10.96)	(-6.12)	(-7.52)
Manufacturing capital		0.000433	0.000628	0.000113	0.00073
		(0.66)	(1.05)	(0.24)	(0.56)
No. of farms		0.00264***	0.00310***	0.00197***	0.00180***
		(5.24)	(6.22)	(3.88)	(4.92)
N	1532	1523	1523	1306	1306
state fixed effects	no	no	yes	no	yes
adj. R^2	0.076	0.164	0.323	0.207	0.328

Additional controls (urban pop, manuf. output, local rail by 1870, frac. of time with local rail) not reported.
t statistics in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4: *Effect of Market Access on Fertility, 1850–1870*

Percentage Point Change in Fertility from 1850 to 1870		
	(1)	(2)
	Δfert	Δfert
$\%\Delta P_{pop-weighted}$	0.0616***	0.0176
	(5.54)	(1.67)
$\%\Delta P_{pop-weighted}$*farms	-0.0244**	-0.0157
	(-2.79)	(-1.95)
$\%\Delta P_{pop-weighted}$*manuf	0.0192***	0.00674*
	(4.26)	(2.07)
N	1523	1523
state fixed effects	no	yes
adj. R^2	0.170	0.324

Additional controls (urban pop, no. of farms, school enroll., manuf. output, manuf. capital, local rail by 1870, frac. of time with local rail) not reported.
t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 5: *Effect of Market Access on Fertility, 1850–1860*

Percentage Point Change in Fertility from 1850 to 1860				
	(1)	(2)	(3)	(4)
	Δfert	Δfert	Δfert	Δfert
$\%\Delta P_{pop-weighted}$	0.0172*	-0.00611	0.0323*	-0.0101
	(2.31)	(-0.80)	(2.28)	(-0.74)
$\%\Delta P_{pop-weighted}$*farms			-0.0234*	0.00466
			(-2.16)	(0.48)
$\%\Delta P_{pop-weighted}$*manuf			0.0168***	0.00220
			(3.35)	(0.52)
N	1537	1537	1537	1537
state fixed effects	no	yes	no	yes
adj. R^2	0.041	0.318	0.044	0.317

Additional controls (urban pop, no. of farms, school enroll., manuf. output, manuf. capital, local rail by 1870, frac. of time with local rail) not reported.
t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 6: *Effect of Market Access on Fertility, 1860–1870*

	Percentage Point Change in Fertility from 1860 to 1870			
	(1)	(2)	(3)	(4)
	Δfert	Δfert	Δfert	Δfert
$\%\Delta P_{pop-weighted}$	0.0624***	0.0183**	0.0794***	0.0319**
	(10.07)	(2.70)	(9.04)	(3.28)
$\%\Delta P_{pop-weighted}$*farms			-0.0329***	-0.0253**
			(-4.53)	(-3.21)
$\%\Delta P_{pop-weighted}$*manuf			0.0153	0.0141
			(1.47)	(1.25)
N	1537	1537	1537	1537
state fixed effects	no	yes	no	yes
adj. R^2	0.186	0.342	0.195	0.347

Additional controls (urban pop, no. of farms, school enroll., manuf. output, manuf. capital, local rail by 1870, frac. of time with local rail) not reported.
t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 7: *Summary Statistics, 1870 – 1890*

Variable	No. of Obs.	Mean	st. dev.	min	max
Δfertility	2,511	-.0168658	.0617843	-.922545	.6382685
$\%\Delta P_{pop-weighted}$	2,790	-.2865632	.0992409	-.6622425	-.0728648
Total pop. (1000s)	2,711	23.78892	59.24977	0	1515.301
Urban pop. (1000s)	2,709	8.493139	55.70446	0	1515.301
No. of farms 1870 (1000s)	2,188	1.308688	1.110345	.001	8.505
Farm machines per capita	2,174	.008954	.1322655	-.0008795	4.652091
School enrollment 1870	2,196	.4862129	.2748626	0	1.217742
Manuf. output 1870 (mil $)	2,201	1.939447	12.09738	0	332.9515
Banks 1870 (1000s)	2,538	.0010733	.0044853	0	.126
Local rail by 1890 (indicator)	3,573	0.703	0.457	0	1
Frac. of time from 1870-1890 with local rail	3,573	0.500	0.448	0	1

Table 8: *Effect of Market Access on Fertility, 1870–1890*

Percentage Point Change in Fertility from 1870 to 1890					
	(1)	(2)	(3)	(4)	(5)
	Δfert	Δfert	Δfert	Δfert	Δfert
$\%\Delta P_{pop-weighted}$	0.0671***	0.0598***	0.0545***	-0.390***	-0.591***
	(9.61)	(8.40)	(4.90)	(-3.30)	(-4.77)
$\%\Delta P_{manuf.ex}$				0.445***	0.656***
				(3.73)	(5.12)
$\%\Delta P_{ag.ex}$				0.00112	0.00298
				(0.44)	(1.18)
N	1768	1755	1755	1674	1674
state fixed effects	no	no	yes	no	yes
adj. R^2	0.132	0.201	0.286	0.226	0.329

Additional controls (population, no. of farms, farm machines, school enroll, manuf. output, no. of banks, local rail by 1890, frac. of time with local rail) not reported.
t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 9: *Effect of Market Access on Fertility, 1870–1890*

Percentage Point Change in Fertility from 1870 to 1890		
	(1)	(2)
	Δfert	Δfert
$\%\Delta P_{pop-weighted}$	0.0963***	0.0907***
	(8.57)	(6.20)
$\%\Delta P_{pop-weighted}$*farms	-0.0433***	-0.0517***
	(-6.76)	(-6.51)
$\%\Delta P_{pop-weighted}$*manuf	-0.00385**	-0.00488**
	(-2.83)	(-3.18)
N	1755	1755
state fixed effects	no	yes
adj. R^2	0.241	0.327

Additional controls (population, no. of farms, farm machines, school enroll, manuf. output, no. of banks, local rail by 1890, frac. of time with local rail) not reported.
t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 10: *Effect of Market Access on Fertility, 1850–1880*

Percent Change in Fertility from 1850 to 1880			
	(1)	(2)	(3)
	%Δfert	%Δfert	%Δfert
$\%\Delta P_{pop-weighted}$	5.393***	5.745*	1.950*
	(3.49)	(2.45)	(2.01)
N	1587	1535	1535
additional controls	no	yes	yes
state fixed effects	no	no	yes
adj. R^2	0.013	0.049	0.299

Additional controls (urban pop, no. of farms, school enroll., manuf. output, manuf. capital, local rail by 1880, frac. of time with local rail) not reported.
t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 11: *Effect of Market Access on Fertility, 1850–1880*

Percent Change in Farm and Non-farm Fertility from 1850 to 1880				
	(1)	(2)	(3)	(4)
	%Δfarm fert	%Δnonfarm fert	%Δfarm fert	%Δnonfarm fert
$\%\Delta P_{pop-weighted}$	0.773*	4.203**	-0.0442	1.491
	(2.38)	(2.65)	(-0.08)	(1.82)
N	1522	1529	1522	1529
state fixed effects	no	no	yes	yes
adj. R^2	0.038	0.057	0.069	0.285

Additional controls (urban pop, no. of farms, school enroll., manuf. output, manuf. capital, local rail by 1880, frac. of time with local rail) not reported.
t statistics in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 12: *Effect of Market Access on Employment Patterns, 1850–1880*

	Changes in Employment Composition from 1850 to 1880				
	(1)	(2)	(3)	(4)	(5)
	%Δhigh skilled	%Δmid skilled	%Δlow skilled	%Δwage-farmers	%Δnon-wage-farmers
%Δ$P_{pop-weighted}$	-0.0759***	-0.164***	-0.0428	-0.0334	0.330***
	(-6.08)	(-4.00)	(-0.94)	(-0.69)	(4.31)
N	1547	1547	1547	1547	1547
adj. R^2	0.473	0.270	0.181	0.243	0.190
state fixed effects	yes	yes	yes	yes	yes

Additional controls (urban pop, no. of farms, school enroll., manuf. output, manuf. capital, local rail by 1880, frac. of time with local rail) not reported. t statistics in parentheses.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 13: *Effect of Market Access on Fertility in Farming Households, 1850–1880*

Percent Change in Fertility from 1850 to 1880				
	(1)	(2)	(3)	(4)
	%Δfert	%Δfert	%Δfert	%Δfert
$\%\Delta P_{pop-weighted}$	-0.411	0.334	-0.379	-0.469
	(-0.27)	(0.33)	(-0.49)	(-0.56)
% high-skilled$_{1850}$	-2.529			
	(-0.40)			
$\%\Delta P_{pop-weighted}$*	-6.020			
% high-skilled$_{1850}$	(-0.39)			
% mid-skilled$_{1850}$		1.423		
		(0.89)		
$\%\Delta P_{pop-weighted}$*		0.400		
% mid-skilled$_{1850}$		(0.10)		
% manuf-workers$_{1850}$			0.703	
			(0.85)	
$\%\Delta P_{pop-weighted}$*			0.636	
% manuf-workers$_{1850}$			(0.30)	
% farm-workers$_{1850}$				-0.165
				(-0.20)
$\%\Delta P_{pop-weighted}$*				0.338
% farm-workers$_{1850}$				(0.17)
N	1522	1522	1522	1522
state fixed effects	yes	yes	yes	yes
adj. R^2	0.068	0.073	0.070	0.068

%Δfert refers to changes in fertility in farming households only.
Additional controls (urban pop, no. of farms, school enroll., manuf. output, manuf. capital, local rail by 1880, frac. of time with local rail) not reported.
t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 14: *Effect of Market Access on Fertility in Non-Farming Households, 1850–1880*

Percent Change in Fertility from 1850 to 1880				
	(1) %Δfert	(2) %Δfert	(3) %Δfert	(4) %Δfert
$\%\Delta P_{pop-weighted}$	2.786	-8.311**	-6.236**	12.06
	(1.30)	(-2.64)	(-2.66)	(1.96)
% high-skilled$_{1850}$	-11.97			
	(-0.86)			
$\%\Delta P_{pop-weighted}$*	-13.62			
% high-skilled$_{1850}$	(-0.39)			
% mid-skilled$_{1850}$		24.03**		
		(2.79)		
$\%\Delta P_{pop-weighted}$*		55.13*		
% mid-skilled$_{1850}$		(2.36)		
% manuf-workers$_{1850}$			9.255**	
			(2.80)	
$\%\Delta P_{pop-weighted}$*			22.81*	
% manuf-workers$_{1850}$			(2.40)	
% farm-workers$_{1850}$				-6.693*
				(-2.46)
$\%\Delta P_{pop-weighted}$*				-16.75*
% farm-workers$_{1850}$				(-2.08)
N	1529	1529	1529	1529
state fixed effects	yes	yes	yes	yes
adj. R^2	0.288	0.365	0.304	0.295

%Δfert refers to changes in fertility in non-farming households only.
Additional controls (urban pop, no. of farms, school enroll., manuf. output, manuf. capital, local rail by 1880, frac. of time with local rail) not reported.
t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

References

Ager, P., F. Cinnirella, P. Jensen. 2018. The Kindergarten Movement and the U.S. Demographic Transition. Work in progress.

Aker, J. C. 2010. Information from Markets Near and Far: Mobile Phones and Agricultural Markets in Niger. American Economic Journal: Applied Economics 2: 46–59.

Atack, J. 2016. "Historical Geographic Information Systems (GIS) database of U.S. Railroads for [1830–1890]"

Baldwin. R. 2016. The Great Convergence: Information Technology and the New Globalization. Harvard University Press.

Becker, G.S., Lewis, H.G. 1973. On the Interaction between Quality and Quantity of Children. Journal of Political Economy, 81(2), 279–288

Cervellati, M., Sunde, U. 2015. The Economic and Demographic Transition, Mortality, and Comparative Development. American Economic Journal: Macroeconomics, 7(3): 189–225

Cordoba, J. C., M. Ripoll. 2018. The Elasticity of Intergenerational Substitution, Parental Altruism, and Fertility Choice. Review of Economic Studies 86(5): 1935–1972.

Delventhal, M. J., J. Fernández-Villaverde and N. Guner. 2021. Demographic Transitions Across Time and Space. NBER Working Paper No. 29480.

Doepke, M. 2004. Accounting for Fertility Decline During the Transition to Growth. Journal of Economic Growth 9: 347–383.

Donaldson, D., R. Hornbeck. 2016. Railroads and American Economic Growth: A "Market Access" Approach, Quarterly Journal of Economics 131(2): 799–858.

Easterlin, R. A. 1975. An Economic Framework for Fertility Analysis. Studies in Family Planning 6(3): 54–63

Galor, O., A. Mountford. 2008. Trading Population for Productivity: Theory and Evidence. Review of Economic Studies 75(4): 1143–1179.

Galor, O., Weil, D.N. 2000. Population, Technology, and Growth: From Malthusian Stagnation to the Demographic Transition and Beyond. American Economic Review 90(4), 806–828.

Goyal, A. 2010. Information, Direct Access to Farmers, and Rural Market Performance in Central India. American Economic Journal: Applied Economics 2(3): 22–45.

Greenwood, J., Seshadri, A. 2002. The U.S. Demographic Transition. American Economic

Review (Papers and Proceedings), 153–159.

Guinnane, T.W. 2011. The Historical Fertility Transition: A Guide for Economists. Journal of Economic Literature 49(3): 589–614.

Haines, Michael R. 2000. The Population of the United States, 1790-1920. S. Engerman and R. Gallman (eds.) The Cambridge Economic History of the United States, Vol. 2. Cambridge, UK: Cambridge University Press.

Haines, M. R. 2010. Historical, Demographic, Economic, and Social Data: The United States, 1790–2000, volume ICPSSR02896-v3. Inter-university Consortium for Political and Social Research [distributor], Ann Arbor, MI.

Hansen, C., P. Jensen, L. Lønstrup. 2017. The fertility decline in the United States: schooling and income, Macroeconomic Dynamics, 22(6): 1584–1612.

Hornbeck, R., M. Rotemberg. 2019. Railroads, Reallocation, and the Rise of American Manufacturing. NBER no. 26594.

Jaremski, M., P Fishback. 2018. Did Inequality in Farm Sizes Lead to Suppression of Banking and Credit in the Late Nineteenth Century?, Journal of Economic History 78(01): 155–195.

Jensen, R. 2007. The Digital Provide: Information (Technology), Market Performance, and Welfare in the South Indian Fisheries Sector. Quarterly Journal of Economics 122(3): 879–924.

Jones, L., M. Tertilt. 2008. Chapter 5: An Economic History of Fertility in the United States: 1826–1960. Volume 1 — Frontiers of Family Economics, ed. Peter Rupert: 165–230.

Kim, Sukkoo. 1998. Economic Integration and Convergence: U.S. Regions, 1840–1987. Journal of Economic History 58(03): 659–683.

Kitchens, Carl T., Rodgers, Luke P. 2020. The Impact of the WWI Agricultural Boom and Bust on Female Opportunity Cost and Fertility. NBER Working Paper No. 27530.

Klemp, M., Weisdorf, J.L. 2012. Fecundity, Fertility and Family Reconstitution Data: The Child Quantity-Quality Trade-Off Revisited. CEPR Discussion Paper No. DP9121.

Mintz, S., S. McNeil. 2018. Digital History. Retrieved January 15, 2022 from http://www.digitalhistory.ul

Murphy, T. E. 2015. Old habits die hard (sometimes): Can "departement" heterogeneity tell us something about the French fertility decline? Journal of Economic Growth 20(2): 177–222.

Murtin, F. 2013. Long-term Determinants of the Demographic Transition: 1870-2000.

Review of Economics and Statistics, 95(2), 617–631.

O'Rourke, K., A. S. Rahman, A. Taylor. 2013. Luddites and the Demographic Transition. Journal of Economic Growth, 18(4): 373–409.

O'Rourke, K., A. S. Rahman, A. Taylor. 2018. Trade, Technology and the Great Divergence. Working paper.

Ruggles, S., C. A. Fitch, R. Goeken, J. D. Hacker, M. A. Nelson, E. Roberts, M. Schouweiler, and M. Sobek. 2021. IPUMS Ancestry Full Count Data: Version 3.0 [dataset]. Minneapolis, MN.

Rupert, P., R. Rogerson, R. Wright. 1995. Estimating Substitution Elasticities in Household Production Models. Economic Theory 6(1): 179–193.

Schultz, T. P. 1985. Changing World Prices, Women's Wages, and the Fertility Transition: Sweden, 1860-1910. Journal of Political Economy 93(6): 1126–1155.

UN DESA and Gapminder. 2019. Total fertility rate in the United States from 1800 to 2020* [Graph]. In Statista. Retrieved March 05, 2022, from https://www.statista.com/statistics/1033027/fertility-rate-us-1800-2020/

Wanamaker, M. 2012. Industrialization and Fertility in the 19th Century: Evidence from South Carolina, Journal of Economic History. 72: 168–196.

Wrigley, E. A. 1988. Continuity, Chance, and Change. Cambridge University Press, Cambridge.