Revisiting the Link Between Electrification and Fertility: Evidence from the Early 20th Century United States

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Abstract

The decline in fertility occurring throughout the first half of the 20th century in the United States and preceding the baby boom remains largely unexplored. This paper presents empirical and theoretical evidence linking this decline to the spread of electricity. Using data on early electrification efforts, I empirically disentangle two channels linking electrification and fertility: the introduction of time-saving appliances that reduce the time needed for child-rearing; and the rise in female wages which raises the opportunity cost of childcare. I then use these empirical estimates to calibrate a model that features both channels and quantifies the aggregate impact of electrification on fertility. I find that electrification explains 3.1% of the overall fertility decline in 1900–1940 in the US, and that this decline is driven by young childless women who can reap the labor market gains of electricity.

JEL Codes: J13, J16, J22, O33, E24

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From 1900 to 1940, the total fertility rate in the United States declined sharply. At the beginning of the century, American women had an average of 3.8 children throughout their reproductive years. By 1940, this number had dropped to 2.3 (Haines (2006)). The magnitude of this decline is comparable to the baby boom, which induced a rise in the total fertility rate of American women of about 1.3 children between 1940 and 1960. However, unlike for the baby boom, the drivers behind this large decline in fertility remain largely unexplored.[1] In this paper, I present empirical and theoretical evidence linking this decline to the rollout of electricity occurring concurrently in the United States during this period.

Several papers point to technological change as a key driver of fertility transitions (Galor and Weil (1996), Greenwood et al. (2017), Bailey and Hershbein (2018)). According to this literature, technological change plays an outsize role by altering three key margins mediating the costs and benefits of childbearing: (1) the explicit cost of children (such as the relative cost of food, clothing, and childcare time needs); (2) the opportunity cost of children (such as the relative cost of giving up work time in order to engage in childcare); and (3) the utility of children (such as the potential to help with household chores, farm duties or in parental care in old age). Electricity affects several of these margins and as a consequence, the effect of electrification on fertility is theoretically ambiguous. On the one hand, as highlighted by Greenwood et al. (2005), electrification may increase fertility by encouraging the use of time-saving appliances in the home which reduce the time needed for childrearing. On the other hand, electrification may decrease fertility by increasing female wages and thus the opportunity cost of child-rearing as highlighted by Vidart (2024).[2]

In this paper, I first present empirical evidence disentangling these two channels and documenting the empirical link between electrification and fertility using data from the early electrification of the United States. I focus, in particular, on the effects of electrification investments made during the 1910s, an interesting and seldom-examined period in the history of electrification.[3] I combine an individual-level panel dataset built from the full-count 1910–1940 decennial census waves using the record linkages proposed in the Census Tree Project developed by Price et al. (2021) and Buckles et al. (2023), a dataset with information about the electric capacity generated within each county in 1911 and 1919 built from digitized his-

[1]See Van Bavel and Reher (2013) for a review of the extensive literature exploring the causes of the baby boom.

[2]Like other technological advances, electrification may affect fertility through other channels like income or the relative cost of food and other goods. I focus on the opportunity cost and time-saving appliance margins in the empirics since they are more unique to electrification as a technology, but do allow for other channels, such as income and cost of living in the model.

[3]During this era, the proportion of households with electricity rose from 15 to 35 percent, and electrification efforts concentrated in "Middle America": midsize urban areas that were electrified after large cities, but still early in the expansion of the electric grid across America (Rieder (1989), Nye (1992)).

torical documents, and a dataset with measures of electrical prices in different cities built from United States Department of Labor and Statistics. (1992). Using these data sources, I study the effects of electrification in the 1910s on the fertility of women in the 1910-1940 period.

I rely on two empirical estimates in order to disentangle the two aforementioned channels mediating the relationship between electrification and fertility. First, I use the differential effect of electrification on the fertility of women who had one or more children in the baseline period of 1910, relative to those who had no children, in order to pin down the effect of electrification working through the opportunity cost channel. Since mothers were much less likely to engage in the labor force due to cultural factors, childrearing responsibilities, and other barriers, women who were already mothers upon electrification were less likely to take into consideration changes in female wages or labor opportunities when making their subsequent fertility decisions.[4] Second, I compute the differential effect of electrification on the fertility of women living in areas where the residential price of electricity was higher, relative to those living in areas where it was lower, in order to pin down the effect of electrification on fertility working through the time savings of home production channel. Since areas with a higher cost of residential electricity face a higher cost of operating time-saving appliances, women living in these areas are less affected by the time savings dimension of electrification.[5] I use a triple difference (DDD) approach to identify each of these effects. I provide empirical and anecdotal evidence in support of the identification strategy, along with pre-treatment trend tests. In particular, I show that electrification investments made during the 1910s were driven primarily by static cost considerations and continued well into the 1920s. This provides a control group comprising counties of similar characteristics that gained access to electricity at different times. Moreover, the specification includes a rich set of controls comprising demographic, income, and wealth variables, along with individual, county, year and state-by-year fixed effects.

I find that the decline in the number of children per woman triggered by electrification was

[4] An example of such barriers were marriage bars which were policies adopted by firms and local school boards that restricted the employment of married women. These bars were very common throughout the United States in the first half of the 20th century (Goldin (1991)). In practice, many women kept their marital status secret from employers in order to circumvent these marriage bars (McDonald Way (2018)). Keeping this secret became much harder with pregnancy and childbirth, however.

[5] One potential concern with this strategy is that firms in areas with higher residential electricity costs also faced higher electrical costs, thus also potentially reducing the opportunity cost of labor for women. I show that this does not seem to be the channel operating here since the differential effects of electrification on the fertility of women by residential electricity price are still prevalent (and particularly marked) among women who were already mothers upon electrification and thus less prone to be affected by wage or job opportunity changes.

0.31 children lower among women who were already mothers in 1910 (about 83% smaller relative to those who had no children). This suggests that electrification had a less marked effect in decreasing fertility for women who had a limited attachment to the labor market. Moreover, I find that this differential effect is even more marked among older cohorts, who are even less likely to be attached to the labor market. Further, I find that increasing the price of one mega-watt of residential electricity by $10 increases the decline in the number of children born per woman induced by electrification by 0.036 children. This effect is driven by women who lived in the North and in urban areas. This suggests that the importance of the time savings channel of electrification was dwarfed in the rural South, and that other factors, such as the prevalence of Jim Crow laws, along with the reduction of infant mortality triggered by electrification due to the use of water pumps in rural areas (Lewis (2018)), were more important drivers of the fertility patterns in this region during the first half of the 20th century.[6]

I then build a model that embeds these time-saving and opportunity cost mechanisms in an overlapping generations structure. In the model, electrification reduces the price of electricity encouraging appliance use and reducing the time burden of childcare, but also increases female wages raising the opportunity cost of childcare. I calibrate the model to the first half of the 20th century United States, and use the empirical estimates described above to discipline the parameters mediating these two channels by computing analogous DDD estimates to the ones computed empirically in the context of the model. In order to generate the maternal status heterogeneity exploited in the empirical analysis, I introduce household-level heterogeneity in the relative value of female leisure which changes the relative cost of childcare and motherhood. In addition, in order to generate the regional heterogeneity in electricity prices exploited in the empirical analysis, I assume there are several regions in the model featuring different region-specific technologies for the production of electricity matching the distribution of prices observed empirically. I further assume that these regions are split into sub-regions which gain progressive access to electrification.

I simulate the expansion of the electricity grid from 1900–1940 in the United States, and find that the model can explain 3.1% of the decline in fertility in this period. This decline

[6] These mechanisms are also alluded to when I explore the effects of electrification on fertility *per se* in a double differences framework. In particular, I find that although electrification depressed women's overall fertility, this decline concentrates among younger cohorts, with older cohorts experiencing a slight increase in fertility after electrification. This is consistent with the results outlined above where for younger women who are less likely to be mothers and are more attached to the labor market the opportunity cost channel of electrification is particularly important, while for older women the time savings channel may be more important. Relatedly, I also find that electrification delayed the timing of childbearing for subsequent cohorts of women (particularly those who were very young when electrification occurred), highlighting the importance of the opportunity cost channel of electrification among newer cohorts.

is driven by the opportunity cost channel as electrification raises the opportunity cost of spending time at home raising children instead of working. However, the magnitude of this decline is moderated since the opportunity cost channel heavily concentrates among young women as these do not have childcare responsibilities that dampen their labor market gains from electricity. In particular, among older women and mothers, fertility trajectories are reduced less by electrification (and in some cases even increase) since labor market gains are dampened due to childcare requirements, and the time needed for childcare is reduced. This matches the evidence presented in the empirical section suggesting that electrification reduces the fertility of women who were not mothers upon electrification more, and the evidence presented in Goldin (2020) who shows that at the turn of the 20th century women's female labor force participation concentrated during their youth, and was significantly reduced once they married and became mothers.

Finally, I perform counterfactual analyses that subsequently shut down the opportunity cost and time savings channels in the model to shed light on their relative importance. First, I find that when the opportunity cost channel is shut down, and since in this case electrification solely reduces the time burden of childcare, fertility counterfactually increases in 1900–1940. Second, I find that when the time savings channel is shut down, the decline in fertility predicted by the model in 1900–1940 is only 1.16 percentage points larger than in the baseline case. This implies that the opportunity cost channel is preponderant in explaining the response of fertility to electrification, and that the fact that this channel heavily concentrates among young women is a key moderating force of the aggregate effect of electrification.

The rest of the paper is organized as follows: Section 1 situates this paper and its contributions in the literature. Section 2 provides a brief history of fertility and electrification trends in the United States from 1900 to 1940, with a discussion of the importance of different channels in driving the connection between these two phenomena. Section 3 presents data and evidence on the link between electrification and fertility in the early 20th-century United States and discusses the results of the effects of electrification used to calibrate the model. Section 4 presents the model, calibration, and quantitative results. Section 5 concludes.

1 Related Literature

This paper contributes to multiple strands of literature. The model features a joint work and fertility framework first formalized by Becker and Lewis (1973), and later explored and extended by several others (Becker et al. (1990), Galor and Weil (1996), De La Croix and Doepke (2003, 2004), Greenwood et al. (2005), Doepke et al. (2013), Baudin et al. (2015)).

Within this framework, I embed two mechanisms specifically related to electrification: childcare time savings as first proposed by Greenwood et al. (2005), and relative increase in female wages as proposed by Vidart (2024). The model developed in Greenwood et al. (2005) features mechanisms similar to the ones presented here in order to explain the baby boom and the secular decline in fertility that both preceded and succeeded it. In particular, their model and quantitative exercises explain the decline in fertility via the rise in market wages stemming from technological progress in the market sector, and reconcile the baby boom through the childcare time savings triggered by electrification and appliance use in the home sector. There are some key differences between this analysis and mine. First, the direct quantitative role of electrification on the aforementioned mechanisms is not considered by Greenwood et al. (2005). In their model and quantitative assessment, these mechanisms emerge as a consequence of technological progress broadly defined: real wage growth stems from TFP growth in the past 200 years, and household-level productivity is assumed to have a growth burst starting in 1940. In contrast, this paper uses well-identified empirical estimates to discipline the parameters mediating the time savings and opportunity costs dimensions of electrification, and links these channels to the decline in fertility occurring during the first half of the 20th century.

By exploring the impact of electrification on fertility, this paper also relates to the empirical literature that examines the link between electrification, fertility, (Cavalcanti and Tavares (2008), Coen-Pirani et al. (2010), Bailey and Collins (2011), Lewis (2018)), and other female outcomes (Dinkelman (2011), Lewis and Severnini (2017)). This paper contributes to this literature in three ways. First, this paper empirically distinguishes and disentangles two theoretically opposing channels driving the link between electrification and fertility: the rise of time-saving appliances which reduce the time needed for child-rearing and encourage fertility, and the rise of female wages, which increase the opportunity cost of childcare and discourage fertility. This contrasts with most of the papers in this literature which predominantly focus on the effects of appliance use on fertility or other female outcomes. Second, this paper explores the impacts of early electrification efforts on fertility, and particularly those occurring in "Middle America". Due to data availability, other papers predominantly focus on electrification efforts and consumer durable expansions that occurred many decades later. Finally, the paper approaches this issue from a macro perspective that links the empirical effects of electrification with the aggregate decline in fertility observed during the first half of the 20th century in a quantitative framework.

More broadly, this paper relates to the literature exploring the effects of technological change on fertility. This literature includes work examining the relationship between technological progress and changes in fertility and family structure from a macroeconomic perspective (see Greenwood et al. (2017) for a survey of this literature), and work exploring the impact of specific technologies on fertility from an applied perspective (see Lafortune et al. (2020) and Bailey and Hershbein (2018) for surveys). Some of the technologies shown to have an impact on fertility include the contraceptive pill (Goldin and Katz (2002), Bailey (2006), Knowles (2009)), medical advances (Albanesi and Olivetti (2016)), air conditioning (Barreca et al. (2018)), and broadband internet (Guldi and Herbst (2017)).

Finally, this paper relates to studies investigating the sources driving the fertility trends observed in the United States during the 20th century (Greenwood et al. (2005), Bailey et al. (2012), Doepke et al. (2013), Bellou and Cardia (2014), Albanesi and Olivetti (2016), Siegel (2017), Kitchens and Rodgers (2020)).[7] By exploring the impact of electrification on the decline of fertility in the first half of the 20th century, this paper particularly relates to Kitchens and Rodgers (2020), who also explore the drivers behind this decline, and focus specifically on the role of increases in crop revenues triggered by World War I.

2 Context and Motivation: The Decline of Fertility in the US in the First Half of the 20th Century

From 1900 to 1940, the total fertility rate in the United States declined sharply. At the beginning of the century, American women had an average of 3.8 children throughout their reproductive years. By 1940, this number had dropped to 2.3 (Haines (2006)).[8] From 1940 to 1960, during the baby boom, the total fertility rate rose again, reaching levels comparable to those of 1900. After the baby boom there was a countervailing baby bust that lasted until 1980. Fertility has increased slightly since, with the total fertility rate hovering around 2 children in 1990 and 2000.

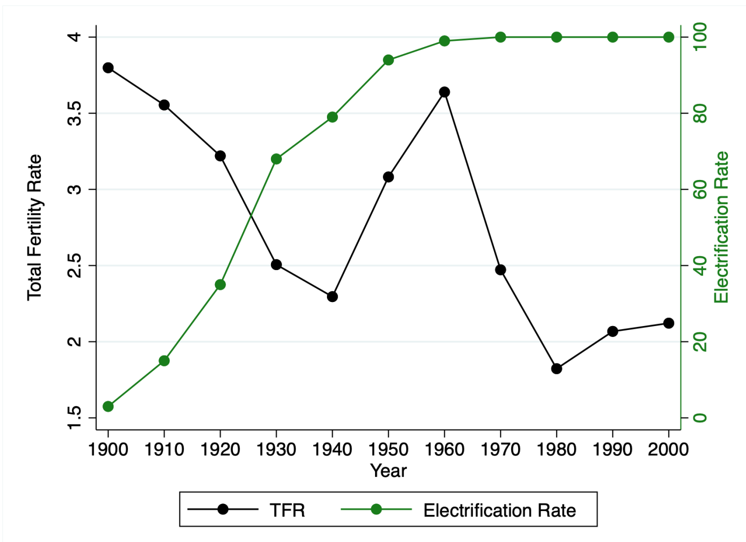
During the first half of the 20th century, as fertility was declining, electrification spread widely in the United States (see Figure 2.1 for a graphical depiction of these electrification and fertility trends). This process started in 1882 with the building of the Pearl Street Generating Station in New York City by the Edison Illuminating Company and Thomas A. Edison overseeing its operations. In the next two decades, privately owned utility companies expanded electricity to all large cities. One example is the Commonwealth Edison Company owned and run by Sam Insull, who played an instrumental role in building electricity infrastructure in Chicago and throughout much of the Midwest (Wasik (2008)). During the 1910s and 1920s,

[7] See Bailey and Hershbein (2018) for a survey.

[8] This decline was prevalent among both black and white women, see Figure A.1.

the electrification impetus continued into midsize towns and cities driven by private interests looking for new opportunities outside large cities. Rural America, however, lagged behind, with less than 10 percent of rural homes reporting having access to electricity in 1930 (Lewis (2018)). As a consequence, Franklin D. Roosevelt established the Rural Electrification Administration (REA) as part of the New Deal in the 1930s. The process of electrification of rural America lasted until 1960, when virtually all households in America reported having access to electricity.

Figure 2.1: Total Fertility Rate (TFR) and Electrification Rate in the United States



Source: Lebergott (1976) (Proportion of Electrified Households) and Haines (2006), combined with proportion of women by race from Census.[9]

Fertility and electrification have been linked via two main explanations. The first explanation highlights the role of childcare time savings triggered by appliance use and electricity. According to this view, electrification led to a rise in fertility by making home production and childcare less time intensive. This explanation is particularly relevant to 1900–1940, since several key time-saving appliances were first patented and mass produced during this period,[10] leading to a consistent rise in adoption by American households captured in Figure 2.2a. The second explanation roots the link between electrification and fertility on the fact that the expansion of electricity increased the demand for labor, and fueled the creation of new work opportunities for women. According to this view, electricity increased the demand for skilled and semi-skilled labor (Goldin and Katz (1998), Gray (2013)), and thus

[9]The fertility rate data provided by Haines (2006) is divided by race. I construct the nation-wide measure of fertility presented here by weighting the race-specific fertility rates with the proportion of 15–49 women of each race at each year.

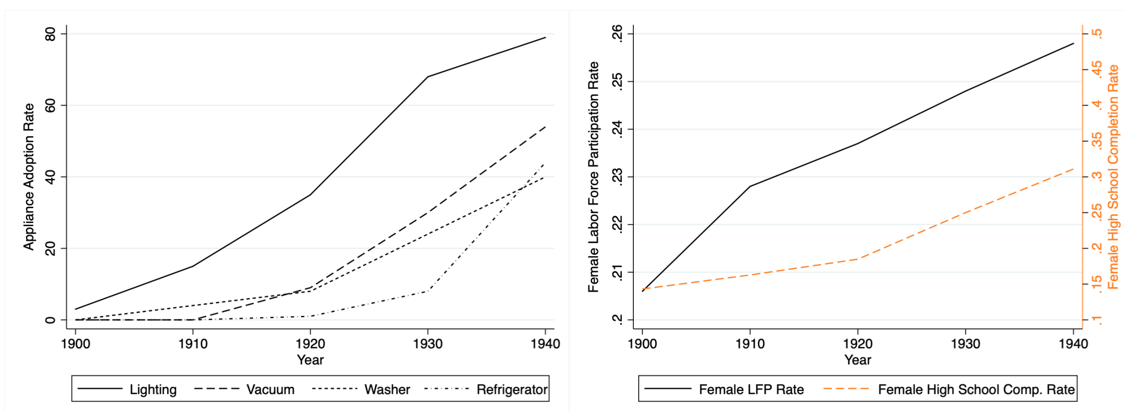
[10]Some of these appliances include the vacuum cleaner (patented in 1908), washing machine (patented in 1908), iron (patented in 1905), and refrigerator (patented in 1915). In Figure A.3, I include some examples of ads promoting these appliances at the time.

led to the creation and expansion of clerical positions where brawn ability was not important and female labor was favored (Nye (1992), Vidart (2024)).[11] This in turn increased the opportunity cost of childrearing and depressed fertility. In Figure 2.2b, I show patterns consistent with this view by depicting the increase in female labor force participation and high school completion rate in 1900–1940. Female labor force participation rose from 20.6% in 1900 to 25.8% in 1940, while high school attainment also rose sharply, from 14.32% in 1900 to 31.1% by 1940. In this paper, I revisit the relationship between electrification and fertility by empirically disentangling these two channels, and then using these empirical estimates in a model of endogenous fertility to quantify the aggregate effect of electrification on fertility in 1900–1940 in the United States.

Figure 2.2: Electrical Appliance Adoption Rate, Female Labor Force Participation (LFP) and Female High School Completion Rate in 1900–1940

(a) Electrical Appliance Adoption Rate

(b) Female Labor Force Participation (LFP) Rate and Female High School Completion Rate



Sources: Lebergott (1976), Goldin (1990), and own calculations from census data.

An important issue to note here is the availability of birth control during the period considered, and the agency women had to regulate their fertility. The practice of birth control was common throughout the United States even prior to 1914, when the movement to legalize contraception began. Longstanding techniques include the rhythm method, withdrawal, pessaries, condoms and diaphragms made from linens and animal skin, and prolonged breastfeeding. In the 1840's, condoms and diaphragms made from vulcanized rubber started being mass produced and became common to regulate fertility. The Comstock laws were enacted in 1873, however, and deterred the use of these by prohibiting advertisements, information, and distribution of birth control. In response, contraceptive trade was concealed but not eliminated. Advertisements for birth control used euphemisms such as "marital aids" or "hy-

[11] In Figure A.2, I include two examples of the clerical positions opened and encouraged by electrification favoring women: switchboard operators and secretaries.

gienic devices", and drug stores continued to sell condoms as "rubber goods" and pessaries as "womb supporters" or "uterine elevators". (Engelman (2011)).

3 Empirical Evidence

I now present empirical evidence focused on disentangling the opportunity cost and time savings channels linking electrification and fertility. I use data from the first half of the 20th century in the United States, and estimate the effects of electrification efforts put forward during the 1910s on individual outcomes in the 1920–1940 period. I employ two triple difference (DDD) approaches focusing on the heterogeneity of the effects of electrification by maternal status and residential price of electricity, respectively, in order to explore the differential impact of electrification on the fertility of women who were more or less likely to be affected by the opportunity cost and time savings channels of electrification. I also explore the effects of electrification on fertility *per se* through a double differences framework in Appendix C, along with the effects of electrification on age at first birth in Appendix E. These results are discussed below.

I combine data from three sources. First, I use an individual-level panel dataset built from the full-count census waves in 1910–1940 using the record linkages proposed in the Census Tree Project developed by Price et al. (2021) and Buckles et al. (2023). Second, I use county-level electrification data in the 1910s built from a dataset with the universe of utilities and central generating stations in 1911 and 1919 (Vidart (2024)). Finally, I use data on the prices of residential electricity in the 1910s built from United States Department of Labor and Bureau of Labor Statistics (1992) which contains information from a survey about household-level expenses for a variety of goods and services in 100 cities throughout the United States in 1917–1919.

The 1910s was a decade of rapid expansion of electricity generation and the electricity grid in the United States. During this period, the proportion of American homes with access to electricity increased by 20 percentage points, rising from 15 percent in 1910 to 35 percent in 1920 (Lebergott (1976)). Electrification efforts during this era were primarily focused in "Middle America," meaning medium-sized towns comprising an urban area with a defined city center, a few streets, and small factories and productive operations (Rieder (1989)).[12] The process of electrification in these areas was marked by two distinct eras. The first, which lasted roughly from 1890 to 1900, was driven by municipal interests which built small generating

[12] In 1910, roughly 23 percent of the United States 15+ population lived in "Middle America," defined as counties with a 15+ population between 15,000 and 30,000 (approx. 70th to 90th percentiles of United States county-level population).

plants to power street arc lighting. In the second era, which lasted from 1910 to 1930, new generating plants were built (and older ones expanded) by privately owned electricity utilities looking for new business opportunities and consolidation outside the already-electrified large cities (Nye (1992)). This process was mostly cost-driven, with geographical considerations like slope and the length of lines that needed to be built being chief drivers of plant location. The electrification of "Middle America" continued into the 1920s, after which time only rural areas remained to be electrified.

3.1 Electricity Data

I use county-level measures of electrification in the United States in the 1910s built from a dataset with the universe of central generating stations in 1911 and 1919 (Vidart (2024)). This historical dataset was constructed by digitizing two editions of "Central station directory: a complete list of electric light and power companies with data" (McGraw Publishing Company (1911, 1919)) which contain capacity and location information for 5409 and 5631 generators in 1911 and 1919, respectively. Using this location and generation capacity information, I construct measures of the capacity generated within and around each county in the United States.[13] The preferred treatment definition follows from this, and is given by the change in the total electrical capacity within and 50 miles around each county's boundaries between 1911 and 1919.

Given historical constraints in transmission technology, this treatment definition approximates the change in the extent of electrification in each county during the 1910s.[14] Moreover, this measure captures smaller plants which are important in this period and tend to be overlooked in other studies that only consider the output and location of large plants.[15,16] For details on these books, the digitization process, the construction of the electrification variables, and the historical context of transmission and suitability of the county-level electrification measures, please see Vidart (2024).

In Figure 3.1, I present county-level maps of the change in the total capacity within and 50

[13]County boundaries have changed throughout time in the United States. In order to maintain consistent county boundary definitions, I use the county definitions from 1910, and link these back to other years using the crosswalk built by Eckert et al. (2020).

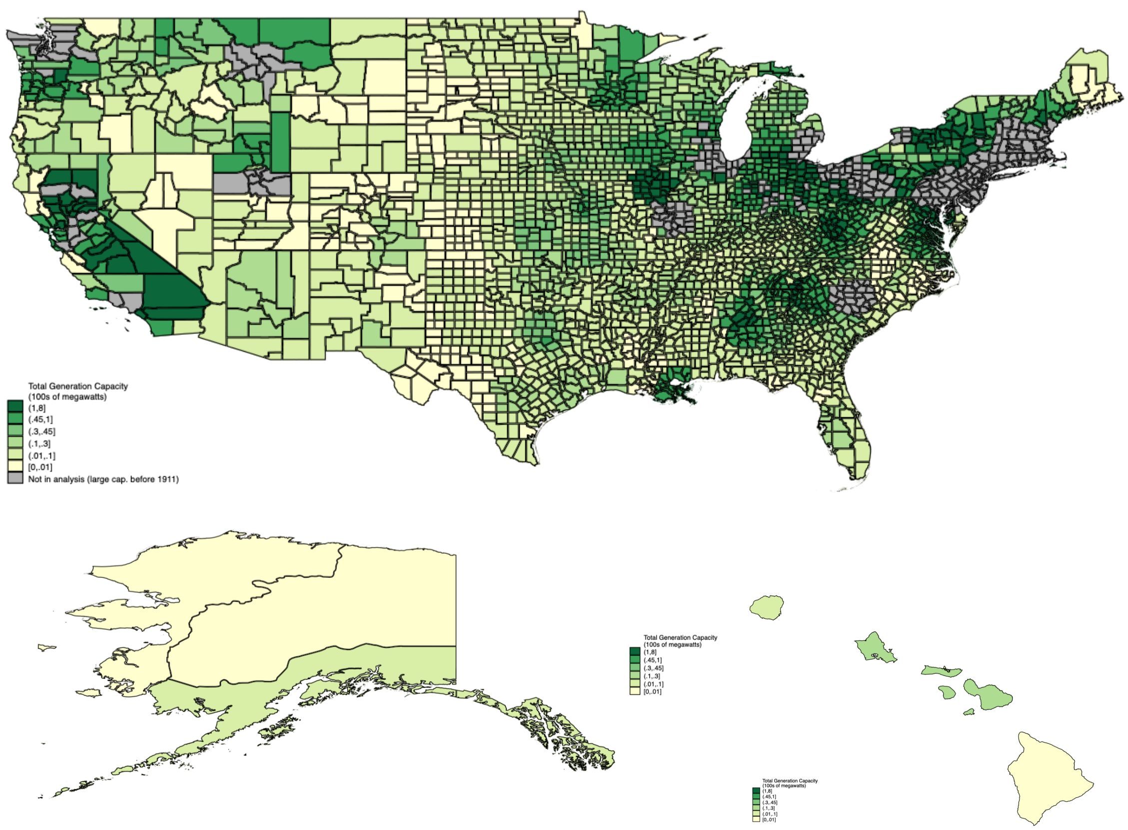
[14]This measure has limitations, however, since it does not capture the exact location of lines within each county. To the best of my knowledge, there is no data on electric transmission lines prior to 1919.

[15]This treatment measure also strongly correlates with measures of farm electrification available from the agricultural censuses in 1930 and 1940, which represent direct measures of area-level electrification. See Vidart (2024) for details.

[16]The results are similar when I use an alternate treatment definition based on proximity to large electricity generating plants. For this, I use a dummy indicating whether the county is 100 miles or less from a large capacity generating plant (20 megawatts or more). See Appendix F.5 for details.

miles around county boundaries between 1911 and 1919 that follow from this electrification data. In this treatment definition, I exclude counties that were already widely electrified before 1911 (above 90th percentile of generation capacity), in order to focus on areas that gained access to electricity during the 1910s. The excluded areas correspond to large cities such as New York, Washington DC, Los Angeles, Chicago, Seattle, and Detroit, and areas with substantial generating resources, such as some areas in Montana (hydroelectricity) and West Virginia (coal). The treatment, however, encompasses most of the United States (in terms of both population and land mass), and has substantial regional variation.

Figure 3.1: Map of County-Level Intensity of Electrification Treatment in the United States

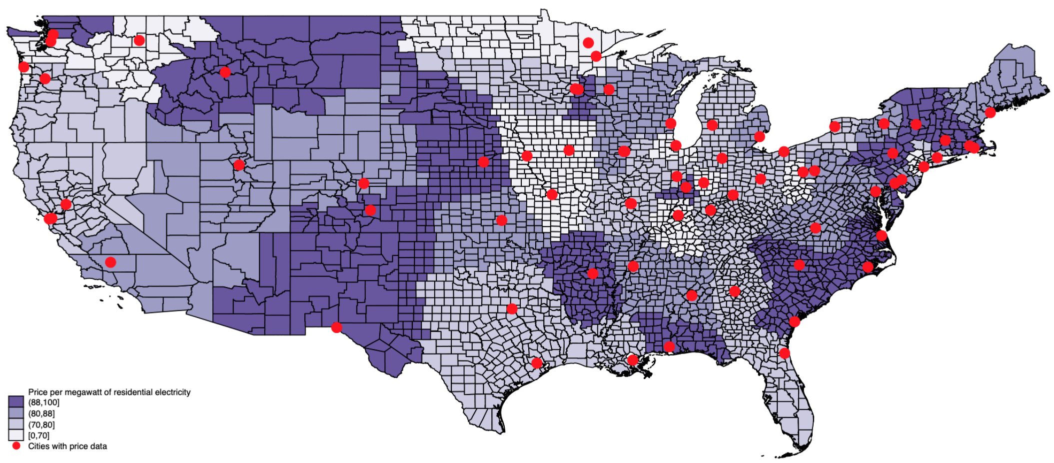


Notes: Electrical generation capacity within and 50 miles around each county.

3.2 Residential Electricity Price Data

I use data on the prices of residential electricity in 1917–1919 taken from a household expenditure survey put forward by United States Department of Labor and Bureau of Labor Statistics (1992). This survey aimed to estimate the cost of living of a "typical" American family in 1917–1919, and therefore collected information from families of wage earners or salaried workers in 100 cities across the United States. Specifically, the survey asked about family expenses and quantities purchased of food, housing, clothing, fuel, furniture, and miscellaneous household items in the last calendar year. I use information on the quantity and total expenditure on electricity used for heating, cooking or lighting in the household in order to construct an average measure of the price per kilowatt/hour of residential electricity in each city. I then attach to each county the price in the closest city in the survey, where distance is measured using the county-centroid as the point of reference.[17] In Figure 3.2 I present county-level maps of the prices of residential electricity which also indicate the cities surveyed.[18] In Table 3.1 I present some summary statistics on the residential electricity price data. For details on this survey and the construction of the residential price of electricity measures please see Appendix B.2.

Figure 3.2: Map of County-Level Residential Electricity Prices in the United States



Notes: Price per megawatt of residential electricity corresponding to that of the closest city in the price survey to the county centroid.

Table 3.1: Summary Statistics on the County-Level Residential Electricity Price Data

	Mean	Std. Dev.	Min.	Max.
Price of mw/hour of residential electricity (dollars)	79.32	9.71	60.14	99.37
Share of total expenditure spent in electricity (for connected HHs)	0.01	0.002	0.006	0.015
Distance to closest city with price data (miles)	107.83	128.39	0.12	2456.193

3.3 Panel Data

I combine the electrification and residential electricity price data with an individual-level panel dataset built from the full-count 1910–1940 decennial census waves using the record

[17] In Appendix F.10 I consider the robustness of the results to using an alternate measure of electricity prices based on the utility-level rate structures collected by the National Electric Light Association in some cities.

[18] The county-level measures of electricity prices are more granular in the eastern portion of the United States rather than the west since most of the cities in the survey are located there. As such, in Appendix F.4 I repeat the main empirical analyses after dropping all counties west of the hundredth meridian and find the results to be consistent to baseline.

linkages proposed in the Census Tree Project developed by Price et al. (2021) and Buckles et al. (2023). This linking method leverages familial relationships entered into the genealogy platform FamilySearch.org to link records across census waves, and thus overcomes the challenge of linking women's census records arising from name changes upon marriage as users of the platform generally have private familial information such as maiden names.

A vast portion of these linkages come directly from users of the platform who can identify their relatives across different census waves thus creating a census-to-census links. Further links are created by using the direct links created by users as training data for a machine learning algorithm, and by adding matches from the Census Linking Project and the IPUMS Multigenerational Longitudinal Panel.[19] For details on the construction of this panel data, please see Appendix B.3.

Table 3.2: Summary Statistics in Panel and Repeated Cross-Section Data in 1910 (women of ages 15–44 living in areas that were not electrified in 1910)

	Panel Women	Repeated XSec Women
Avg. children born per woman	2.84	2.37
Avg. number of own children in HH per woman	1.73	1.40
Avg. number of own children <18 in HH per woman	1.68	1.34
Prop. mothers	0.86	0.78
Avg. age at first birth[20]	22.21	21.37
Labor force participation	0.17	0.2
Prop. attending school	0.11	0.12
Prop. married	0.71	0.60
Prop. urban	0.31	0.37
Avg. socioeconomic index	4.63	5.46
Prop. white	0.95	0.86
Total obs.	4,267,775	13,064,666

In the analysis, I focus on individuals who were between 15 and 44 years old in 1910, and lived in areas that gained access to electricity during the 1910s using the data and treatment

[19]The false positive rate among the predicted matches is about 12% in this data. In Appendix F.11 I consider the robustness of the main results to two alternate and more conservative record-linking methods matching individuals across census waves: a method that leverages the algorithm proposed by Abramitzky et al. (2012, 2014) and that thus relies on name, birth year, and state or country of birth matches to link records; and the method proposed by Althoff et al. (2023) which leverages social security application information to link records. The results from these alternate linking strategies are very consistent with the baseline results.

[20]Due to data constraints, the age at first birth is measured by subtracting the age of the eldest child currently living with the woman from her current age. Thus, this variable does not always capture the true age at first birth, particularly for older women whose eldest child has likely left the household.

described above and depicted through non-grey areas in Figure 3.1.[21] There are total of 4,267,775 in the matched panel sample in this category. In Table 3.2 I report average values for select variables of interest in this panel sample along with the full repeated cross-section data (encompassing all individuals in each census wave), for individuals in the cohorts and treatment areas of interest.[22] I find that the linked panel sample is similar to the full cross-sectional sample along all dimensions considered, which follows from the fact that the linked data obtained from the linkages developed in this project is highly representative of the population at large. Nevertheless, a few differences remain given that the matched panel sample has information for the entire 1910–1940 period (and thus involves individuals who survive and can be identified in all census waves in this period), and stems from genealogical information that may overstate individuals who had descendants.[23]

3.4 Strategy and Identification

I focus on three fertility variables when studying the effects of electrification on fertility. The first variable corresponds to number of children ever born, available in 1910 and 1940.[24] The second and third variables correspond to the number own children of all ages and under the age of 18, respectively, residing in the same household, available in all waves considered. By comparing the number of children born to women in 1940 relative to 1910, I capture changes in completed fertility patterns across women. On the other hand, by comparing the number of own children living in the household in 1920, 1930 and 1940 relative to 1910, I also capture a dimension of fertility timing because I can see at which point in their lives women were most likely to have children living with them. By considering own children residing in the same household of both all ages and under the age of 18 I parse out the possibility of children living in the household longer due to electrification.[25]

I perform two main analyses. The first analysis estimates the effect of electrification working through the opportunity cost channel by following a triple difference strategy that computes

[21] It has been documented that the 1910 census overcounted unpaid female farm laborers (Goldin (1990)). I correct for this by excluding all women reported as unpaid female farm laborers in 1910 from the analysis.

[22] In Appendix B.1 I present these tables for 1920–1940.

[23] In appendix F.8 I consider the robustness of the main results to potential selective migration by limiting the analysis to women who reported living in the same county throughout the period of study, 1910–1940. I find that the results are very similar to baseline in this alternate specification.

[24] This variable encompassed all ever-married age 12+ females in 1910, while only sample-line females in 1940, which reduced the number of observations with this data in 1940.

[25] Please notice that since some of the effects focus on the heterogenous effects of electrification by maternal status, measuring the effects of electrification on the extensive margin of fertility, namely if women ever become mothers, is not informative in this triple difference setup. Moreover, the model is calibrated to the intensive margin I explore in this section. However, when I explore the effects of electrification on fertility *per se* in a double differences framework in Appendix C, I also consider the impacts of electrification on the extensive margin of fertility.

the differential effect of electrification on the fertility of women who had one or more children in the baseline period of 1910, relative to those who had no children. Since mothers were much less likely to engage in the labor force due to cultural factors, childrearing responsibilities and other barriers, women who were already mothers upon electrification were less likely to take into consideration changes in female wages or labor opportunities when making their subsequent fertility decisions. This analysis is captured by the following specification

$$\begin{aligned} Fertility_{i,h,c,t} &= \alpha + \beta_t \Delta Cap_c \times Post_t + \beta^{mom} \Delta Cap_c \times Mom1910_{i,h,c} \\ &+ \beta_t^{mom} Post_t \times Mom1910_{i,h,c} + \beta_t^{cap.mom} \Delta Cap_c \times Post_t \times Mom1910_{i,h,c} \\ &+ \alpha_i + \alpha_t + \alpha_c + \alpha_{s,t} + \beta_{X,t} X_{i,h,c,1910} \times Year_t + \beta_{Z,t} Z_{h,c,1910} \times Year_t + \epsilon_{i,h,c,t}, \end{aligned} \tag{1}$$

where $Fertility$ refers to each of the three fertility variables described above. i, h, c, and t denote the individual, cohort, county of residence, and year, respectively. ΔCap_c corresponds to the preferred measure of electrification, change in generating capacity between 1911 and 1919 (in 100s of megawatts), excluding counties that were already widely electrified before 1911 (above the 90th percentile of generation capacity). $Post_t$ denotes a set of three binary variables indicating post-treatment periods after 1910: 1920, 1930, and 1940. $Mom1910$ corresponds to an indicator variable taking a value of one if the woman was a mother by 1910 (measured by having non-zero own children in the same household), and a value of zero if she was not. α_i, α_t, α_c, and $\alpha_{s,t}$ denote individual, year, county and state-by-year fixed effects, respectively. $X_{i,h,c,1910}$ denotes individual-level controls in 1910 (urban status, marital status, and school attendance), while $Z_{h,c,t}$ denotes cohort by county-level controls in 1910 (total population and socioeconomic index).[26] Standard errors are clustered at the county-by-year level, since the coefficients of interest are derived from county (or treatment) and year interactions.[27] The coefficients of interest in this case are $\beta_t^{cap.mom}$, which capture the heterogeneity in the effect of treatment by maternal status in 1910.

The second analysis also follows a triple difference strategy, which is used to estimate the effect of electrification working through the time savings channel by computing the differential effect of electrification on the fertility of women who lived in areas with higher prices of residential electricity, relative to those who lived in areas lower prices. Since areas with a higher cost of

[26] I include the baseline (1910) level of these controls interacted with post-treatment indicators rather than contemporaneous levels to avoid post-treatment bias since some of the controls might be affected by treatment. Given that I consider a long period of 30 years, and that the existence of concurrent shocks or omitted variables biasing the results might be relevant, in Appendix F.1 I repeat the analyses considering contemporaneous controls. In addition, in Appendix F.6 I repeat the analyses after controlling spouses' socioeconomic status. This requires limiting only to women who are married, and carries the potential risk of post-treatment bias arising from the effect of electrification on men's outcomes and spousal decisions, however.

[27] In Appendix F.2 I consider the robustness of the results to more conservative county-level clustering.

residential electricity face a higher cost of operating time-saving appliances, women living in these areas are less affected by the time savings dimension of electrification. This analysis is captured by the following specification

$$\begin{aligned} Fertility_{i,h,c,t} = \alpha + \beta_t \Delta Cap_c \times Post_t + \beta^{price} \Delta Cap_c \times PriceResElect1919_c \\ +\beta_t^{price} Post_t \times PriceResElect1919_c + \beta_t^{cap.price} \Delta Cap_c \times Post_t \times PriceResElect1919_c \\ +\alpha_i + \alpha_t + \alpha_c + \alpha_{s,t} + \beta_{X,t} X_{i,h,c,1910} \times Year_t + \beta_{Z,t} Z_{h,c,1910} \times Year_t + \epsilon_{i,h,c,t}, \end{aligned} \tag{2}$$

where the notation follows Equation (1), and $PriceResElect1919$ corresponds to a continuous variable capturing the residential price of electricity in each county in 1917–1919, measured as dollars per megawatt/hour of electricity. The coefficients of interest in this case are $\beta_t^{cap.price}$, which capture the heterogeneity in the effect of treatment by the residential price of electricity in 1917–1919.

Identification relies on the assumption that absent electrification, individuals with the same maternal status in 1910 or residential price of electricity in 1917–1919 living in counties experiencing a large change in electrical generation capacity would have trended similarly to their counterparts in counties with a small change. Two main concerns threaten this assumption. First, areas with higher electrification investments may also exhibit other related characteristics exerting a time-varying effect on fertility during the period of study. Second, the early 20th century was a period of rapid change driven by key transformative events like World War I, the Great Depression and the development and expansion of technologies like railroads and telephones, raising the concern that unobservable characteristics or concurrent shocks occurring in areas with high levels of electrification and disproportionately targeting mothers or areas with higher electricity prices are driving the effects. In what follows, I put forth evidence supporting the identification assumptions and addressing these concerns.

The first concern is addressed through the data and historical accounts of the process of electrification, which indicate that in "Middle America" the process was primarily driven by static cost considerations and extended beyond the period of interest (1910s) into the 1920s, providing a natural control group of counties with similar characteristics that were electrified a few years later. This can be evidenced in Figure B.1 which shows that although most of the electrification during the 1910s focused on medium-sizes counties, many of these also experienced small to no change in generation capacity during this period, indicating the staggered nature of this process. This figure also shows that most of the counties that were electrified prior to the period under study had large populations. In Table B.4, I present summary statistics for individuals aged 15–44 living in counties above and below the 50th percentile of treatment, respectively, along with counties that had a large generating capacity prior to 1911 and are thus excluded from the analysis. Counties electrified to a significant extent prior to 1911 are substantially different from those in the analysis. However, the differences between counties above and below the median treatment included in the analysis are much less marked. Moreover, any remaining differences in levels are controlled with the triple differences framework,[28] and the inclusion of a rich set of controls including individual, county, and state-by-year fixed effects along with county- and person-level controls further assures that results are not driven by omitted characteristics.

To address the second concern, I examine the differential fertility effects of the expansion in generation capacity in the 1910s by residential price of electricity in 1917-1919 in 1900 (pre-treatment period).[29] In order to do this, I rely on a sub-sample of the panel sample composed of individuals I can also observe in 1900.[30] I plot the results of these exercises in Figure B.2, documenting no significant fertility differences by residential price of electricity among women living in areas that were electrified in the 1910s. These results suggest an absence of time-varying confounders in the pre-period driving the results presented below.

In addition, I show that the trends in fertility are parallel and more similar for cohorts who finished their fertility decisions prior to the 1910s among treated and control areas, and began diverging afterwards for cohorts who were still of childbearing age. In Figure B.3 I plot the average number of children per woman reported in 1940 (the final period I consider) across different birth-year cohorts by intensity (quartile) of treatment. The graph shows that the differences in fertility rates across more- and less- treated counties are parallel for cohorts born prior to 1870 and thus past childbearing age in 1910 when electricity arrived. In addition, these differences are more muted among these cohorts. For cohorts born after 1870, the differences in fertility between the different quartiles of treatment, and particularly the first and second quartiles become much more marked, indicating an effect of electrification on fertility. These results further suggest that potential omitted factors are not driving the results.

[28] In particular, given that the bulk of the analysis relies on the heterogeneity of the effects of treatment across maternal status and residential electricity price groups, some of the concerns regarding identification are alleviated because for bias to arise women who were not mothers in 1910 need to be differentially different from women who were moms in 1910 in treatment and control counties, or women living in areas with higher residential price of electricity need to be differentially different from women with lower residential price of electricity in treatment and control counties.

[29] I do not consider the differential fertility effects of the expansion in generation capacity in the 1910s by maternal status in 1910 since by construction, women who were not mothers in 1910 will have fertility outcomes of zero in both 1900 and 1910.

[30] Since women who were between 15 and 24 are too young in 1900, I limit this analysis to women who were 25 and above in 1910. Due to differential death and marriage patterns, this subsample may suffer from selection issues. For summary statistics of this subsample in 1900 and 1910 see Table B.8. In addition, I do not use data from 1890 since census records from this wave were largely lost to fire.

3.5 Results: Disentangling the Two Channels

In this section, I present the results from the two triple difference exercises that aim to disentangle the two theoretically opposing channels driving the link between electrification and fertility.

3.5.1 The Differential Effect of Electrification by Maternal Status

I estimate the effect of electrification working through the opportunity cost channel by estimating Equation (1). I present the results of this analysis on the fertility variables of interest in Table 3.3.

Table 3.3: Heterogeneity in the Effects of Electrification on Women's Fertility by Maternal Status in 1910

	No. of Children Born	No. of Own Children in HH	No. of Own Children <18 in HH
ΔCap×1920		-0.25***	-0.24***
		(0.035)	(0.033)
ΔCap×1930		-0.46***	-0.43***
		(0.040)	(0.037)
ΔCap×1940	-0.48***	-0.40***	-0.35***
	(0.059)	(0.037)	(0.034)
ΔCap×1920×Mom1910		0.22***	0.21***
		(0.039)	(0.036)
ΔCap×1930×Mom1910		0.57***	0.55***
		(0.045)	(0.038)
ΔCap×1940×Mom1910	0.31***	0.61***	0.57***
	(0.050)	(0.043)	(0.038)
R^2	0.78	0.69	0.67
Year Fixed Effects	Yes	Yes	Yes
Individual Fixed Effects	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes
State x Year Fixed Effects	Yes	Yes	Yes
Demographic and socioecon. controls	Yes	Yes	Yes
Cluster	County x Year	County x Year	County x Year
N	241,880	16,365,989	16,365,989

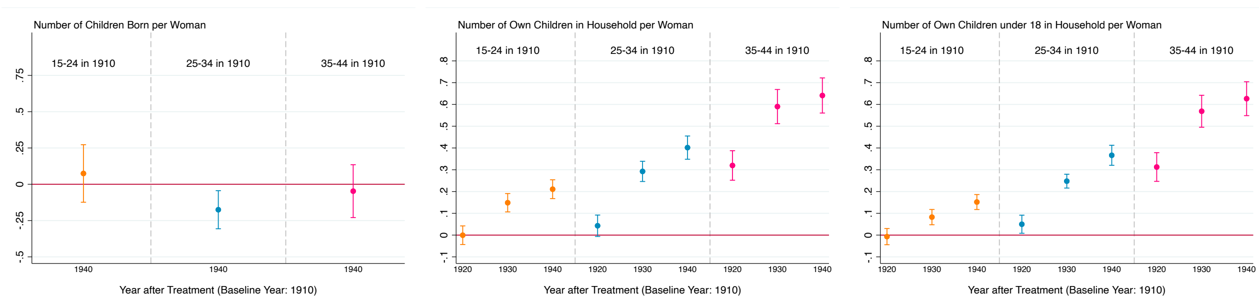
Notes: This specification corresponds to that of Equation (1). Some of the terms omitted due to length. The analyses encompass women in the panel sample who were 15–44 years of age in 1910. Clustered standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

I find that the decrease in fertility triggered by electrification is significantly smaller for women who were already mothers in 1910. In particular, the decrease in the number of children per woman triggered by electrification was 0.31 children lower among women who were already mothers in 1910.[31] In addition, the decrease in both the overall and under 18 number of own children living in the household triggered by electrification was also significantly lower for women who were mothers in 1910.

I then repeat these analyses splitting the sample across different cohorts, and summarize the results in Figure 3.3. Overall, I find that the attenuation in the negative effect of electrification on fertility is especially large among older cohorts of women who are even less likely to be attached to the labor market. For all women who were mothers in 1910, but for older women in particular, electrification caused a much smaller decline, or in some cases an increase, in the number of children in the household. As evidenced in Figure 3.3c, these differential effects do not stem from a difference in the timing of adult children leaving the household, but rather correspond to differences in the number of own children under 18 living in the household.

Figure 3.3: Differential Effect of Electrification on Women's Fertility for Women who were Mothers in 1910 by Cohort

(a) No. of Children Born (b) No. of Own Children in HH (c) No. of Own Childr. <18 in HH



Notes: The coefficients plotted correspond to $\beta_t^{cap.mom}$ in Equation (1), estimated for each cohort separately. These coefficients capture the heterogeneity in difference-in-differences effects by maternal status for each of the post-treatment periods (1920, 1930, and 1940, with baseline 1910). The analyses encompass women in the panel sample who were 15–24, 25–34, and 35–44 years of age in 1910, respectively. 95% confidence intervals built from standard errors clustered at the county-by-year level are plotted.

In addition, I also consider the robustness of these results to comparing mothers of a young child (specifically, women whose eldest child is under 1 year of age) to those who did not have children. With this, I further control for potential differences between mothers and non-mothers by comparing women who just became mothers recently to those who have not yet done so.[32] I present the results of this exercise in Table B.9. The effects are similar to

[31] The sample size used to estimate the regression on the number of children born is smaller, however, since the universe of women who were asked about number of children ever born was greatly reduced in 1940. In particular, this variable encompassed all ever-married age 12+ females in 1910, while only sample-line females in 1940, which reduced the number of observations with this data in 1940.

[32] Since birth of the first child concentrates earlier in life, I focus on the youngest cohort (women between 15 and 24 years of age in 1910) for this analysis.

those at baseline, with a smaller decrease in fertility triggered by electrification for young women who were mothers of one child in 1910 relative to those who weren't. However, the moderating effects of motherhood are attenuated in this case, due to the fact that young mothers with only one child retain more attachment to the labor market relative to those with more children.[33]

3.5.2 The Differential Effect of Electrification by Price of Residential Electricity

I estimate the effect of electrification working through the time savings channel by estimating Equation (2). I present the results of this analysis on the fertility variables of interest in Table 3.4.

I find that the decrease in fertility triggered by electrification is larger for women who lived in areas with a higher price of residential electricity. In particular, the number of children born per woman decreases by 0.036 more children in 1940 as a consequence of electrification when the price of one megawatt/hour of electricity is ten dollars more expensive. However, and potentially partly due to the smaller sample size we get when running this specification and the coarseness of the price of electricity measure, this effect is quite noisy and not statistically significant.[34] Nevertheless, the decrease in both the overall and under 18 number of own children living in the household triggered by electrification was significantly higher for women living in areas where electricity was more expensive in the 1910s.[35,36]

Interestingly, when I restrict this analysis to counties that are not in the South or to women living in urban areas, I find that the negative effect of residential electricity prices on fertility

[33] In Appendix F.9 I consider the robustness of these results to exploiting county-level religiosity instead of motherhood status when estimating the effect of electrification working through the opportunity cost channel. Since women living in more religious counties are likely to face stricter social norms preventing them from joining the labor force, they will be less likely to take into consideration the changes in female wages or labor opportunities triggered by electrification when making their subsequent fertility decisions. The results of this exercise are similar to baseline.

[34] This also matches evidence found by Bailey and Collins (2011), who cast doubt on the time savings channel of electrification by showing that the Amish, a group that traditionally does not use electrical household appliances, also experienced a baby boom.

[35] One potential concern with these results is that areas with higher costs of residential electricity also faced higher costs of business electricity, thus potentially leading to differential female work effects that contaminate the effect of the time savings dimension of electrification that we want to recover. In order to address this concern, I repeat specification Equation (2) restricting the sample to women who were already mothers upon electrification (measured by having non-zero own children in the same household), and thus less likely to work or be affected by the business dimension of electrification. I present the results in Table B.10, and find results consistent with the ones above, where the decrease in fertility triggered by electrification is larger for women who lived in areas with a higher price of residential electricity.

[36] Figure B.4 shows the results of this analysis for different cohorts, and suggests no significant differences in the effects of residential electricity prices across these.

becomes much larger.[37] These results have two important implications. First, the results showing a stronger negative effect of residential electricity prices in the North suggest that the price of residential electricity and therefore the time savings channel of electrification was a much less important determinant of fertility in the South relative to the rest of the country. This likely stems from the fact that this region followed a unique path during this period. For instance, during this time, the South enacted Jim Crow laws disenfranchising African American citizens and thus greatly limiting the economic opportunities available to a large swath of people in the region. The results suggest that these disparities and other idiosyncrasies of the South were more important than the price of residential electricity for the fertility patterns of this region.

Table 3.4: Heterogeneity in the Effects of Electrification on Women's Fertility by Residential Price of Electricity in 1917–1919

	No. of Children Born	No. of Own Children in HH	No. of Own Children <18 in HH
ΔCap×1920		0.35**	0.41**
		(0.18)	(0.20)
ΔCap×1930		0.44**	0.55***
		(0.18)	(0.20)
ΔCap×1940	0.048	0.34*	0.44**
	(0.31)	(0.19)	(0.22)
ΔCap×1920×PriceResElect1919		-0.0062***	-0.0070***
		(0.0023)	(0.0025)
ΔCap×1930×PriceResElect1919		-0.0072***	-0.0084***
		(0.0023)	(0.0026)
ΔCap×1940×PriceResElect1919	-0.0036	-0.0049**	-0.0057**
	(0.0040)	(0.0025)	(0.0028)
R^2	0.78	0.63	0.58
Year Fixed Effects	Yes	Yes	Yes
Individual Fixed Effects	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes
State x Year Fixed Effects	Yes	Yes	Yes
Demographic and socioecon. controls	Yes	Yes	Yes
Cluster	County x Year	County x Year	County x Year
N	241,880	16,365,989	16,365,989

Notes: This specification corresponds to that of Equation (2). Some of the terms omitted due to length. The analyses encompass women in the panel sample who were 15–44 years of age in 1910. Clustered standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Second, the results showing a stronger negative effect of residential electricity prices within urban regions hint at the significance of the decline in infant mortality prompted by the intro-

[37] These results are presented in Table F.6, and Table F.14, respectively.

duction of electricity in rural areas. As shown by Lewis (2018), electricity increased the access to electrical water pumps improving home sanitation. This is crucial in rural areas, but not in urban areas as these had secured access to filtered and treated piped water during the early 1900s (US Environmental Protection Agency (2000)). Nevertheless, high residential electricity prices mitigate the negative impact of electrification on infant mortality in these rural areas by increasing the expenses associated with water pumping. Consequently, rural women counterbalance this effect by undergoing a relatively higher number of pregnancies.

3.6 Discussion and Additional Results

In the previous sections, I showed that electrification efforts put forward in the 1910s (1) decreased the fertility of women who were already mothers by 1910 less than those that were not, and (2) decreased the fertility of women living in areas where the price of residential electricity was higher more than those that lived in areas where this was cheaper, particularly in the North and in urban areas. Taken jointly, these results hint at the existence of the two theoretical channels linking electrification and fertility. First, electrification triggers an opportunity cost channel, through which electrification raises female wages and makes childrearing relatively more costly. This channel is particularly important for women who are more likely to react to labor market shocks, such as non-mothers and younger cohorts. Second, electrification triggers a child-rearing time-saving appliance channel through which electrification and appliance use reduce the time cost of child-rearing, which is particularly important for women living in areas where using these appliances is cheaper. In Section 4 I use these results to discipline a quantitative model of the effects of electrification on fertility that encompasses the time-saving and opportunity cost channels of electrification in order to quantify the aggregate effects of electrification on fertility.

These mechanisms are also alluded to when I explore the effects of electrification on fertility *per se* through a double differences framework in Appendix C. First, I find that electrification depressed women's overall fertility, consistent with the existence and predominance of the opportunity cost channel of electrification. Nevertheless, when I decompose these effects by cohort, I find that electrification reduced the fertility of younger cohorts more. This is consistent with the results outlined in this section, where for younger women who are less likely to be mothers and more attached to the labor market, the opportunity cost channel of electrification is particularly important, while for older women the time savings channel may be more important.[38]

[38] In order to explore the broader impacts of electrification, I complement this analysis using cross-sectional county-by-year data capturing all women in the cohorts of interest in Appendix D and find similar effects.

Relatedly, in Appendix E I find that electrification delayed the timing of childbearing for subsequent cohorts of women, and particularly those who were very young when electrification occurred. This highlights the importance of the opportunity cost channel of electrification among newer cohorts, and matches the evidence presented by Goldin (2020) who shows that at the turn of the 20th century women moved from a regime of having to choose between career or family to a regime where they could pursue a career when young and a family afterwards.

3.7 Robustness

In Appendix F I consider the robustness of the main triple-difference results to different specifications. In particular, I consider robustness to: (1) using contemporaneous controls instead of baseline level controls; (2) clustering at the county level; (3) excluding counties in the South; (4) excluding counties in the West; (5) considering an alternate treatment definition based on the proximity to large electricity generating plants; (6) limiting only to married women and controlling for spouses' socioeconomic status; (7) limiting only to urban women to control for improvements in sanitation and reductions in child mortality; (8) limiting only to women who did not migrate after 1910; (9) using county-level religiosity instead of motherhood status when estimating the effect of electrification working through the opportunity cost channel; (10) using an alternate measure of electricity prices based on utility-level rate structures collected by the National Electric Light Association (NELA) in some cities; and (11) using two alternate record-linking methods to match individuals across census waves: a method that leverages the algorithm proposed by Abramitzky et al. (2012, 2014) and that thus relies on name, birth year, and state or country of birth matches to link records; and the method proposed by Althoff et al. (2023) which leverages social security application information to link records. The main results are qualitatively and quantitatively consistent across all specifications, though the effects of the price of residential electricity on fertility are slightly moderated when we include contemporaneous controls or use the prices collected by NELA (which solely capture some components of electricity rates), and strongly reinforced when we limit the analysis to women who did not live in the South, or to women who did not live in rural areas.

4 Model

I now build a model that quantifies the effect of electrification on fertility in the first half of the 20th century. The model considers both the time-saving and opportunity cost channels of electrification: electrification decreases the price of electricity reducing the time burden of childcare, but also increases female wages raising the opportunity cost of childcare. I discipline the model and in particular each of the two channels of interest using the results from the empirical analysis above.

4.1 Model Setup

The model economy follows an overlapping generations structure and is populated by a continuum of married couples whose adult life spans for $G+J$ periods, indexed from 1 to $G+J$. G denotes child-bearing years, whereas J denotes the remaining lifetime. Men work continuously for the $G+J$ periods, while women can choose whether to participate in the labor market in every period . Couples also decide how many children to have, and when to have them. Parents raise their children for I periods.

Tastes

The period utility function of couples is given by

$$U = \log c + \sigma_l \left(0.5 \log l^f + 0.5 \log l^m\right) + \sigma_m \log(m+1) \quad \text{with} \quad \sigma_l, \sigma_m \ > 0.$$

c denotes consumption, while l^f and l^m denotes female and male leisure, respectively. m denotes the number of children currently in the care of the couple.[39] σ_l and σ_m denote the values of leisure and children relative to consumption, respectively, for the couple.

I incorporate preference heterogeneity in order to generate differences in the fertility and labor decisions of different couples. In particular, I assume that the taste for leisure parameter σ_l differs across couples and is drawn randomly at the beginning of the household's life from a Frechet distribution:[40]

$$\sigma_l \sim Frechet(\text{location of min.}{=}0, \text{scale}{=}\xi, \text{shape} = 1).$$

Fertility choice and time constraints

Men work continuously every period. The time endowment of women is allocated to work, leisure, and childcare obligations.[41] In particular, as in De La Croix and Doepke (2004)

[39] An alternative here would be to have the total number of children (including adults) as determinants of utility. Ceteris paribus, doing this would only generate a change in the level of total fertility. As such, in order to reduce the dimensionality of the problem, I consider only young children here.

[40] Frechet is convenient here since it can be specified to be bounded below by 0.

[41] These childcare obligations reflect both the direct time dedicated to childrearing such as feeding and bathing, but also indirect time related to home production such as increased time in doing dishes and cooking, among others. In addition, although men could share part of the time burden of childcare, child-rearing responsibilities have disproportionately fallen on women throughout history, and thus are modeled

and Moav (2005), childrearing costs time. This childcare time, in turn, depends on both the number of children the couple has in their care and electricity purchases. The time constraints of women (f) and men (m) in each period are captured by

$$n^m + l^m = 1, \quad n^m = \eta_m \quad \text{and} \quad l^f = 1 - \eta_f n^f - M - \kappa b.$$

n^f and n^m denote female and male labor supply respectively. η_m is a parameter capturing the time spent at work by men, and n^m is equal to η_m in each period since men are continuously employed. n^f can be either zero or one, and η_f is a parameter capturing the time spent at work by women who work. M denotes the time cost of caring for children. b is a binary variable indicating the couple's decision to have a baby or not in the current period. $\kappa \geq 0$ is the additional time cost of pregnancy and taking care of a baby.

The time cost of childcare, M, depends on both the number of children currently in the care of the couple, m, and electricity purchases, E, and can be written as

$$M = \phi \left(m\right)^{\psi_m} \left(E\right)^{-\psi_E}.$$

$\phi > 0$ is a parameter governing the level of the time cost of children, while $\psi_m, \psi_E > 0$ capture the curvature of the time cost of children to the number of young children and electricity purchases, respectively.

In addition, fecundity varies with age. The parameter f_j denotes the probability that an attempt to have a baby at age j will result in a live birth. Therefore, conditional on trying to conceive, the value of b for a couple of age j will be 1 with probability f_j, and 0 with probability $1 - f_j$.[42]

Income and Consumption

Households purchase market goods and electricity using the combined male and female incomes. In order to generate regional heterogeneity in the prices of electricity matching that exploited in the empirical analysis, I assume that there are several regions in the model featuring different region-specific technologies for the production of electricity. Since in the empirical analysis these regions are large and encompass both electrified and non-electrified areas, I further assume that these regions are split into equally sized sub-regions which may gain access to electrification at different times.[43] Thus, residential electricity prices

as corresponding solely to women.

[42]For simplicity, I assume that independent of whether the attempt to have a baby at age j results in a live birth, the couple must pay the time costs associated with childrearing of a child in that period.

[43]In particular, the share of households with access to lower prices of electricity and higher electrification-driven wages within each region changes according to the nation-wide trends of electrification documented in Figure 2.1.

and wages will vary across sub-regions and over time. The household budget constraint, is therefore given by

$$c + p^E_{s,t} E = w^m_{s,t} \eta_m + w^f_{s,t} \eta_f n^f.$$

$w^m_{s,t}$ and $w^f_{s,t}$ capture the male and female wages available at time t in sub-region s, while $p^E_{s,t}$ captures the electricity price available in sub-region s.

Production of Consumption Goods

Consumption goods are produced competitively in each sub-region using two production technologies which employ male and female labor, respectively. Both of these technologies follow a CES function that combines electricity and labor,

$$Y_{i,s,t} = A_i \left[\zeta_i E_{i,s,t}^{\frac{\gamma_i - 1}{\gamma_i}} + (1 - \zeta_i) L_{i,s,t}^{\frac{\gamma_i - 1}{\gamma_i}} \right]^{\frac{\gamma_i}{\gamma_i - 1}} \quad \text{for } i \in \{m, f\}.$$

$i \in \{m, f\}$, denotes the technologies using male and female labor, respectively. L_f and L_m denote female and male labor, while E_f and E_m denote the electricity employed in conjunction with each of these, and A_f and A_m denote the corresponding TFP terms. I allow for differences in the share of electricity, ζ_i, and the elasticity of substitution between labor and electricity, γ_i, in the male and female production functions in order to capture potential differences in the complementarities between electrification and each type of labor, and thus in the effects of electrification on male and female wages.

Total production aggregates female and male production:[44]

$$Y_{s,t} = Y_{m,s,t} + Y_{f,s,t}.$$

Production of Electricity

Within each sub-region, electricity is produced competitively using a technology with a binary and exogenous productivity level. Prior to gaining access to the power grid (electrification), electricity is produced with an old and inefficient technology (small generators). With electrification, electricity production is conducted at central generating stations with higher efficiency. I assume that the decision of the type of technology available to produce electricity is determined exogenously. The production of electricity in each sub-region s within region

[44] This production function assumes that the goods produced by the male and female production technologies are perfect substitutes. Although this is a simplification, it does not change the conclusions of the model since the female-bias of electricity yields a higher rise in the female wage than the male wage as long as they are not perfect complements. Moreover, with this I can focus on the trade-off between female and male decisions stemming from intra-household allocations and decision making.

r therefore follows

$$E_s = \begin{cases} A_{E,L}X & \text{prior to electrification} \\ A_{E,H,r}X & \text{after electrification,} \end{cases}$$

where X denotes inputs in terms of the consumption good. $A_{E,L}$ denotes the pre-electrification productivity of electricity production, which is symmetric across regions, while $A_{E,H,r}$ denotes the post-electrification productivity of electricity production, which is heterogeneous across regions. In Appendix G I present the aggregation and equilibrium results of the model.

4.2 What Drives Fertility?

Before turning to quantitative results, it is instructive to highlight the three basic driving forces driving fertility decisions in the model. The first force stems from the fact that fecundity declines after women reach age 32.5, driving most women to have children before the probability of conceiving drops substantially. The second force implies that delaying and/or reducing fertility may be optimal, however, because (1) more earnings can be generated (especially while young and the opportunity cost of time is still low), and (2) more income is available to purchase electricity and reduce the time-burden of existing children. The final force, on the other hand, implies that increasing fertility may be optimal, because the time burden of childcare can be alleviated with electricity purchases. These forces interact with the heterogenous taste for leisure, the heterogenous price of electricity, and the time and opportunity costs of childrearing (which depend on electrification), to determine the total fertility and timing of childbearing.

To see these three forces in action, consider for exposition the case of a woman who is currently working, wishes to have children, and does not anticipate re-entering the labor force after doing so. The first decision she faces concerns the timing of her first child, and involves a tradeoff due to the opportunity cost of having to exit the labor force after childbirth and losing some wage income. The perceived value of that foregone wage income depends on both the female wage and the marginal utility of consumption which itself depends on total household income and thus male wages. The second decision she faces concerns having more children after her first child, and also involves a tradeoff due to the increased time cost of childrearing. The perceived value of that increased childcare time depends on the idiosyncratic value of leisure, the scope of electricity to reduce childcare time, the price of electricity in the region, and the marginal utility of consumption. As such, in this model, the key determinants of fertility are: (1) relative female wages, (2) the price of electricity relative to wages, and (3) the idiosyncratic taste for leisure.[45]

[45]For women who would potentially re-enter the labor force after having children the argument is slightly

Electrification impacts fertility by shaping wages and the price of electricity. First, and since in the calibration (and consistent with previous work) female labor is more complementary to electricity inputs than male labor, electrification raises female wages more than male wages. As illustrated above, this leads women to delay and/or reduce their fertility. This is the *opportunity cost* dimension of electrification on fertility. Second, electrification reduces the price of residential electricity by an average of five-fold, matching the increase in the productivity of new generation technologies relative to older ones. This leads women to hurry and/or increase their fertility. This is the *time-saving* dimension of electrification on fertility. After calibrating the model, we assess the quantitative importance of each of these channels.

4.3 Calibration

I present the values of the calibrated parameters in Table 4.1. The first set of parameters are calibrated externally from the literature and historical context. The first calibration choice concerns the length of a model period. The main characteristic that defines a period in the model is that women can have one child per period. Although in theory this could correspond to nine months at a minimum, women at the time and also currently space their births out longer (Whelpton (1964)). Thus, the length of the model period corresponds to the average time between births observed in the data. According to Whelpton (1964), and as highlighted by Doepke et al. (2013), the average spacing of births narrowed from over 3 years for the cohort of mothers born 1916–1920 to slightly above 2 years for the cohort 1931–35. I follow Doepke et al. (2013) in setting the model period to an intermediate value of 2.5 years. The duration of the child-bearing period, G, is then set at 10 to capture the period between 20 and 45 years of age,[46] while the duration of the post-childbearing period, J, is set to 8 to capture the period between 46 and 65 years of age. The duration of childhood, I, is set to 8 to capture the period between 0 and 20 years of age. Given that each period is 2.5 years long, I set the time discount factor β to 0.91.

η_m and η_f are calibrated using male and female labor hours among employed individuals in 1900, respectively (see Appendix H.1 for details). I choose the differential time cost of pregnancy and caring for a baby, κ, in order to match the increased time cost of caring

more complicated but still similar, with the difference that the relative female wage becomes important also at later stages of life due to both the potential increase in earnings and the possibility of purchasing electricity to reduce the time burden of childcare for existing children.

[46] I choose 20 as the starting age for couples following the fact that the age of majority was placed around 21 years of age in the early 20th century United States (Jordan (1976)), and also given the average age at first marriage in 1900–1940, which hovered around 21–23 for women, and 25–27 for men (Haines (1996)).

for a child 0–5 years of age (see Appendix H.3 for details).[47] The fecundity parameters, f_j, representing the probability of a live birth at every age are calibrated using information on female age-related fertility decline. I follow the information presented in Menken et al. (1986) and assume fecundity is unimpaired up to age 30 ($f_j = 1$ $j \leq 4$), and begins declining afterwards. I set $f_5 = f_6 = 0.99$ for ages 30–35, $f_7 = f_8 = 0.9$ for ages 35–40, and $f_9 = f_{10} = 0.62$ for ages 40–45.

Table 4.1: Model Parameters

Parameter	Value	Source
Externally Calibrated		
Length of Model Period	2.5 years	Doepke et al. (2013)
Duration of Childhood I	8	0-20 years of age
Duration of Childbearing Period G	10	20-45 years of age
Duration of Post-Childbearing Period J	8	46-65 years of age
Time spent working by men η_m	0.54	Male work hours in 1900
Time spent working by employed women η_f	0.34	Female work hours in 1900
Time cost of pregnancy/young child κ	0.064	Differential time cost of young child
Fecundity of women < 30, f_j $j \leq 4$	1	Menken et al. (1986)
Fecundity of women $30 - 35$, f_5, f_6	0.99	Menken et al. (1986)
Fecundity of women $35 - 40$, f_7, f_8	0.9	Menken et al. (1986)
Fecundity of women $40 - 45$, f_9, f_{10}	0.62	Menken et al. (1986)
Level of Child Time Cost ϕ	0.13	Time spent in childcare outside no. of children
Elasticity of Child Time Cost to No. Children ψ_m	0.55	Change in time spent in childcare to no. of children
Time Discount Factor β	0.91	Standard for 2.5 years per period
Share of electricity in male production ζ_m	0.017	Share of energy in male-dominated industries in 1939
Elasticity of subst. between male labor and electricity γ_m	0.15	Hassler et al. (2012)
Female TFP A_f	1.46	Gender wage gap in 1900
Regional electricity prod. after electrif. $A_{E,H,r}$	See Table H.4	Price from small generators vs. grid (IER(2019))
		+ Empirical distribution of prices
Internally Calibrated		
Electricity prod. before electrification $A_{E,L}$	0.65	Time spent in childcare in 1900
Relative value of children σ_m	0.27	Average fertility in 1900
Share of electricity in female production ζ_f	0.17	Female labor force participation in 1900
Scale parameter of relative value of leisure dist. ξ	0.95	Average female leisure in 1900
Elasticity of subst. between female labor and electricity γ_f	0.07	Empirical estimate of opp. cost channel
Share of electricity in childcare time ψ_E	0.04	Empirical estimate of time savings channel
Normalized		
Male TFP A_m	1	

I now turn my attention to the parameters in the child time cost function. I choose the

[47] I choose children ages 0–5 as the benchmark since this matches the information available on the 1965 American Heritage Time Use Survey.

level parameter, ϕ, and curvature parameter on the number of children, ψ_m, to match the ratio of time spent in childcare for women with different number of children in 1965 from the American Heritage Time Use Survey (see Appendix H.2 for details).[48]

Regarding production parameters, I choose the elasticity of substitution between electricity and male labor, γ_m, following the work of Hassler et al. (2012) who found that the short-term elasticity of substitution between energy and a labor-capital composite that matches postwar aggregate US data was close to zero (around 0.02), but can be approximated by unity in the long term. Since each period considered is 2.5 years in the model, I take an intermediate value of 0.15. I choose the value of the share of electricity in male labor to match the share of energy fuels and electricity expenditures in male-dominated manufacturing industries (see Appendix H.4 for details). I normalize the TFP of male labor, A_m, and calibrate the TFP of female labor, A_f, to match the ratio of average male and female occupational scores in 1900. To compute this ratio, I use the occupation information available in the 1900 census in conjunction with the Lasso-adjusted industry, demographic, and occupation (LIDO) occupational score approach proposed by Saavedra and Twinam (2020) which adjusts occupation scores by race, sex, age, industry, and geography, and reduces the attenuation bias in gender earnings gaps (see Appendix H.5 for details). I set the number of regions in the model to 5, and choose the efficiency of electricity production after electrification in each region, $A_{E,H,r}$, to match (1) the relative price charged for electricity produced by a small generator rather than a large-scale plant as documented by Institute for Energy Research (2019);[49] and (2) the distribution of prices of electricity observed empirically and documented in Section 3.5.2 (see Appendix H.6 for details).

I calibrate the rest of parameters internally to minimize the distance between model and data moments.[50] In particular, I choose the values of the efficiency of electricity production prior to electrification, $A_{E,L}$, the relative value of children, σ_m, the share of electricity in female production, ζ_f, the scale parameter of the relative value of leisure distribution, ξ, the elasticity of substitution between female labor and electricity, γ_f, and the share of electricity in the time spent in childcare, ψ_E, to minimize the distance between the moments generated by the model and the following moments in the data: average time spent in childcare in 1900, average

[48] Although 1965 is later than the period of interest, Ramey and Francis (2009) documents that the time spent on childcare after controlling for number of children did not change almost at all throughout the 20th century after controlling for income, location, and the age of the children.

[49] This calibration follows from comparing the average price of electricity in 1902 when privately run small generators were the primary source of energy to that in 1930 when central stations provided most power (Casazza (2004), Hunter and Lynwood (1991)).

[50] See Table H.5 for a comparison of the data and model moments targeted in the method of moments, along with further discussion of the source of the data moments.

fertility in 1900, female labor force participation in 1900, average female leisure time in 1900, and the empirical estimates capturing (1) the opportunity cost channel of electrification summarized in Section 3.5.1, and (2) the time savings channel of electrification summarized in Section 3.5.2.[51] The empirical estimate of the opportunity cost channel corresponds to the 1930 coefficient of the heterogenous effect of electrification on the number of own children in the household for young women (15–24 years of age in 1910) who were mothers in 1910.[52] The empirical estimate of the time savings channel corresponds to the 1930 coefficient of the heterogenous effect of electrification on the number of own children in the household for young women (15–24 years of age in 1910) in areas where residential electricity is one more dollar more expensive.[53,54]

4.4 Results: Impact of Electrification on Fertility

I now present the effects of electrification on fertility predicted by the model. I start by illustrating the impact of electrification on different couples' fertility decisions at different ages. Then, I examine the aggregate impact of the rollout of electricity from 1900 to 1940 on fertility stemming from the joint effects of the opportunity cost and time savings channels.[55] Finally, in Section 4.5 I subsequently shut down the opportunity cost and time savings channels, and examine the counterfactual evolution of fertility in each case.

4.4.1 Impact of Elecrification on Fertility for Different Couples

In order to illustrate the impact of electrification on couples' fertility choices, I plot the fertility outcomes at ages 20–45 for couples at each decile of σ_l in a given region and model iteration, and under different technological regimes. Figure 4.1a and Figure 4.1b plot these decisions for couples who live their whole lives with and without electrification, respectively.

[51]In Appendix H.8 I show the importance of these empirical estimates to the model's results by examining how the results change when I change the values of the key parameters pinned down by these empirical estimates.

[52]I focus on the coefficient corresponding to young women since these are more affected by the opportunity cost dimension of electrification, and thus their response is more relevant to the overall effects of electrification in the model. The quantitative conclusions are very robust to considering the effect of electrification on all women who were mothers in 1910.

[53]I focus on the coefficient corresponding to young women to match the demographic target for the opportunity cost empirical estimate. The quantitative conclusions are very robust to considering the effect of electrification for all women in areas where residential electricity is one more dollar more expensive.

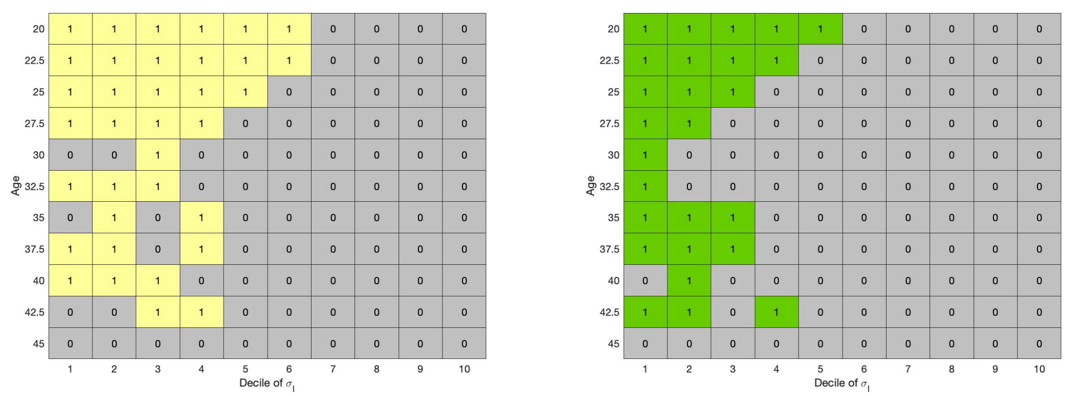
[54]In order to solve the model, I discretize the values of the leisure distribution into 10 bins each containing 10% of individuals according to the parametrized distribution. Given that there is randomness associated with whether a couple will have a live birth after an attempt to conceive, and given that this affects subsequent decisions, I solve the model for each of the 10 leisure bins 1000 times, and then take the average across these iterations to characterize aggregate patterns.

[55]In Appendix H.8 I examine the role of different parameters in shaping this aggregate fertility response.

The plots indicate that both with and without electrification, couples with a high preference for leisure do not have children in any period since this would lead to childcare time costs and thus less time for leisure. However, there are two patterns worth mentioning among couples with a lower preference for leisure. First, a lower taste for leisure generally leads to higher fertility levels. Second, couples tend to have their first child quite young, but those with a higher taste for leisure tend to space out their subsequent children more to dampen the time cost of childcare.

Figure 4.1: Fertility Decisions With and Without Electrification

(a) Without Electrification (b) With Electrification

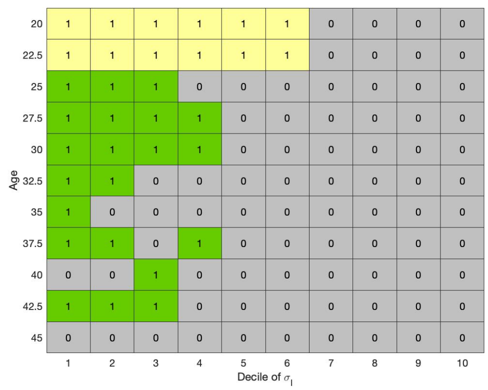


Notes: These figures plot the outcome of having a baby (yellow or green) or not (grey) at different ages for couples with different values of taste for leisure σ_l living prior to and after electrification in the median region of electricity prices.

With electrification, couples alter their fertility decisions in a few important ways relating to the opportunity cost and time-saving dimensions of electrification. First, per the opportunity cost dimension, which raises the opportunity cost of childcare by raising the relative wages of women: (1) fewer couples have children (e.g. the couple at the sixth decile of σ_l); (2) some couples have fewer children (e.g the couple at the fifth decile of σ_l), and (3) some couples space out their births more (e.g the couple at the second decile of σ_l). Second, per the time-saving dimension of electrification, which by reducing electricity prices, reduces the time-burden of childcare, some couples tend to have more children (e.g the couple in the first decile of σ_l).

In order to further understand the effect of electrification on fertility, I plot the analogous graph assuming couples gain access to electricity during their lifetimes, and specifically at the beginning of life period 3 (age 25) in Figure 4.2. This plot suggests that the decline in fertility and spacing out of births occurring per the opportunity cost channel are less marked than in the scenario where couples have access to electricity since the beginning of their lives (see for

Figure 4.2: Fertility Decisions With Electrification at 25



Notes: This figure plots the decision to attempt to have a baby (yellow or green) or not (grey) at different ages for couples with different values of taste for leisure σ_l who gained access to electricity at the beginning of life period 3 (age 25).

example the couple at the fourth decile of σ_l). This follows from the fact that older women have already incurred more childcare responsibilities which dampen their labor market gains from electricity, and thus reduce their incentive to alter their fertility downwards. In addition, these incentives are further reduced since the time-saving dimension of electricity moderates the childcare time requirements and thus further encourages fertility.

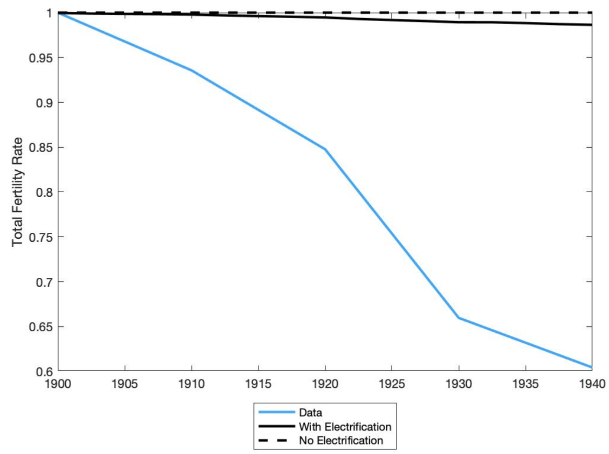
4.4.2 Aggregate Impact of Electrification on Fertility

In Figure 4.3 I contrast the aggregate effects of electrification on fertility predicted by the model and the data. I find that the model explains 3.10% of the aggregate decline in fertility in the 1900–1940 period. This decline is generated by the relative enhancement of female labor market opportunities stemming from electrification, and the consequent rise in the opportunity cost of childcare.[56] However, this decline is moderated by two forces: the time-saving dimension of electrification, which reduces the time needed for childcare and therefore incentivizes women to have more children; and the fact that the opportunity cost effect of electrification is limited to women who are young and still attached to the labor market, and thus has a limited aggregate effect. In what follows, I further explore the importance of these age effects by examining the effects of electrification for women in different age groups through time.

In Figure 4.4, I plot the change in average fertility for women in their early (20–30 years of age) and late (30–45 years of age) childbearing years in each period relative to the same age group in 1900. This plot suggests that fertility declines concentrate more heavily during

[56]For the non-normalized trajectories of fertility and female LFP see Figure I.1.

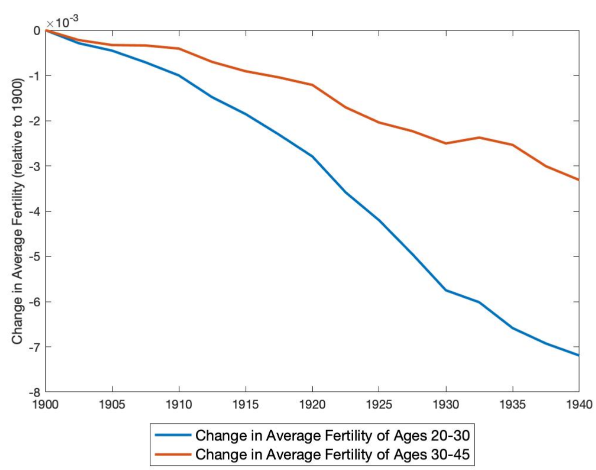
Figure 4.3: Fertility: Model and Data



Notes: This plot depicts the trajectory of (aggregate) fertility in the model. Fertility follows the demographic definition, and thus captures the number of children that would be born to each woman if she were to live to the end of life, and give birth to children according to age-specific birth rates. Data Source: Haines (2006), combined with proportion of women by race from Census. Normalized 1900=1.

the initial periods of a woman's life. This follows from the fact young childless women have fewer childcare responsibilities to attend to which could dampen their labor market gains from electricity. In particular, for older women and mothers, the labor market gains triggered by electrification are dampened due to childcare requirements, and these requirements themselves are moderated due to the time-saving dimension of electricity.[57] This matches the evidence presented in the empirical section suggesting that electrification reduces the fertility of women who were not mothers upon electrification more, and the evidence pre-

Figure 4.4: Change in Fertility by Age Group



Notes: This plot depicts the change in age-specific fertility for different age groups in the model. The age-specific fertility rate captures the average number of births per woman of each age in each period.

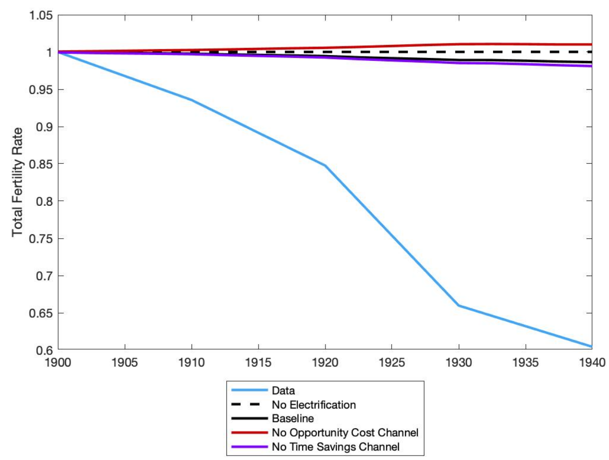
[57]Figure I.2 plots the paths of fertility and female LFP across the lifecycle of all cohorts born in 1900–1940.

sented in Goldin (2020) who shows that at the turn of the 20th century women's female labor force participation concentrated during their youth, and was significantly reduced once they married and became mothers.

4.5 Counterfactual Analysis: Role of Opportunity Cost and Time-Saving Dimensions of Electricity

To better assess the role of the opportunity cost and time savings channels of electricity in shaping aggregate fertility trends, I now perform counterfactual analyses where I subsequently shut down each of these two channels and examine how fertility evolves in each case. First, I set female wages to be fixed at the baseline level of 1890 in order to shut down the opportunity cost channel. Then, I set the price of residential electricity to be fixed at the baseline level of 1890 in order to shut down the time savings channel.

Figure 4.5: Fertility, Counterfactual Analysis



Notes: This plot depicts the trajectory of (aggregate) fertility in the model in alternate scenarios. Fertility follows the demographic definition, and thus captures the number of children that would be born to each woman if she were to live to the end of life, and give birth to children according to age-specific birth rates. Data Source: Haines (2006), combined with proportion of women by race from Census. Normalized 1900=1.

I present the effects of electrification on fertility that follow from shutting down the opportunity cost and time savings channels of electricity, respectively, in Figure 4.5. I find that when the opportunity cost channel is shut down, fertility counterfactually increases from 1900 to 1940. This is to be expected since in this case electrification solely reduces the price of residential electricity, thus moderating the time burden of childcare. In addition, I find that when the time savings channel is shut down, the decline in fertility predicted by the model in 1900–1940 is only 1.16 percentage points larger than in the baseline case. This implies that the opportunity cost channel is preponderant in explaining the response of fertility to electrification (and that the fact that this channel heavily concentrates among young women is a key moderating force of the aggregate effect of electrification in the model), while the time savings channel plays a smaller role. This matches the empirical evidence which suggested that the opportunity cost of channel was stronger than the time savings channel: the decline in fertility induced by electrification by 1940 was considerably stronger for women who had a closer attachment to the labor market, while although electrification had a more marked effect in decreasing fertility for women who faced higher residential electricity prices, this result was less strong. In addition, this result is consistent with the results found in Appendix C suggesting that overall women's fertility declined in response to electrification.

5 Conclusions

In this paper, I presented empirical and theoretical evidence linking the decline in fertility observed during first half of the 20th century in the United States to the rollout of electricity occurring concurrently during this period. First, I empirically disentangled two theoretically opposing channels driving the link between electrification and fertility: the use of time-saving appliances which reduce the time needed for child-rearing and encourage fertility, and the rise of female wages, which increase the opportunity cost of childcare and discourage fertility. I then built a model that embedded these time-saving and opportunity cost mechanisms in an overlapping generations structure. I calibrated the model to the first half of the 20th century United States, and used the empirical estimates to discipline the parameters mediating these two channels. I simulated the expansion of the electricity grid in this period, and found that the model can explain 3.1% of the decline in fertility observed in 1900–1940. This decline is driven by the opportunity cost channel, and heavily concentrates among young women as these do not have childcare responsibilities that dampen their labor market gains from electricity.

The above results have potential policy implications for current electrification interventions taking place in the developing world. In particular, this paper suggests that the scope for electrification to change fertility patterns depends on the relative importance of the time savings and opportunity cost channels of electrification, and thus on the labor market opportunities available for women, along with the cost of operating and adopting time-saving appliances. Moreover, this paper suggests that although the time-saving dimension of electricity applies to both young and old women alike, the opportunity cost dimension concentrates among young women who have not yet had children or childcare responsibilities to attend to which could dampen their labor market gains from electricity. This suggests important cross-cohort differences in the effects of electrification on fertility, and more broadly, significant cross-cohort differences in the effects of electricity on female empowerment.

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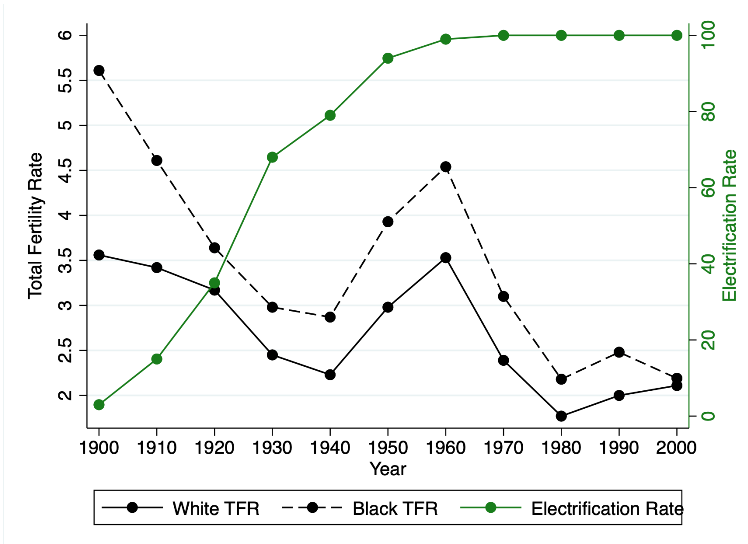
A Appendix: Context and Motivation

Figure A.1: Total Fertility Rate (TFR) and Electrification Rate in the United States



Source: Lebergott (1976) (Proportion of Electrified Households) and Haines (2006)

Figure A.2: Market Opportunities for Women in the First Half of the 20th Century

(a) Telephone switchboard operators in 1915

(b) Secretaries in the 1920s

Sources: Harris and Ewing, and Office Museum.

Figure A.3: Ads for Electric Appliances in the 1910s

(a) Ad for electric washing machine in 1910

(b) Ad for electric vacuum cleaner in 1915

(c) Ad for electric iron in 1915

B Appendix: Data Construction and Empirical Strategy

B.1 Summary Statistics in Panel and Repeated Cross-Section Data in 1920, 1930 and 1940

Table B.1: Summary Statistics in Panel and Repeated Cross-Section Data in 1920 (women of ages 15–44 in 1910 living in areas that were not electrified in 1910)

	Panel Women	Repeated XSec Women
Avg. number of own children in HH per woman	2.58	2.09
Avg. number of own children <18 in HH per woman	2.31	1.83
Avg. age at first birth[58]	23.98	24.02
Labor force participation	0.12	0.17
Prop. attending school	0.01	0.01
Prop. married	0.87	0.79
Prop. urban	0.37	0.42
Avg. socioeconomic index	4.03	4.87
Prop. white	0.95	0.87

Table B.2: Summary statistics in Panel and Repeated Cross-Section Data in 1930 (women of ages 15–44 in 1910 living in areas that were not electrified in 1910)

	Panel Women	Repeated XSec Women
Avg. number of own children in HH per woman	2.23	1.88
Avg. number of own children <18 in HH per woman	1.61	1.40
Avg. age at first birth	26.80	27.06
Labor force participation	0.13	0.17
Prop. attending school	0.01	0.01
Prop. married	0.84	0.77
Prop. urban	0.41	0.46
Avg. socioeconomic index	4.32	4.96
Prop. white	0.96	0.88

[58] Due to data constraints, the age at first birth is measured by subtracting the age of the eldest child currently living with the woman from her current age. Thus, this variable does not always capture the true age at first birth, particularly for older women whose eldest child has likely left the household.

Table B.3: Summary statistics in Panel and Repeated Cross-Section Data in 1940 (women of ages 15–44 in 1910 living in areas that were not electrified in 1910)

	Panel Women	Repeated XSec Women
Avg. children born per woman	3.98	3.61
Avg. number of own children in HH per woman	1.25	1.14
Avg. number of own children <18 in HH per woman	0.50	0.51
Prop. mothers	0.91	0.87
Avg. age at first birth	29.57	29.66
Labor force participation	0.13	0.22
Prop. attending school	0.00	0.01
Prop. with comp. high school	0.19	0.19
Prop. married	0.72	0.66
Prop. urban	0.43	0.47
Avg. socioeconomic index	4.17	5.90
Prop. white	0.96	0.90

B.2 Residential Electricity Price Data Constriction

In order to construct a county-level measure of the price per kilowatt/hour of residential electricity, I use data from United States Department of Labor and Bureau of Labor Statistics (1992) which contains information from a survey about household expenses in 100 American cities in 1917–1919. I construct the price per kilowatt/hour of residential electricity for each household in the survey by taking the ratio between expenditure and quantity of electricity purchased.[59] I then winsorize these prices both at the state and national level in order to exclude extreme price values (above the 90th and below the 10th percentile). Then, I average the residential electricity prices across all cities surveyed, and exclude cities with information from fewer than 4 households. Finally, I attach to each county the price in the closest city in the survey, where distance is measured using the county-centroid as the point of reference. This data provides information of the full realized prices consumers pay for electricity, and thus provides a comprehensive summary of the expenses entailed by electrical use.

An alternate approach here could potentially be to focus on the prices of appliances rather than the prices of electricity, given that the use of the former are the ones leading to time savings in childcare. In theory this would be possible since the data described above does include expenditures and purchases of certain appliances, namely washing machines, vacuum cleaners and refrigerators. In practice, however this strategy presents a few key challenges. First, the proportion of households in the data who reported purchasing one of these appliances in

[59] About 40% of households in the survey reported access to electricity, and had information on expenses and quantities purchased.

1917–1919 is extremely low (2.8% percent for washing machines, 5.1% for vacuum cleaners, and 6.7% for refrigerators). This is because unlike electricity, appliances are durable goods which are purchased only once every several years, whereas electricity is purchased continuously. Second, the price of these appliances varies by brand and model, making it difficult to establish an average or median price. Finally, the price of appliances directly correlates with the distance to the factory or retailer of the appliances. As an example, purchases done via mail order catalogs from large retailers such as Macy's or Sears had a set price for each appliance, but charged additional shipping costs. Since the base prices were set and applicable nationwide, differences in prices across the country stem solely from the distance or time from factory to destination, which likely correlate with other factors that could muddle the analysis. Electricity prices, on the other hand, stem from the technology used to generate electricity. For example, areas with abundant hydroelectric resources can produce electricity cheaply after the initial fixed costs of dams are put forward.

B.3 Panel Data Construction

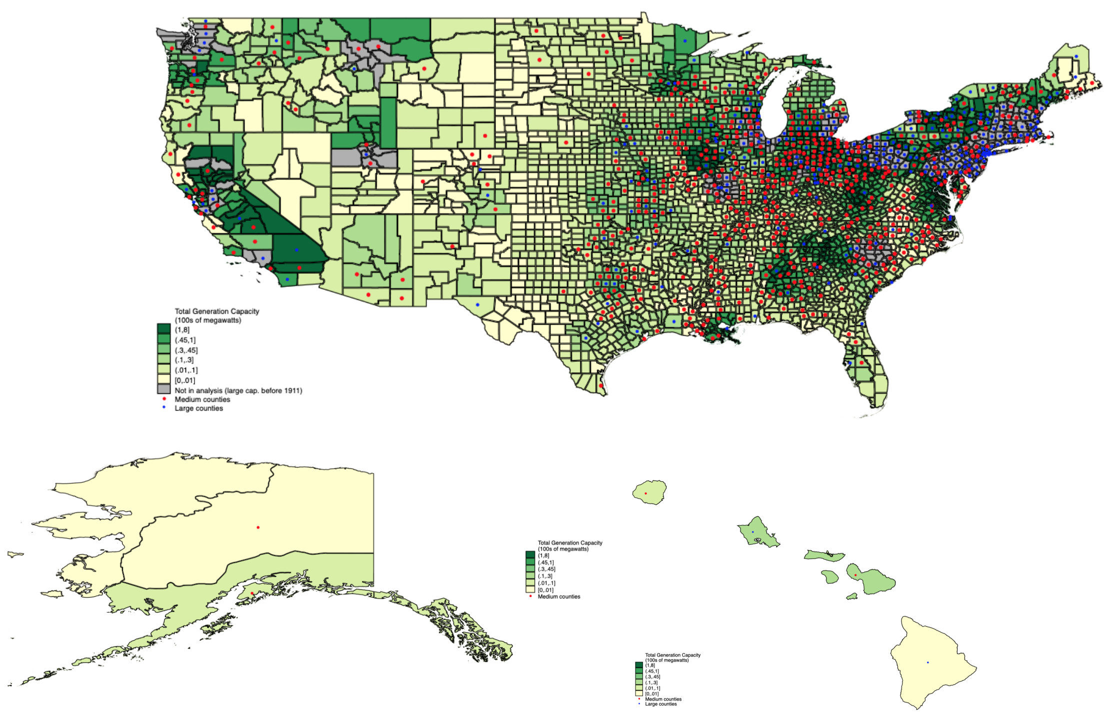
I build an individual-level panel dataset from the full-count 1910–1940 decennial census waves using the record-linkages proposed in the Census Tree Project developed by Price et al. (2021) and Buckles et al. (2023). This linking method leverages familial relationships entered into the genealogy platform FamilySearch.org to link records across census waves. In particular, the method relies on the source documents provided by users researching their own family histories. These source documents include census records, which users can attach to their ancestors' profiles, and can thus then be used to link individuals across census waves. These family-provided linkages are high-quality and rely on private information that can be used to identify the person of interest across multiple data sets such as maiden names or the names of other household members. FamilySearch includes information and family trees for over 1.2 billion deceased individuals with over 12.6 million registered users who can contribute information to those profiles.

The linkages provided directly by users of FamilySearch provide a large portion of the linkages proposed. However, further links are created by using these FamilySearch links as training data for a supervised machine learning algorithm, and by adding matches obtained through other linking methods, namely the Census Linking Project, and the IPUMS Multigenerational Longitudinal Panel. The final data set ("Census Tree") contains 71.4% of the potential matches between the 1910 and 1920 full-count US censuses (54.8 million matches). Please see Price et al. (2021), Buckles et al. (2023), and Censustree.org for further details about this data.

I use the information linking records in adjacent census waves in this data, namely 1910–1920, 1920–1930, and 1930–1940, in conjunction with the personal identifiers found in the full-count census data available in IPUMS, to follow individuals for the full 1910–1940 period. I limit the analysis to women who were between 15 and 44 years of age in 1910 and who can be observed in every census wave from 1910 to 1940. The total number of women in the matched panel sample in this category equal 6,465,081 which correspond to 30.6% of the population of women who were between 15 and 44 years of age in 1910.

B.4 Identification

Figure B.1: Map of County-Level Intensity of Electrification Treatment and County Population in the United States



Notes: Electrical generation capacity within and 50 miles around each county. Medium counties have a 15+ population in 1910 between 15,000 and 30,000 (approx. 70th percentile to 90th percentile), and large counties have a 15+ population in 1910 above 33,000.

Table B.4: Averages in Above and Below Median Treatment Intensity Counties, and Previously Electrified Counties in 1910 (individuals of ages 15–44)

	Treat. < 50%	Treat. > 50%	Elect. pre-1911
Avg. children born per woman	3.05	2.64	2.49
Avg. no. of own children in HH per woman	1.56	1.30	1.12
Avg. no. of own children <18 in HH per woman	1.47	1.23	1.06
Prop. mothers	0.84	0.80	0.79
Avg. age at first birth for women[60]	21.90	22.57	23.18
Male labor force participation	0.81	0.78	0.74
Female labor force participation	0.19	0.21	0.28
Prop. of men attending school	0.13	0.11	0.08
Prop. of women attending school	0.13	0.12	0.08
Prop. married	0.54	0.53	0.51
Prop. urban	0.22	0.43	0.77
Avg. socioeconomic index	10.51	11.87	13.88
Prop. white	0.81	0.89	0.96
Number of counties	1430	1229	287
Share of population	0.24	0.38	0.38

Table B.5: Averages in Above and Below Median Treatment Intensity Counties, and Previously Electrified Counties in 1920 (individuals of ages 15–44)

	Treat. < 50%	Treat. > 50%	Elect. pre-1911
Avg. no. of own children in HH per woman	1.54	1.32	1.19
Avg. no. of own children <18 in HH per woman	1.47	1.26	1.13
Avg. age at first birth for women	21.82	22.46	23.05
Male labor force participation	0.74	0.72	0.70
Female labor force participation	0.19	0.21	0.26
Prop. of men attending school	0.10	0.09	0.07
Prop. of women attending school	0.11	0.10	0.07
Prop. married	0.57	0.56	0.55
Prop. urban	0.26	0.48	0.80
Avg. socioeconomic index	10.10	11.82	14.60
Prop. white	0.81	0.89	0.95
Number of counties	1430	1229	287
Share of population	0.24	0.37	0.39

[60] Due to data constraints, the age at first birth is measured by subtracting the age of the eldest child currently living with the woman from her current age. Thus, this variable does not always capture the true age at first birth, particularly for older women whose eldest child has likely left the household.

Table B.6: Averages in Above and Below Median Treatment Intensity Counties, and Previously Electrified Counties in 1930 (individuals of ages 15–44)

	Treat. < 50%	Treat. > 50%	Elect. pre-1911
Avg. no. of own children in HH per woman 1.42	1.27	1.12	
Avg. no. of own children <18 in HH per woman	1.35	1.20	1.05
Avg. age at first birth for women	21.76	22.38	23.00
Male labor force participation	0.76	0.72	0.69
Female labor force participation	0.21	0.23	0.28
Prop. of men attending school	0.13	0.13	0.12
Prop. of women attending school	0.13	0.13	0.11
Prop. married	0.57	0.57	0.56
Prop. urban	0.31	0.52	0.82
Avg. socioeconomic index	11.12	13.08	15.79
Prop. white	0.81	0.89	0.94
Number of counties	1427	1229	287
Share of population	0.23	0.35	0.42

Table B.7: Averages in Above and Below Median Treatment Intensity Counties, and Previously Electrified Counties in 1940 (individuals of ages 15–44)

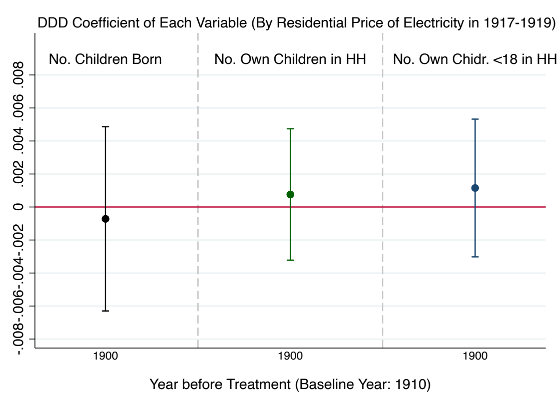
	Treat. < 50%	Treat. > 50%	Elect. pre-1911
Avg. children born per woman	2.31	2.06	1.79
Avg. no. of own children in HH per woman	1.25	1.11	0.92
Avg. no. of own children <18 in HH per woman	1.18	1.04	0.85
Prop. mothers	0.79	0.77	0.75
Avg. age at first birth for women	21.76	22.32	23.13
Male labor force participation	0.83	0.82	0.83
Female labor force participation	0.30	0.33	0.39
Prop. of men attending school	0.13	0.14	0.14
Prop. of women attending school	0.12	0.12	0.12
Prop. married	0.59	0.58	0.55
Prop. urban	0.35	0.51	0.77
Avg. socioeconomic index	13.25	15.50	18.67
Prop. white	0.82	0.90	0.94
Prop. men with comp. high school	0.22	0.28	0.31
Prop. women with comp. high school	0.28	0.34	0.34
Number of counties	1427	1227	287
Share of population	0.24	0.36	0.40

Table B.8: Summary Statistics in Pre-Treatment Sample in 1900 and 1910 (for women 24-44 years of age in 1910 living in areas that were not electrified in 1910)

	1900	1910
Avg. children born per woman	1.51	3.63
Avg. number of own children in HH per woman	1.22	2.75
Avg. number of own children <18 in HH per woman	1.22	2.65
Labor force participation	0.12	0.12
Prop. attending school	0.10‡	0.01
Prop. married	0.62	0.88
Prop. urban	0.24	0.30
Avg. socioeconomic index	3.66	3.43
Prop. white	0.96	0.96
Total obs.	1,881,663	

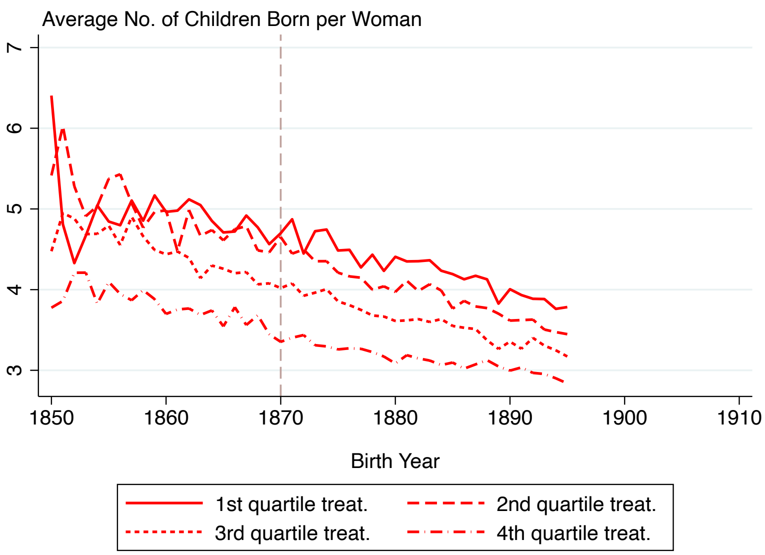
‡ The universe of people to whom the school attendance question was asked was different in 1900, as it encompassed only persons "of school age." As such, for 1900 this variable is built using the number of months the respondent attended school during the 1899-1900 school year, which was asked of everybody. In particular, the variable takes a value of 1 if the respondent spent one or more months in school, and 0 otherwise.

Figure B.2: Pre-Treatment Trends: Effects of Electrification by Residential Price of Electricity in 1917–1919 Fertility in 1900



Notes: The coefficients plotted correspond to $\beta_t^{cap.price}$ in Equation (2), but focusing in the 1900 and 1910 periods. These coefficients capture the heterogeneity in difference-in-differences effects by price of residential electricity for each of the pre-treatment period (1900, with baseline 1910). The analyses encompass women in the panel sample who were 25–44 years of age in 1910, and who also have information in 1900. 95% confidence intervals built from standard errors clustered at the county-by-year level are plotted.

Figure B.3: Women's Fertility in 1940 by Cohort and Treatment Intensity



B.5 Additional Results on the Differential Effect of Electrification by Maternal Status

Table B.9: Heterogeneity in the Effects of Electrification on Women's Fertility by Maternal Status of Young Child in 1910 (for women 15–24 years of age in 1910)

	No. of Children Born	No. of Own Children in HH	No. of Own Children <18 in HH
ΔCap×1920		-0.12***	-0.13***
		(0.029)	(0.028)
ΔCap×1930		-0.19***	-0.23***
		(0.038)	(0.038)
ΔCap×1940	-0.42***	-0.15***	-0.13***
	(0.12)	(0.029)	(0.028)
ΔCap×1920×MomYoungChild1910		0.012	0.0079
		(0.022)	(0.020)
ΔCap×1930×MomYoungChild1910		0.047**	-0.029
		(0.023)	(0.022)
ΔCap×1940×MomYoungChild1910	0.17	0.072***	0.0070
	(0.16)	(0.023)	(0.019)
R^2	0.77	0.71	0.69
Year Fixed Effects	Yes	Yes	Yes
Individual Fixed Effects	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes
State x Year Fixed Effects	Yes	Yes	Yes
Demographic and socioecon. controls	Yes	Yes	Yes
Cluster	County x Year	County x Year	County x Year
N	25,936	4,790,711	4,790,711

Notes: This specification corresponds to that of Equation (1), but where the variable for maternal status compares young mothers to non-mothers by assigning a one to women whose eldest child was under 1 year of age, and a 0 for women who did not have children. Some of the terms omitted due to length. The analyses encompass women in the panel sample who were 15–44 years of age in 1910. Clustered standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

B.6 Additional Results on the Differential Effect of Electrification by Price of Residential Electricity

Table B.10: Heterogeneity in the Effects of Electrification on Women's Fertility by Prices of Residential Electricity in 1917–1919 (for women who were mothers in 1910)

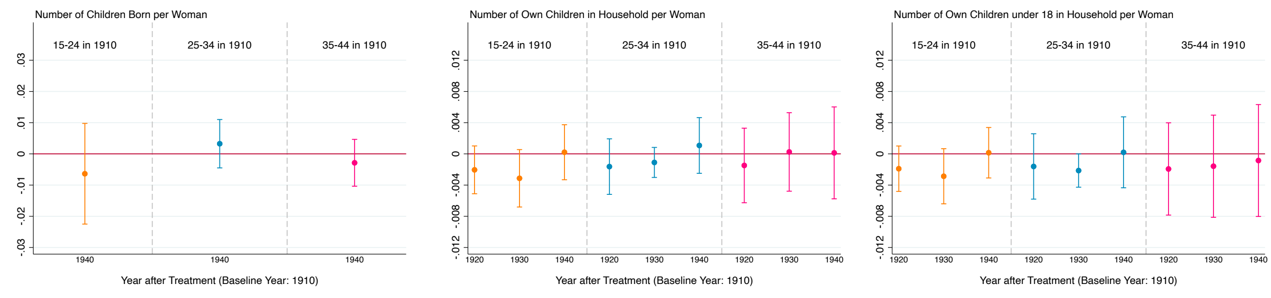
	No. of Children Born	No. of Own Children in HH	No. of Own Children < Children <18 in HH
ΔCap×1920		0.23	0.29
		(0.19)	(0.21)
ΔCap×1930		0.32*	0.45**
		(0.19)	(0.19)
ΔCap×1940	0.016	0.26	0.37*
	(0.33)	(0.19)	(0.22)
ΔCap×1920×PriceResElect1919		-0.0049**	-0.0057**
		(0.0024)	(0.0026)
ΔCap×1930×PriceResElect1919		-0.0055**	-0.0071***
		(0.0023)	(0.0024)
ΔCap×1940×PriceResElect1919	-0.0032	-0.0036	-0.0045*
	(0.0043)	(0.0025)	(0.0027)
R^2	0.76	0.65	0.65
Year Fixed Effects	Yes	Yes	Yes
Individual Fixed Effects	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes
State x Year Fixed Effects	Yes	Yes	Yes
Demographic and socioecon. controls	Yes	Yes	Yes
Cluster	County x Year	County x Year	County x Year
N	198,640	9,805,760	9,805,760

Notes: This specification corresponds to that of Equation (2). Some of the terms omitted due to length. The analyses encompass women in the panel sample who were 15–44 years of age and mothers (measured by having non-zero own children in the same household) in 1910. Clustered standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.[61]

[61] Due to the significant reduction in sample size, I only present results for the number of children in the household, and number of children under 18 in the household.

Figure B.4: Differential Effect of Electrification on Women's Fertility by Residential Price of Electricity in 1917–1919 and Cohort

(a) No of Children Born (b) No. of Own Children in HH (c) No. of Own Childr. < 18 in HH



Notes: The coefficients plotted correspond to $\beta_t^{cap.price}$ in Equation (2), estimated for each cohort separately. These coefficients capture the heterogeneity in difference-in-differences effects by price of residential electricity for each of the post-treatment periods (1920, 1930, and 1940, with baseline 1910). The analyses encompass women in the panel sample who were 15–24, 25–34, and 35–44 years of age in 1910, respectively. 95% confidence intervals built from standard errors clustered at the county-by-year level are plotted.

C Appendix: Overall Effect of Electrification on Fertility

In this section, I present the results of the effects of electrification on the number of children ever born, the number of own children in the household, and an indicator for maternal status for women in the panel sample.[62] These results are suggestive of the overall effect of electrification on the intensive and extensive margins of fertility. To this end, I estimate the following regression

$$\begin{aligned} Fertility_{i,h,c,t} = \alpha + \beta_t \Delta Cap_c \times Post_t + \alpha_i + \alpha_t + \alpha_c + \alpha_{s,t} + \beta_{X,t} X_{i,h,c,1910} \times Year_t \\ + \beta_{Z,t} Z_{h,c,1910} \times Year_t + \epsilon_{i,h,c,t}, \end{aligned} \tag{C.1}$$

which follows the notation from Equation (1). I estimate this regression for the three fertility variables explored in the main text, and for an indicator variable that take a value of one if woman i had one or more children ever born in year t.

I present the results from these exercises in Table C.1. I find that an increase on 100mw in generating capacity reduced the completed lifetime fertility by 0.22 children for women in 1940 relative to 1910, while also reducing the probability of ever becoming a mother, though this latter effect is not statistically significant. In addition, I find that an increase of 100mw in generating capacity reduced the number of own children in the household, both overall and for those under the age of 18. These results are consistent with the existence and predominance of the opportunity cost channel of electrification, per which electrification

[62]I complement this analysis by using cross-sectional county-by-year data considering all women in the cohorts of interest in Appendix D.

increased the opportunity cost of childcare due to increased female wages and new work opportunities.[63]

Table C.1: Effects of Electrification on Women's Fertility

	No. of Children Born	No. of Own Children in HH	No. of Own Children <18 in HH	Ever-Mother
ΔCap×1920		-0.12***	-0.12***	
		(0.030)	(0.032)	
ΔCap×1930		-0.11***	-0.091***	
		(0.032)	(0.034)	
ΔCap×1940	-0.22***	-0.025	-0.003	-0.006
	(0.041)	(0.032)	(0.034)	(0.004)
R^2	0.78	0.63	0.58	0.70
Year Fixed Effects	Yes	Yes	Yes	Yes
Individual Fixed Effects	Yes	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes	Yes
State x Year Fixed Effects	Yes	Yes	Yes	Yes
Demog. and socioecon. controls	Yes	Yes	Yes	Yes
Cluster	County x Year	County x Year	County x Year	County x Year
N	241,880	16,365,989	16,365,989	241,880

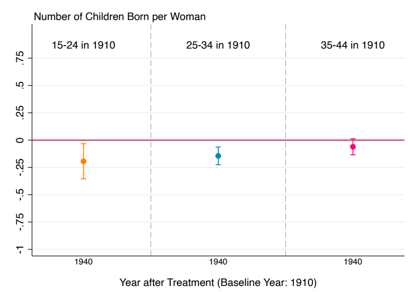
This specification corresponds to that of Equation (C.1). Some of the terms omitted due to length. The analyses encompass women in the panel sample who were 15–44 years of age in 1910. Clustered standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

I then repeat these analyses splitting the sample across different cohorts and summarize the results in Figure C.1. First, I find that electrification reduced the intensive margin of fertility, as measured by the number of children born, for women who were younger in 1910. In addition, the results for the number of children in the household suggest the timing of fertility was also altered for these cohorts, since the decline in these variables for the two younger cohorts was particularly marked in 1920 and 1930, and less in 1940, suggesting young women in electrified areas waited to have children.

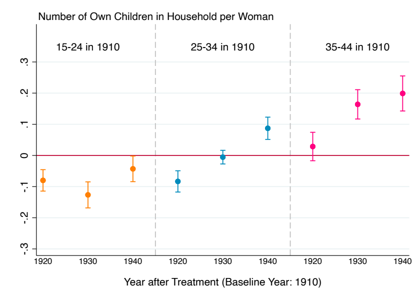
In contrast, for older cohorts, the results suggest an increase in the number of own children living in the same household in latter years. These patterns match those found when we look at the effects on the number of own children under the age of 18 in the household, and suggest that electrification induced these older cohorts to have children. This suggests that

[63]Furthermore, it is worth noting that the fact that these effects are prevalent among all the fertility variables considered, and particularly those capturing the number of own children in the household, strongly suggests that electrification changed the desirability of children, and did not only affect other channels such as infant mortality. In particular, since electricity reduces infant mortality (Lewis (2018)), it is in theory possible that the reduction we observe in the number of children born after electrification does not reflect a change in the desirability of children, but rather that women internalize that now more of their children will survive and thus choose to have fewer pregnancies. This is addressed by looking at the effects of electrification on the number of own children in the household since this captures the number of children a woman has after (most of) the realization of infant mortality in both the pre- and post- electrification periods. Thus, the negative effect we observe suggests a reduction in the number of children in the household even in the presence of higher child survival, highlighting a reduction in the number of children women choose to have.

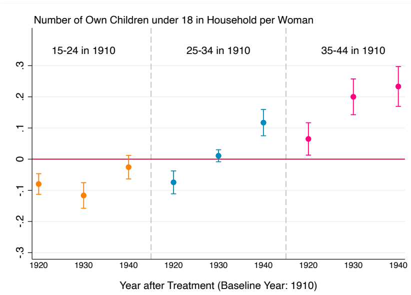
Figure C.1: Effect of Electrification on Women's Fertility by Cohort



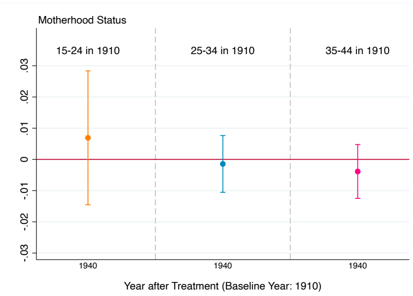
(a) No. of Children Born



(b) No. of Children in HH



(c) No. of Children <18 in HH



(d) Ever-mother

Notes: The coefficients plotted correspond to β_t in Equation (C.1), estimated for each cohort separately. These coefficients capture the difference-in-differences effects for each of the post-treatment periods (1920, 1930, and 1940, with baseline 1910). The analyses encompass women in the panel sample who were 15–24, 25–34, and 35–44 years of age in 1910, respectively. 95% confidence intervals built from standard errors clustered at the county-by-year level are plotted.

for women who are more attached to the labor market, like younger women, the opportunity cost channel of electrification is particularly important, while for older women this mechanism is muted and the time savings channel may be more important.

D Appendix: Overall Effect of Electrification on Fertility using Cross-Sectional Data

In this section, I explore the broader impacts of electrification on overall fertility patterns by using aggregate cross-sectional county-by-year data capturing all women in the cohorts of interest. Specifically, I average the information of interest for all women who were 15–44 years of age in 1910 across different counties and time periods using the full-count census, and compare the effects of electrification on the extensive and intensive margins of fertility in counties that were electrified versus those that were not.[64] To this end, I estimate the

[64]The summary statistics for this repeated cross-section sample can be found in Table 3.2 for 1910, and Appendix B.1 for 1920–1940.

following regressions:

$$Fertility_{c,t} = \alpha + \beta_t \Delta Cap_c \times Post_t + \alpha_t + \alpha_{s,t} + \alpha_c + \beta_{Z,t} Z_{c,1910} \times Post_t + \epsilon_{c,t}, \tag{D.1}$$

where $Fertility$ captures the following variables for women who were 15–44 years of age in 1910 in year t and county c: the average number of children ever born per woman, the average number of total and under 18 years old own children residing in each woman's household, and the share of women who had one or more children ever born. ΔCap_c corresponds to the preferred measure of electrification, change in generating capacity between 1911 and 1919 (in 100s of megawatts). $Z_{c,1910}$ denotes county-level controls for the cohorts of interest in 1910 (proportion urban, racial composition, total population, proportion married, and average socioeconomic index). Similar to the baseline results, I cluster these results at the county-by-year level. Since this analysis is performed at the aggregated county-level, the results should be interpreted as suggestive.

Table D.1: Effects of Electrification on Women's Fertility (Aggregate Cross-Sectional Data)

	No. of Children Born	No. of Own Children in HH	No. of Own Children <18 in HH	Ever-Mother
ΔCap×1920		-0.06***	-0.05***	
		(0.013)	(0.012)	
ΔCap×1930		-0.04**	-0.02**	
		(0.013)	(0.010)	
ΔCap×1940	-0.12***	0.02	0.04**	-0.001
	(0.031)	(0.013)	(0.014)	(0.003)
R^2	0.96	0.99	0.99	0.93
Year Fixed Effects	Yes	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes	Yes
State x Year Fixed Effects	Yes	Yes	Yes	Yes
Demog. and socioecon. controls	Yes	Yes	Yes	Yes
Cluster	County x Year	County x Year	County x Year	County x Year
N	5,254	10,618	10,616	5,254

This specification corresponds to that of Equation (D.1). Some of the terms omitted due to length. The analyses encompass the aggregate county-by-year data of all women 15–44 years of age in 1910. Clustered standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

I present the results from these exercises in Table D.1. I find results consistent with those found using the panel sample in Appendix C, though, unsurprisingly, the magnitude of these is compressed since the analysis here considers the impacts of electrification on average fertility patterns.

E Appendix: Effects of Electrification on Age at First Birth

In this section, I explore the effects of electrification on the age at first birth. Since there is no change in this variable within individuals, a panel or cohort-level analysis following the same individuals over time is not informative. Instead, I conduct this analysis at the age-group level by aggregating cross-sectional county-by-year data capturing subsequent generations of young women, and compare the effects of electrification on women's age at first birth in counties that were electrified versus those that were not. For this analysis, and given that the age at first birth is measured by subtracting the age of the eldest child currently living with the woman from her current age, I focus on women who were 15–34 years of age in each period, since these have likely had their first child, and this is almost certainly still young and living with them. I estimate the following equation:

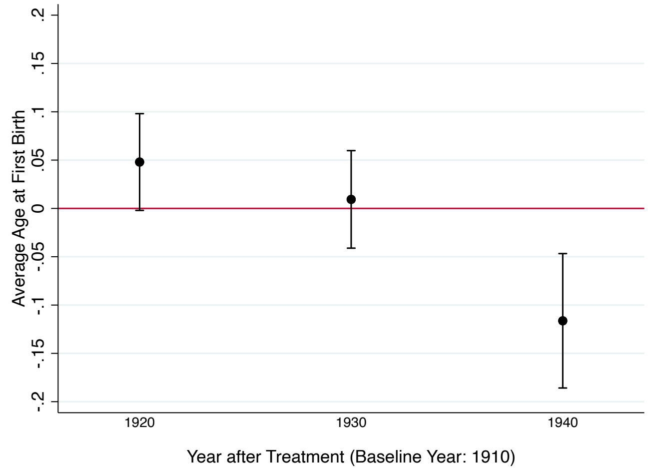
$$AgeFirstBirth_{c,t} = \alpha + \beta_t \Delta Cap_c \times Post_t + \alpha_t + \alpha_{s,t} + \alpha_c + \beta_{Z,t} Z_{c,1910} \times Post_t + \epsilon_{c,t}, \tag{E.1}$$

where $AgeFirstBirth$ captures the average age at first birth for women of 15–34 years of age in year t and county c. ΔCap_c corresponds to the preferred measure of electrification, change in generating capacity between 1911 and 1919 (in 100s of megawatts). $Z_{c,1910}$ denotes county-level controls in 1910 (proportion urban, racial composition, total population, proportion married, and average socioeconomic index). Similar to the baseline results, I cluster these results at the county-by-year level. Since this analysis is performed at the aggregated county-level, and given that these results focus on groups of women born at different times, the results, particularly in the latter periods, should be interpreted with caution as other factors may be driving women's fertility decisions.

I plot the results of these exercises in Figure E.1. I find that an increase of 100mw in generating capacity increased the age at first birth by roughly 0.05 years in 1920 for women of 15–34 years of age relative to 1910. This indicates that women who very young when electrification occurred waited longer to have their first child than previous cohorts, and highlights the importance of the opportunity cost channel of electrification among these. However, this effect is reversed for women of 15–34 years of age in 1940, which may follow from the introduction and spread of several key time-saving appliances during this period (such as the refrigerator, which became much more affordable during this period) and following the time savings channel of electrification, or other factors, such as those relating to the baby boom.

The increase in the age at first birth for women who very young in the 1910s when electri-

Figure E.1: Effects of Electrification on Women's Ever-Married Status



Notes: The coefficients plotted correspond to β_t in Equation (E.1). These coefficients capture the difference-in-differences effects for the post-treatment periods (1920, 1930, and 1940 with baseline 1910). The analyses encompass the aggregate county-by-year data of all women 15–34 years of age in each year. 95% confidence intervals built from standard errors clustered at the county-by-year level are plotted.

fication occurred matches the evidence presented by Goldin (2020), who shows that at the turn of the 20th century women moved from a regime of having to choose between career or family to a regime where they could pursue a career when young and a family afterwards. In particular, this evidence suggests that electricity was a key factor in this transition.

F Appendix: Robustness of Main Empirical Results

I now repeat the main results in the empirical section presented in Table 3.3 and Table 3.4 using the following alternate specifications: (1) using contemporaneous controls instead of baseline level controls; (2) clustering at the county level; (3) excluding counties in the South; (4) excluding counties in the West; (5) considering an alternate treatment definition based on the proximity to large electricity generating plants; (6) limiting only to married women and controlling for spouses' socioeconomic status; (7) limiting only to urban women to control for improvements in sanitation and reductions in child mortality; (8) limiting only to women who did not migrate after 1910; (9) using county-level religiosity instead of motherhood status when estimating the effect of electrification working through the opportunity cost channel; (10) using an alternate measure of electricity prices based on utility-level rate structures collected by the National Electric Light Association (NELA) in some cities; and (11) using two alternate record-linking methods to match individuals across census waves: a method that leverages the algorithm proposed by Abramitzky et al. (2012, 2014) and that thus relies on name, birth year, and state or country of birth matches to link records; and the method proposed by Althoff et al. (2023) which leverages social security application information to link records.

F.1 Contemporaneous Controls

Due to the risk of post-treatment bias arising from the effect of treatment on controls, in the baseline specification I included the baseline (1910) level of the controls interacted with post-treatment indicators rather than contemporaneous levels. This, however, leads to concerns about omitted variable bias stemming from the long period considered in the analysis and the possibility of concurrent shocks. In this section, I repeat the two main analyses considering contemporaneous levels of controls in addition to fixed effects. I estimate the following regressions:

$$\begin{aligned} Fertility_{i,h,c,t} &= \alpha + \beta_t \Delta Cap_c \times Post_t + \beta^{mom} \Delta Cap_c \times Mom1910_{i,h,c} \\ &+ \beta_t^{mom} Post_t \times Mom1910_{i,h,c} + \beta_t^{cap.mom} \Delta Cap_c \times Post_t \times Mom1910_{i,h,c} \\ &+ \alpha_i + \alpha_t + \alpha_c + \alpha_{s,t} + \beta_{X,t} X_{i,h,c,t} + \beta_{Z,t} Z_{h,c,t} + \epsilon_{i,h,c,t} \end{aligned} \tag{F.1}$$

$$\begin{aligned} Fertility_{i,h,c,t} &= \alpha + \beta_t \Delta Cap_c \times Post_t + \beta^{price} \Delta Cap_c \times PriceResElect1919_c \\ &+ \beta_t^{price} Post_t \times PriceResElect1919_c + \beta_t^{cap.price} \Delta Cap_c \times Post_t \times PriceResElect1919_c \\ &+ \alpha_i + \alpha_t + \alpha_c + \alpha_{s,t} + \beta_{X,t} X_{i,h,c,t} + \beta_{Z,t} Z_{h,c,t} + \epsilon_{i,h,c,t}, \end{aligned} \tag{F.2}$$

where the notation follows from Equation (1) and Equation (2), respectively, and standard errors are clustered at the county-by-year level.

Table F.1: Heterogeneity in the Effects of Electrification on Women's Fertility by Maternal Status in 1910 (with contemporaneous controls)

	No. of Children Born	No. of Own Children in HH	No. of Own Children <18 in HH
ΔCap×1920×Mom1910		0.13***	0.12***
		(0.038)	(0.034)
ΔCap×1930×Mom1910		0.53***	0.51***
		(0.041)	(0.035)
ΔCap×1940×Mom1910	0.27***	0.58***	0.54***
	(0.049)	(0.039)	(0.034)
R^2	0.78	0.69	0.67
Year Fixed Effects	Yes	Yes	Yes
Individual Fixed Effects	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes
State x Year Fixed Effects	Yes	Yes	Yes
Demographic and socioecon. controls	Yes	Yes	Yes
Cluster	County x Year	County x Year	County x Year
N	241,876	16,365,988	16,365,988

Notes: This specification corresponds to that of Equation (F.1). Some of the terms omitted due to length. The analyses encompass women in the panel sample who were 15–44 years of age in 1910. Clustered standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table F.2: Heterogeneity in the Effects of Electrification on Women's Fertility by Residential Price of Electricity in 1917–1919 (with contemporaneous controls)

	No. of Children Born	No. of Own Children in HH	No. of Own Children <18 in HH
ΔCap×1920×PriceResElect1919		-0.0033**	-0.0038**
		(0.0017)	(0.0018)
ΔCap×1930×PriceResElect1919		-0.0022**	-0.0034***
		(0.0010)	(0.0013)
ΔCap×1940×PriceResElect1919	-0.0040	0.0012	0.00008
	(0.0043)	(0.0018)	(0.0020)
R^2	0.77	0.60	0.54
Year Fixed Effects	Yes	Yes	Yes
Individual Fixed Effects	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes
State x Year Fixed Effects	Yes	Yes	Yes
Demographic and socioecon. controls	Yes	Yes	Yes
Cluster	County x Year	County x Year	County x Year
N	241,880	16,366,039	16,366,043

Notes: This specification corresponds to that of Equation (F.2). Some of the terms omitted due to length. The analyses encompass women in the panel sample who were 15–44 years of age in 1910. Clustered standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

The results of these analyses are presented in Table F.1 and Table F.2. I find that these results are qualitatively and quantitatively similar to the baseline results, with one difference: the effects of the price of residential electricity on fertility are moderated in this specification. This likely stems from the fact that this specification includes concurrent county socioeconomic indices, and thus controls for the fact that electrification also changes incomes. In particular, this suggests that a part of the effect of electricity prices on fertility follows from the fact that in places where the price of electricity is higher, the productive and household income gains are smaller, and therefore these prices are more relevant to household decisions.

F.2 Alternate Clustering

In the baseline analysis I cluster the standard errors at the county-by-year level. This level is sensible given the specifications considered, where the coefficients of interest are derived from county (or treatment) and year interactions. However, there might still be a concern of serial correlation among observations at the county level, which persists among different census waves. In order to account for that, in this section I consider the robustness of the results by estimating Equation (1) and Equation (2), respectively, while allowing for county-level clustering.

The results of these analyses are presented in Table F.3 and Table F.4. Though the standard errors are slightly larger as a result of a more conservative level of clustering, the significance of the results is similar to the baseline case.

Table F.3: Heterogeneity in the Effects of Electrification on Women's Fertility by Maternal Status in 1910 (with alternate clustering)

	No. of Children Born	No. of Own Children in HH	No. of Own Children <18 in HH
ΔCap×1920×Mom1910		0.22***	0.21***
		(0.031)	(0.029)
ΔCap×1930×Mom1910		0.57***	0.55***
		(0.063)	(0.053)
ΔCap×1940×Mom1910	0.31**	0.61***	0.57***
	(0.064)	(0.060)	(0.051)
R^2	0.78	0.69	0.67
Year Fixed Effects	Yes	Yes	Yes
Individual Fixed Effects	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes
State x Year Fixed Effects	Yes	Yes	Yes
Demographic and socioecon. controls	Yes	Yes	Yes
Cluster	County	County	County
N	241,880	16,365,989	16,365,989

Notes: This specification corresponds to that of Equation (1). Some of the terms omitted due to length. The analyses encompass women in the panel sample who were 15–44 years of age in 1910. Clustered standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table F.4: Heterogeneity in the Effects of Electrification on Women's Fertility by Residential Price of Electricity in 1917–1919 (with alternate clustering)

	No. of Children Born	No. of Own Children in HH	No. of Own Children <18 in HH
ΔCap×1920×PriceResElect1919		-0.0062**	-0.0070**
		(0.0026)	(0.0028)
ΔCap×1930×PriceResElect1919		-0.0072**	-0.0084**
		(0.0031)	(0.0035)
ΔCap×1940×PriceResElect1919	-0.0036	-0.0049	-0.0057
	(0.0055)	(0.0030)	(0.0035)
R^2	0.78	0.63	0.58
Year Fixed Effects	Yes	Yes	Yes
Individual Fixed Effects	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes
State x Year Fixed Effects	Yes	Yes	Yes
Demographic and socioecon. controls	Yes	Yes	Yes
Cluster	County x Year	County x Year	County x Year
N	241,880	16,365,989	16,365,989

Notes: This specification corresponds to that of Equation (2). Some of the terms omitted due to length. The analyses encompass women in the panel sample who were 15–44 years of age in 1910. Clustered standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

F.3 Excluding Counties in the South

During the time period of interest, the southern region of the United States followed a significantly different path from the rest of the country. Given this, there might be some concern that the results are driven by idiosyncrasies of the South rather than the opportunity cost and time savings dimensions of electrification on fertility. In this section, I account for this by estimating Equation (1) and Equation (2), respectively, while dropping counties in the South. In particular, I drop observations from all counties in the following states: Alabama, Arkansas, Delaware, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia.

The results of these analyses are presented in Table F.5 and Table F.6. I find that these results are qualitatively and quantitatively similar to the baseline results, though in this specification the negative effect of residential electricity prices on fertility is much larger. This indicates that the time savings channel of electrification on fertility was more muted in the South relative to the North.

Table F.5: Heterogeneity in the Effects of Electrification on Women's Fertility by Maternal Status in 1910 (excluding counties in the South)

	No. of Children Born	No. of Own Children in HH	No. of Own Children <18 in HH
ΔCap×1920×Mom1910		0.19***	0.20***
		(0.048)	(0.043)
ΔCap×1930×Mom1910		0.56***	0.55***
		(0.055)	(0.047)
ΔCap×1940×Mom1910	0.12**	0.59***	0.52***
	(0.052)	(0.052)	(0.045)
R^2	0.80	0.71	0.67
Year Fixed Effects	Yes	Yes	Yes
Individual Fixed Effects	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes
State x Year Fixed Effects	Yes	Yes	Yes
Demographic and socioecon. controls	Yes	Yes	Yes
Cluster	County x Year	County x Year	County x Year
N	140,162	10,232,624	10,232,624

Notes: This specification corresponds to that of Equation (1). Some of the terms omitted due to length. The analyses encompass women in the panel sample who were 15–44 years of age in 1910, and who did not live in the South. Clustered standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table F.6: Heterogeneity in the Effects of Electrification on Women's Fertility by Residential Price of Electricity in 1917–1919 (excluding counties in the South)

	No. of Children Born	No. of Own Children in HH	No. of Own Children <18 in HH
ΔCap×1920×PriceResElect1919		-0.0094***	-0.011***
		(0.0025)	(0.0029)
ΔCap×1930×PriceResElect1919		-0.011***	-0.012***
		(0.0026)	(0.0029)
ΔCap×1940×PriceResElect1919	-0.0086*	-0.0073***	-0.0078**
	(0.0045)	(0.0028)	(0.0033)
R^2	0.80	0.65	0.59
Year Fixed Effects	Yes	Yes	Yes
Individual Fixed Effects	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes
State x Year Fixed Effects	Yes	Yes	Yes
Demographic and socioecon. controls	Yes	Yes	Yes
Cluster	County x Year	County x Year	County x Year
N	140,162	10,232,624	10,232,624

Notes: This specification corresponds to that of Equation (2). Some of the terms omitted due to length. The analyses encompass women in the panel sample who were 15–44 years of age in 1910, and who did not live in the South. Clustered standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

F.4 Excluding Counties in the West

Technological constraints associated to the transmission of electricity during the first half of the 20th century made it unfeasible to consume power far from the generation site. Due to these constraints, there may be some worry that the county-level electrification measure does not adequately capture the availability of electricity in counties that are larger in area, namely counties in the Western United States. In addition, the county-level measures of electricity prices are more sparse in the west since fewer of the cities in the survey are located there. In order to account for this, in this section I consider the robustness of the results by estimating Equation (1) and Equation (2), respectively, while excluding counties in the West. In particular, I drop observations from all counties whose centroid lies west of the hundredth meridian.

The results of these analyses are presented in Table F.7 and Table F.8. I find that these results are qualitatively and quantitatively similar to the baseline results.

Table F.7: Heterogeneity in the Effects of Electrification on Women's Fertility by Maternal Status in 1910 (excluding counties in the West)

	No. of Children Born	No. of Own Children in HH	No. of Own Children <18 in HH
ΔCap×1920×Mom1910		0.22***	0.22***
		(0.043)	(0.039)
ΔCap×1930×Mom1910		0.59***	0.57***
		(0.048)	(0.041)
ΔCap×1940×Mom1910	0.35***	0.63***	0.59***
	(0.054)	(0.046)	(0.039)
R^2	0.78	0.70	0.67
Year Fixed Effects	Yes	Yes	Yes
Individual Fixed Effects	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes
State x Year Fixed Effects	Yes	Yes	Yes
Demographic and socioecon. controls	Yes	Yes	Yes
Cluster	County x Year	County x Year	County x Year
N	217,288	15,418,872	15,418,872

Notes: This specification corresponds to that of Equation (1). Some of the terms omitted due to length. The analyses encompass women in the panel sample who were 15–44 years of age in 1910, and who did not live in the West. Clustered standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table F.8: Heterogeneity in the Effects of Electrification on Women's Fertility by Residential Price of Electricity in 1917–1919 (excluding counties in the West)

	No. of Children Born	No. of Own Children in HH	No. of Own Children <18 in HH
ΔCap×1920×PriceResElect1919		-0.0052**	-0.0055**
		(0.0023)	(0.0026)
ΔCap×1930×PriceResElect1919		-0.0050**	-0.0061**
		(0.0024)	(0.0026)
ΔCap×1940×PriceResElect1919	-0.0024	-0.0027	-0.0035
	(0.0044)	(0.0025)	(0.0029)
R^2	0.77	0.64	0.59
Year Fixed Effects	Yes	Yes	Yes
Individual Fixed Effects	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes
State x Year Fixed Effects	Yes	Yes	Yes
Demographic and socioecon. controls	Yes	Yes	Yes
Cluster	County x Year	County x Year	County x Year
N	217,288	15,418,872	15,418,872

Notes: This specification corresponds to that of Equation (2). Some of the terms omitted due to length. The analyses encompass women in the panel sample who were 15–44 years of age in 1910, and who did not live in the West. Clustered standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

F.5 Alternate Treatment Definition based on Proximity to Large Plants

The treatment variable in the main analysis is given by the change in the total electrical capacity within and 50 miles around each county's boundaries between 1911 and 1919. This measure has several advantages, including the fact that it captures the generation of smaller plants, which are important in this period and frequently overlooked in other studies that only consider the output and location of large generating plants.

In this section, I show that the results are robust to using an alternate treatment definition based on the location of large plants. In particular, I define treatment through a dummy indicating whether the county-centroid distance to a large-capacity generating plant (20 megawatts or more) is less than 100 miles.[65] I estimate the following regressions:

$$\begin{aligned} Fertility_{i,h,c,t} &= \alpha + \beta_t DistLargePlant_c \times Post_t + \beta^{mom} DistLargePlant_c \times Mom1910_{i,h,c} \\ &+ \beta_t^{mom} Post_t \times Mom1910_{i,h,c} + \beta_t^{dist.mom} DistLargePlant_c \times Post_t \times Mom1910_{i,h,c} \\ &+ \alpha_i + \alpha_t + \alpha_c + \alpha_{s,t} + \beta_{X,t} X_{i,h,c,1910} \times Year_t + \beta_{Z,t} Z_{h,c,1910} \times Year_t + \epsilon_{i,h,c,t} \end{aligned} \tag{F.3}$$

$$\begin{aligned} Fertility_{i,h,c,t} &= \alpha + \beta_t DistLargePlant_c \times Post_t + \beta^{price} DistLargePlant_c \times PriceResElect1919_c \\ &+ \beta_t^{price} Post_t \times PriceResElect1919_c + \beta_t^{dist.price} DistLargePlant_c \times Post_t \times PriceResElect1919_c \\ &+ \alpha_i + \alpha_t + \alpha_c + \alpha_{s,t} + \beta_{X,t} X_{i,h,c,1910} \times Year_t + \beta_{Z,t} Z_{h,c,1910} \times Year_t + \epsilon_{i,h,c,t} \end{aligned} \tag{F.4}$$

where $DistLargePlant_c$ denotes a dummy variable indicating whether the centroid in county c is less than 100 miles away from a large-capacity generating plant (20 megawatts or more).[66] The rest of the notation follows Equation (1) and Equation (2), respectively.

The results of these analyses are presented in Table F.9 and Table F.10. I find results consistent with the baseline results.

[65] As before, and to ensure comparability with the main results, I limit the analysis to counties that were not electrified by 1910 according to the main measure.

[66] I choose the generating threshold of 20 megawatts and distance threshold of 100 miles based on technological and institutional facts of this era. First, the 20-megawatts generating threshold corresponds to a medium- to large-sized plant in the period considered. As such, this alternate treatment definition captures proximity to a plant with large nameplate capacity producing enough electricity to power all homes and business in its vicinity. This matches similar approaches followed by the literature examining the effects of electrification in the United States. For a later period (1930 to 1940), Lewis and Severnini (2017) define treatment as the county-centroid distance to the nearest power plant with at least 30 megawatts of generating capacity. I do not use inverse distance, however, because during this period consuming electricity more than 100 miles away from the generating source was unfeasible. As such, I set the distance threshold of 100 miles based on the technological constraints of the transmission of electricity during this time.

Table F.9: Heterogeneity in the Effects of Electrification on Women's Fertility by Maternal Status in 1910 (with alternate treatment definition)

	No. of Children Born	No. of Own Children in HH	No. of Own Children <18 in HH
DistLargePlant×1920×Mom1910		0.21***	0.20***
		(0.028)	(0.027)
DistLargePlant×1930×Mom1910		0.50***	0.48***
		(0.032)	(0.029)
DistLargePlant×1940×Mom1910	0.24***	0.51***	0.45***
	(0.057)	(0.032)	(0.029)
R^2	0.78	0.69	0.67
Year Fixed Effects	Yes	Yes	Yes
Individual Fixed Effects	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes
State x Year Fixed Effects	Yes	Yes	Yes
Demographic and socioecon. controls	Yes	Yes	Yes
Cluster	CountyxYear	CountyxYear	CountyxYear
N	241,580	16,360,995	16,360,995

Notes: This specification corresponds to that of Equation (F.3). Some of the terms omitted due to length. The analyses encompass women in the panel sample who were 15–44 years of age in 1910. Clustered standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table F.10: Heterogeneity in the Effects of Electrification on Women's Fertility by Residential Price of Electricity in 1917–1919 (with alternate treatment definition)

	No. of Children Born	No. of Own Children in HH	No. of Own Children <18 in HH
DistLargePlant×1920×PriceResElect1919		-0.0040***	-0.0047***
		(0.0014)	(0.0015)
DistLargePlant×1930×PriceResElect1919		-0.0045***	-0.0053***
		(0.0015)	(0.0015)
DistLargePlant×1940×PriceResElect1919	-0.0036	-0.0037**	-0.0042***
	(0.0032)	(0.0015)	(0.0016)
R^2	0.78	0.63	0.58
Year Fixed Effects	Yes	Yes	Yes
Individual Fixed Effects	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes
State x Year Fixed Effects	Yes	Yes	Yes
Demographic and socioecon. controls	Yes	Yes	Yes
Cluster	County x Year	County x Year	County x Year
N	241,580	16,360,995	16,360,995

Notes: This specification corresponds to that of Equation (F.4). Some of the terms omitted due to length. The analyses encompass women in the panel sample who were 15–44 years of age in 1910. Clustered standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

F.6 Controlling for Spouses' Socioeconomic Status

In the baseline specification I do not control for husbands' socioeconomic index since this would require limiting only to women who are married, and given the potential risk of post-treatment bias arising from the effect of electrification on men's outcomes and spousal decisions. This, however, leads to concerns about the possibility that the observed changes follow from changes to men's situations rather than women's.

In this section, I repeat the two main analyses after limiting only to married women and controlling spouses' socioeconomic status in each wave. I estimate the following regressions:

$$Fertility_{i,h,c,t} = \alpha + \beta_t \Delta Cap_c \times Post_t + \beta^{mom} \Delta Cap_c \times Mom1910_{i,h,c}$$
$$+\beta_t^{mom} Post_t \times Mom1910_{i,h,c} + \beta_t^{cap.mom} \Delta Cap_c \times Post_t \times Mom1910_{i,h,c}$$
$$+\alpha_i + \alpha_t + \alpha_c + \alpha_{s,t} + \beta_{X,t} X_{i,h,c,1910} \times Year_t + \beta_{Z,t} Z_{h,c,1910} \times Year_t + \beta_{SSI} SSI_{i,h,c,t} + \epsilon_{i,h,c,t} \tag{F.5}$$

$$Fertility_{i,h,c,t} = \alpha + \beta_t \Delta Cap_c \times Post_t + \beta^{price} \Delta Cap_c \times PriceResElect1919_c$$
$$+\beta_t^{price} Post_t \times PriceResElect1919_c + \beta_t^{cap.price} \Delta Cap_c \times Post_t \times PriceResElect1919_c$$
$$+\alpha_i + \alpha_t + \alpha_c + \alpha_{s,t} + \beta_{X,t} X_{i,h,c,1910} \times Year_t + \beta_{Z,t} Z_{h,c,1910} \times Year_t + \beta_{SSI} SSI_{i,h,c,t} + \epsilon_{i,h,c,t}, \tag{F.6}$$

where $SSI_{i,h,c,t}$ denote each woman's spouse's socioeconomic index in each year. The rest of the notation follows from Equation (1) and Equation (2), respectively, and standard errors are clustered at the county-by-year level.

The results of these analyses are presented in Table F.11 and Table F.12. I find that these results are qualitatively and quantitatively similar to the baseline results.

Table F.11: Heterogeneity in the Effects of Electrification on Women's Fertility by Maternal Status in 1910 (for married women)

	No. of Children Born	No. of Own Children in HH	No. of Own Children <18 in HH
ΔCap×1920×Mom1910		0.23***	0.21***
		(0.036)	(0.033)
ΔCap×1930×Mom1910		0.56***	0.53***
		(0.039)	(0.033)
ΔCap×1940×Mom1910	0.26***	0.60***	0.56***
	(0.058)	(0.037)	(0.033)
R^2	0.77	0.71	0.69
Year Fixed Effects	Yes	Yes	Yes
Individual Fixed Effects	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes
State x Year Fixed Effects	Yes	Yes	Yes
Demographic and socioecon. controls	Yes	Yes	Yes
Spouse's socioecon. index control	Yes	Yes	Yes
Cluster	County x Year	County x Year	County x Year
N	167,766	12,391,800	12,391,800

Notes: This specification corresponds to that of Equation (1). Some of the terms omitted due to length. The analyses encompass women in the panel sample who were 15–44 years of age in 1910, and who were married. Clustered standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table F.12: Heterogeneity in the Effects of Electrification on Women's Fertility by Residential Price of Electricity in 1917–1919 (for married women)

	No. of Children Born	No. of Own Children in HH	No. of Own Children <18 in HH
ΔCap×1920×PriceResElect1919		-0.0049**	-0.0058**
		(0.0024)	(0.0027)
ΔCap×1930×PriceResElect1919		-0.0059**	-0.0074***
		(0.0024)	(0.0026)
ΔCap×1940×PriceResElect1919	-0.0071	-0.0038	-0.0051
	(0.0048)	(0.0027)	(0.0029)
R^2	0.77	0.67	0.64
Year Fixed Effects	Yes	Yes	Yes
Individual Fixed Effects	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes
State x Year Fixed Effects	Yes	Yes	Yes
Demographic and socioecon. controls	Yes	Yes	Yes
Spouse's socioecon. index control	Yes	Yes	Yes
Cluster	County x Year	County x Year	County x Year
N	167,766	12,391,800	12,391,800

Notes: This specification corresponds to that of Equation (2). Some of the terms omitted due to length. The analyses encompass women in the panel sample who were 15–44 years of age in 1910, and who were married. Clustered standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

F.7 Limiting to Urban Women

A potential concern of the baseline analyses is that the effects of electrification I document do not capture a change in the desirability of children for women, but rather a change in infant mortality. This is supported by the findings of Lewis (2018) who documents a large and significant reduction in infant mortality after the electrification of rural areas in 1930–1960 due to increased access to electrical water pumps improving home sanitation along with electrical stoves reducing the need for coal or wood and thus indoor pollution.

The use of electrical stoves is not a major concern in my setting since these appliances only started spreading widely in the 1930s, and thus past the main period of interest (Busch (1983)). To address the concern regarding the use of pumped water, in this section I estimate Equation (1) and Equation (2), respectively, while limiting only to women living in urban settings during each of the years in question since urban homes gained access to filtered and treated piped water during the early 1900s (US Environmental Protection Agency (2000)), and thus did not need pumped water in the period of interest.

The results of these analyses are presented in Table F.13 and Table F.14. I find that these results are qualitatively and quantitatively similar to the baseline results, though in this specification the negative effect of residential electricity prices on fertility is much larger. This indicates that the time savings channel of electrification on fertility was more muted in rural areas, with the effect of electrification on infant mortality being a likely driver of this. In particular, higher residential electricity prices mitigate the negative impact of electrification on infant mortality in rural areas by increasing the expenses associated with water pumping. Consequently, rural women counterbalance this effect by undergoing a relatively higher number of pregnancies.

Table F.13: Heterogeneity in the Effects of Electrification on Women's Fertility by Maternal Status in 1910 (for urban women)

	No. of Children Born	No. of Own Children in HH	No. of Own Children <18 in HH
ΔCap×1920×Mom1910		0.22***	0.22***
		(0.045)	(0.041)
ΔCap×1930×Mom1910		0.39***	0.33***
		(0.048)	(0.037)
ΔCap×1940×Mom1910	0.17**	0.36***	0.27***
	(0.078)	(0.044)	(0.038)
R^2	0.80	0.75	0.70
Year Fixed Effects	Yes	Yes	Yes
Individual Fixed Effects	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes
State x Year Fixed Effects	Yes	Yes	Yes
Demographic and socioecon. controls	Yes	Yes	Yes
Cluster	County x Year	County x Year	County x Year
N	55,942	5,633,804	5,633,804

Notes: This specification corresponds to that of Equation (1). Some of the terms omitted due to length. The analyses encompass women in the panel sample who were 15–44 years of age in 1910, and who were married. Clustered standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table F.14: Heterogeneity in the Effects of Electrification on Women's Fertility by Residential Price of Electricity in 1917–1919 (for urban women)

	No. of Children Born	No. of Own Children in HH	No. of Own Children <18 in HH
ΔCap×1920×PriceResElect1919		-0.0060**	-0.0074**
		(0.0027)	(0.0032)
ΔCap×1930×PriceResElect1919		-0.0077***	-0.010***
		(0.0027)	(0.0031)
ΔCap×1940×PriceResElect1919	0.0036	-0.0083***	-0.010***
	(0.0061)	(0.0030)	(0.0036)
R^2	0.80	0.71	0.63
Year Fixed Effects	Yes	Yes	Yes
Individual Fixed Effects	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes
State x Year Fixed Effects	Yes	Yes	Yes
Demographic and socioecon. controls	Yes	Yes	Yes
Cluster	County x Year	County x Year	County x Year
N	55,942	5,633,804	5,633,804

Notes: This specification corresponds to that of Equation (2). Some of the terms omitted due to length. The analyses encompass women in the panel sample who were 15–44 years of age in 1910, and who were married. Clustered standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

F.8 Limiting to Women Who Did Not Migrate

A potential concern of the baseline analyses is that the effects of electrification I document are driven by selective migration and spatial sorting, as electrification (and also potentially lower electricity prices and motherhood) may motivate certain women, who perhaps have different fertility desires and career prospects, to migrate to electrified areas. In order to address this issue, in this section I estimate Equation (1) and Equation (2), respectively, while limiting only to women who reported living in the same county throughout the whole period of study, 1910–1940.

The results of these analyses are presented in Table F.15 and Table F.16. I find that these results are qualitatively and quantitatively very similar to the baseline results suggesting that selective migration and spatial sorting are not driving the results observed.

Table F.15: Heterogeneity in the Effects of Electrification on Women's Fertility by Maternal Status in 1910 (for women who did not migrate)

	No. of Children Born	No. of Own Children in HH	No. of Own Children <18 in HH
ΔCap×1920×Mom1910		0.17***	0.19***
		(0.047)	(0.041)
ΔCap×1930×Mom1910		0.56***	0.56***
		(0.054)	(0.046)
ΔCap×1940×Mom1910	0.16***	0.60***	0.55***
	(0.058)	(0.052)	(0.043)
R^2	0.80	0.71	0.68
Year Fixed Effects	Yes	Yes	Yes
Individual Fixed Effects	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes
State x Year Fixed Effects	Yes	Yes	Yes
Demographic and socioecon. controls	Yes	Yes	Yes
Cluster	County x Year	County x Year	County x Year
N	133,844	8,158,197	8,158,197

Notes: This specification corresponds to that of Equation (1). Some of the terms omitted due to length. The analyses encompass women in the panel sample who were 15–44 years of age in 1910, and who were married. Clustered standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table F.16: Heterogeneity in the Effects of Electrification on Women's Fertility by Residential Price of Electricity in 1917–1919 (for women who did not migrate)

	No. of Children Born	No. of Own Children in HH	No. of Own Children <18 in HH
ΔCap×1920×PriceResElect1919		-0.0047**	-0.0062**
		(0.0024)	(0.0027)
ΔCap×1930×PriceResElect1919		-0.0076***	-0.0088***
		(0.0024)	(0.0027)
ΔCap×1940×PriceResElect1919	-0.0041	-0.0055**	-0.0055*
	(0.0042)	(0.0026)	(0.0029)
R^2	0.80	0.65	0.59
Year Fixed Effects	Yes	Yes	Yes
Individual Fixed Effects	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes
State x Year Fixed Effects	Yes	Yes	Yes
Demographic and socioecon. controls	Yes	Yes	Yes
Cluster	County x Year	County x Year	County x Year
N	133,844	8,158,197	8,158,197

Notes: This specification corresponds to that of Equation (2). Some of the terms omitted due to length. The analyses encompass women in the panel sample who were 15–44 years of age in 1910, and who were married. Clustered standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

F.9 Using Religiosity Instead of Motherhood Status

In the main analysis, and since mothers were much less likely to engage in the labor force due to a variety of factors, I estimate the effect of electrification on fertility working through the opportunity cost channel by comparing the effect of electrification on the fertility of women who were mothers in the baseline period of 1910, relative to those who were not. However, concerns may arise from this strategy since motherhood status may be correlated with other personal characteristics that may exert a time-varying effect that differs in counties where electrification capacity increased more in the 1910s relative to counties where it increased less.

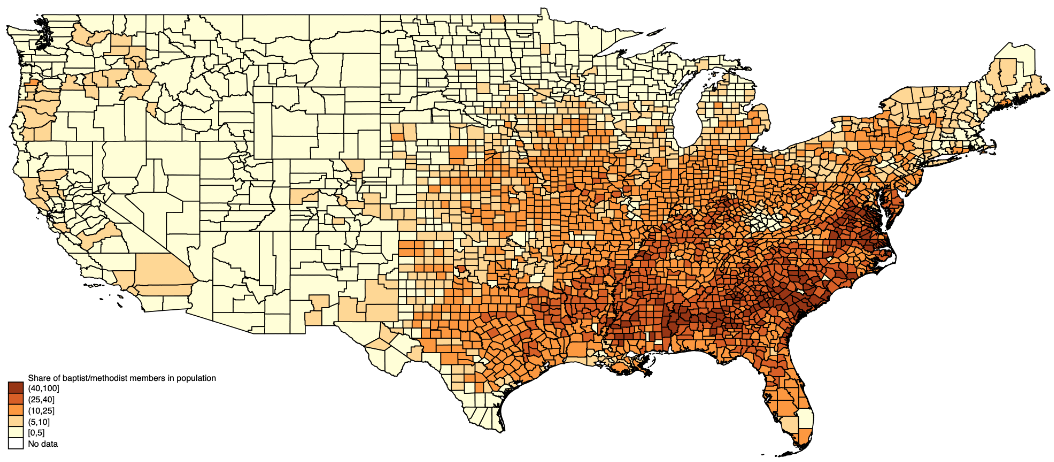
In this section, I consider the robustness of these results to exploiting county-level religiosity instead of motherhood status when estimating the effect of electrification working through the opportunity cost channel. Since women living in more religious counties are likely to face stricter social norms preventing them from joining the labor force, they will be less likely to take into consideration the changes in female wages or labor opportunities triggered by electrification when making their subsequent fertility decisions.

I use data from the 1906 Religious Census put together by Ferrara and Testa (2023) to build a county-level measure of religiosity based on the share of individuals reporting membership to baptism or methodism (of all denominations) in each county's population.[67] I focus on

[67] I use the county-level population reported in the 1910 census to construct this share.

baptism and methodism specifically since these religious groups were the two largest in the US in 1906, had strict views about the role of women in society and the family, and were widely spread across the country.[68] In Figure F.1, I present a map of the distribution of this religiosity measure across counties.

Figure F.1: Map of County-Level Religiosity



Notes: Religiosity captures the share of baptist and methodist church members in each county's population.

I explore the differential effects of electrification on fertility by county-level religiosity by estimating the following regression:

$$Fertility_{i,h,c,t} = \alpha + \beta_t \Delta Cap_c \times Post_t + \beta_t^{relig} Post_t \times Relig1906_c + \beta_t^{cap.relig} \Delta Cap_c \times Post_t \times Relig1906_c \\ + \alpha_i + \alpha_t + \alpha_c + \alpha_{s,t} + \beta_{X,t} X_{i,h,c,1910} \times Year_t + \beta_{Z,t} Z_{h,c,1910} \times Year_t + \epsilon_{i,h,c,t}, \tag{F.7}$$

where $Relig1906$ corresponds to a continuous variable capturing the share of baptist and methodist church members in each county's population in 1906. The rest of the notation follows Equation (1).

I present the results of this analysis in Table F.17. I find that these results are similar to the baseline results, with the decline in fertility triggered by electrification being smaller for women who lived in areas with higher religious affiliation. In particular, the decrease in the number of children born triggered by electrification was 0.024 children lower in 1940 among women who lived in areas where religious affiliation was one percentage point higher in 1906.

[68]In particular, baptism and methodism had much less regional concentration than catholicism, for example.

Table F.17: Heterogeneity in the Effects of Electrification on Women's Fertility by County-Level Religiosity in 1906

	No. of Children Born	No. of Own Children in HH	No. of Own Children <18 in HH
ΔCap×1920×Relig1906		0.021***	0.024***
		(0.0042)	(0.0047)
ΔCap×1930×Relig1906		0.028***	0.029***
		(0.0044)	(0.0050)
ΔCap×1940×Relig1906	0.024***	0.019***	0.017***
	(0.0081)	(0.0045)	(0.0050)
R^2	0.80	0.65	0.59
Year Fixed Effects	Yes	Yes	Yes
Individual Fixed Effects	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes
State x Year Fixed Effects	Yes	Yes	Yes
Demographic and socioecon. controls	Yes	Yes	Yes
Cluster	County x Year	County x Year	County x Year
N	138,884	10,122,780	10,122,780

Notes: This specification corresponds to that of Equation (F.7). Some of the terms omitted due to length. The analyses encompass women in the panel sample who were 15–44 years of age in 1910. Clustered standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

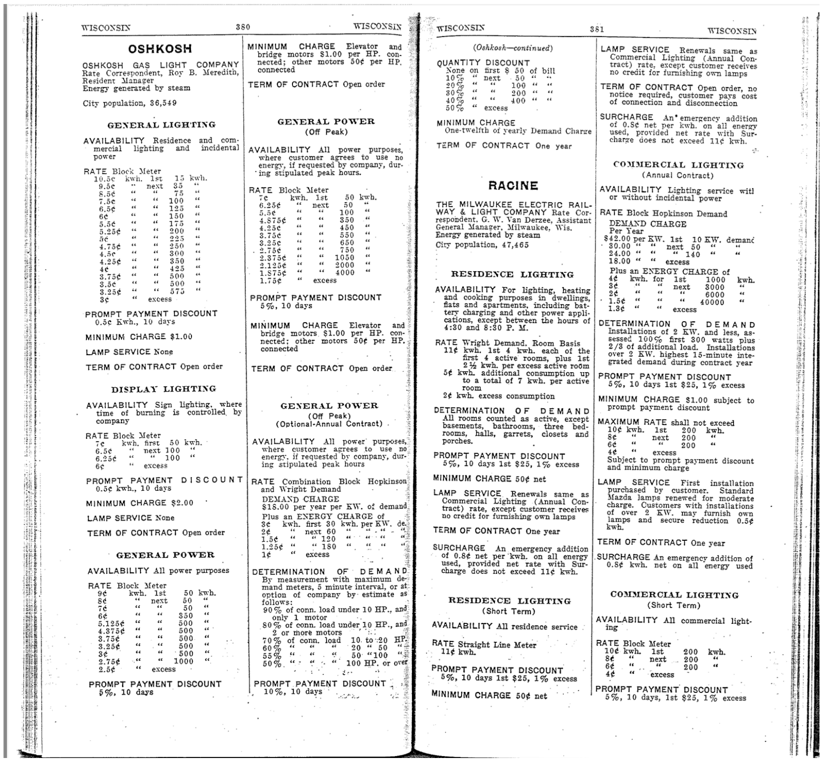
F.10 Alternate Electricity Prices based on NELA Data

In the main analysis, I build the measures of county-level electricity price using information from a 1917–1919 on households' reported electricity expenses. In this section, I use an alternate measure of electricity prices based on the utility-level rate structures collected by the National Electric Light Association (NELA) in some cities. In particular, I construct a city-level measure of "electrical charge rates" which captures the average meter rate consumers pay for each kilowatt/hour of electricity by digitizing the rate structures available in a book by National Electric Light Association (1920). This NELA book presents the principal rates for electrical light and power in January 1st of 1920 in utilities serving cities with 25,000 or more residents. In Figure F.2, I present an example of the information in this book. This figure shows how the data is organized by state, city, utility, and type of power, with each entry containing information on the various charges for electricity use of each type, and other service and billing details.

When constructing the electricity price for each utility, I focus on (1) the meter rates for general or residence lighting[69] capturing energy charges solely since those remain most consistent across utilities, and (2) the average price per kilowatt/hour for 100 kilowatts (or 100 hours) of electricity given the variable structure of rates. To construct the county-level measures of electricity prices from this data, I then average these prices across all utilities in

[69]Most utilities include information on general or residence lighting. For those that do not, or in which this information is unclear, I rely on the prices of other types of power such as general power.

Figure F.2: Examples of Data from "NELA Rate Book"



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OSHKOSH

OSHKOSH GAS LIGHT COMPANY Rate Correspondent, Roy B. Meredith, Resident Manager
Energy generated by steam

City population, 36,549

GENERAL LIGHTING

AVAILABILITY Residence and commercial lighting and incidental power

RATE Block Meter
10.5¢ kwh. 1st 15 kwh.
9.5¢ " next 35 "
8.5¢ " " 75 "
7.5¢ " " 100 "
6.5¢ " " 125 "
6¢ " " 150 "
5.5¢ " " 175 "
5.25¢ " " 200 "
5¢ " " 225 "
4.75¢ " " 250 "
4.5¢ " " 300 "
4.25¢ " " 350 "
4¢ " " 425 "
3.75¢ " " 500 "
3.5¢ " " 500 "
3.25¢ " " 575 "
3¢ " excess

PROMPT PAYMENT DISCOUNT
0.5¢ Kwh., 10 days

MINIMUM CHARGE $1.00

LAMP SERVICE None

TERM OF CONTRACT Open order

DISPLAY LIGHTING

AVAILABILITY Sign lighting, where time of burning is controlled by company

RATE Block Meter
7¢ kwh. first 50 kwh.
6.5¢ " next 100 "
6.25¢ " " 100 "
6¢ " excess

PROMPT PAYMENT DISCOUNT
0.5¢ kwh., 10 days

MINIMUM CHARGE $2.00

LAMP SERVICE None

TERM OF CONTRACT Open order

GENERAL POWER

AVAILABILITY All power purposes

RATE Block Meter
9¢ kwh. 1st 50 kwh.
8¢ " next 50 "
7¢ " " 50 "
6¢ " " 350 "
5.125¢ " " 500 "
4.375¢ " " 500 "
3.75¢ " " 500 "
3.25¢ " " 500 "
3¢ " " 500 "
2.75¢ " " 1000 "
2.5¢ " excess

PROMPT PAYMENT DISCOUNT
5%, 10 days

MINIMUM CHARGE Elevator and bridge motors $1.00 per HP. connected; other motors 50¢ per HP. connected

TERM OF CONTRACT Open order

GENERAL POWER
(Off Peak)

AVAILABILITY All power purposes, where customer agrees to use no energy, if requested by company, during stipulated peak hours.

RATE Block Meter
7¢ kwh. 1st 50 kwh.
6.25¢ " next 50 "
5.5¢ " " 100 "
4.875¢ " " 350 "
4.25¢ " " 450 "
3.75¢ " " 550 "
3.25¢ " " 650 "
2.75¢ " " 750 "
2.375¢ " " 1050 "
2.125¢ " " 2000 "
1.875¢ " " 4000 "
1.75¢ " excess

PROMPT PAYMENT DISCOUNT
5%, 10 days

MINIMUM CHARGE Elevator and bridge motors $1.00 per HP. connected; other motors 50¢ per HP. connected

TERM OF CONTRACT Open order

GENERAL POWER
(Off Peak)
(Optional-Annual Contract)

AVAILABILITY All power purposes, where customer agrees to use no energy, if requested by company, during stipulated peak hours

RATE Combination Block Hopkinson and Wright Demand
DEMAND CHARGE
$18.00 per year per KW. of demand
Plus an ENERGY CHARGE of
3¢ kwh. first 30 kwh. per KW. de.
2¢ " next 60 " " " "
1.5¢ " " 120 " " " "
1.25¢ " " 180 " " " "
1¢ " excess

DETERMINATION OF DEMAND
By measurement with maximum demand meters, 5 minute interval, or at option of company by estimate as follows:
90% of conn. load under 10 HP., and only 1 motor
80% of conn. load under 10 HP., and 2 or more motors
70% of conn. load 10 to 20 HP.
60% " " " 20 " 50 "
55% " " " 50 "100 "
50% " " " 100 HP. or over

PROMPT PAYMENT DISCOUNT
10%, 10 days

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(Oshkosh—continued)

QUANTITY DISCOUNT
None on first $ 50 of bill
10% " next 50 " "
20% " " 100 " "
30% " " 200 " "
40% " " 400 " "
50% " excess

MINIMUM CHARGE
One-twelfth of yearly Demand Charge

TERM OF CONTRACT One year

RACINE

THE MILWAUKEE ELECTRIC RAILWAY & LIGHT COMPANY Rate Correspondent, G. W. Van Derzee, Assistant General Manager, Milwaukee, Wis.
Energy generated by steam
City population, 47,465

RESIDENCE LIGHTING

AVAILABILITY For lighting, heating and cooking purposes in dwellings, flats and apartments, including battery charging and other power applications, except between the hours of 4:30 and 8:30 P. M.

RATE Wright Demand. Room Basis
11¢ kwh. 1st 4 kwh. each of the first 4 active rooms, plus 1st 2½ kwh. per excess active room
5¢ kwh. additional consumption up to a total of 7 kwh. per active room
2¢ kwh. excess consumption

DETERMINATION OF DEMAND
All rooms counted as active, except basements, bathrooms, three bedrooms, halls, garrets, closets and porches.

PROMPT PAYMENT DISCOUNT
5%, 10 days 1st $25, 1% excess

MINIMUM CHARGE 50¢ net

LAMP SERVICE Renewals same as Commercial Lighting (Annual Contract) rate, except customer receives no credit for furnishing own lamps

TERM OF CONTRACT One year

SURCHARGE An emergency addition of 0.8¢ net per kwh. on all energy used, provided net rate with Surcharge does not exceed 11¢ kwh.

RESIDENCE LIGHTING
(Short Term)

AVAILABILITY All residence service

RATE Straight Line Meter
11¢ kwh.

PROMPT PAYMENT DISCOUNT
5%, 10 days 1st $25, 1% excess

MINIMUM CHARGE 50¢ net

LAMP SERVICE Renewals same as Commercial Lighting (Annual Contract) rate, except customer receives no credit for furnishing own lamps

TERM OF CONTRACT Open order, no notice required, customer pays cost of connection and disconnection

SURCHARGE An emergency addition of 0.8¢ net per kwh. on all energy used, provided net rate with Surcharge does not exceed 11¢ kwh.

COMMERCIAL LIGHTING
(Annual Contract)

AVAILABILITY Lighting service with or without incidental power

RATE Block Hopkinson Demand
DEMAND CHARGE
Per Year
$42.00 per KW. 1st 10 KW. demand
30.00 " " next 50 " "
24.00 " " " 140 " "
18.00 " " excess
Plus an ENERGY CHARGE of
4¢ kwh. for 1st 1000 kwh.
3¢ " " next 3000 "
2¢ " " " 6000 "
1.5¢ " " " 40000 "
1.3¢ " " excess

DETERMINATION OF DEMAND
Installations of 2 KW. and less, assessed 100% first 300 watts plus 2/3 of additional load. Installations over 2 KW. highest 15-minute integrated demand during contract year

PROMPT PAYMENT DISCOUNT
5%, 10 days 1st $25, 1% excess

MINIMUM CHARGE $1.00 subject to prompt payment discount

MAXIMUM RATE shall not exceed
10¢ kwh. 1st 200 kwh.
8¢ " next 200 "
6¢ " " 200 "
4¢ " excess
Subject to prompt payment discount and minimum charge

LAMP SERVICE First installation purchased by customer. Standard Mazda lamps renewed for moderate charge. Customers with installations of over 2 KW. may furnish own lamps and secure reduction 0.5¢ kwh.

TERM OF CONTRACT One year

SURCHARGE An emergency addition of 0.8¢ kwh. net on all energy used

COMMERCIAL LIGHTING
(Short Term)

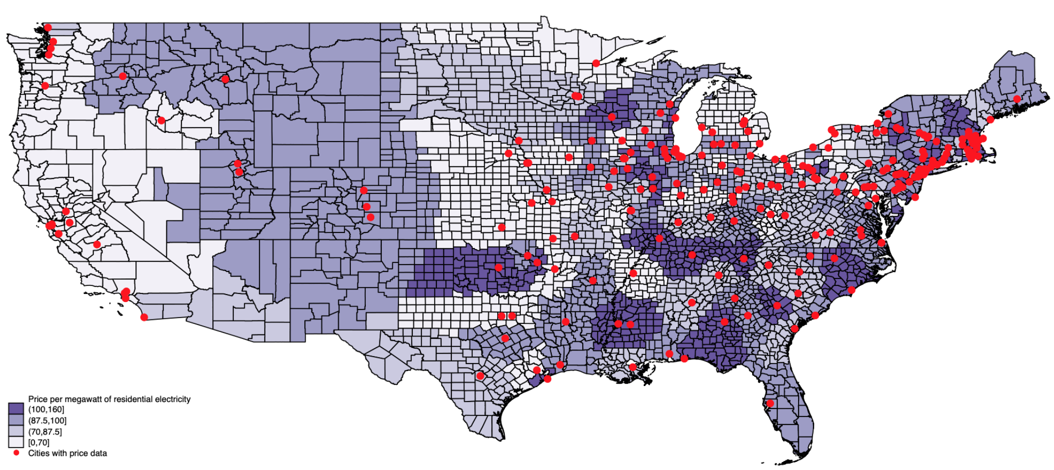
AVAILABILITY All commercial lighting

RATE Block Meter
10¢ kwh. 1st 200 kwh.
8¢ " next 200 "
6¢ " " 200 "
4¢ " excess

PROMPT PAYMENT DISCOUNT
5%, 10 days, 1st $25, 1% excess

every city, and then attach to each county the price in the closest city in the survey, where distance is measured using the county-centroid as the point of reference. In Figure F.3 I present county-level maps of the prices of residential electricity from this NELA data which indicate the cities surveyed. This map provides similar geographic patterns to those of the main electricity measure summarized in Figure 3.2. Further, in Table F.18 I present some summary statistics of the county-level residential electricity price built from NELA.

Figure F.3: Map of County-Level Residential Electricity Prices from NELA Data



Notes: Price per megawatt of residential electricity corresponding to that of the closest city in the price survey to the county centroid.

Table F.18: Summary Statistics on the County-level NELA Residential Electricity Price Data

	Mean	Std. Dev.	Min.	Max.
Price of mw/hour of residential electricity (dollars)	85.53	20.65	29	150
Distance to closest city with price data (miles)	83.30	130.71	0.02	2456.19

It is worth noting that unlike the residential price data used in the main analysis, these prices do not capture the realized actual price consumers pay for electricity, since this would depend on the type of power used (e.g lighting, fan, heating, or outlet) and time of electricity demand (day or night and season), and would include demand rates, fixed charges sometimes based on the number of rooms, and employee, early payment, and other discounts which vary across utilities. Therefore, this data does not fully capture the costs consumers pay for electricity.

I repeat the main analysis on the differential effects of electrification on fertility by residential electricity prices using this data. I estimate the following regression:

$$
\begin{aligned}
Fertility_{i,h,c,t} &= \alpha + \beta_t \Delta Cap_c \times Post_t + \beta^{price} \Delta Cap_c \times PriceResElectNELA1920_c \\
&+ \beta_t^{price} Post_t \times PriceResElectNELA1920_c + \beta_t^{cap.price} \Delta Cap_c \times Post_t \times PriceResElectNELA1920_c \\
&+ \alpha_i + \alpha_t + \alpha_c + \alpha_{s,t} + \beta_{X,t} X_{i,h,c,1910} \times Year_t + \beta_{Z,t} Z_{h,c,1910} \times Year_t + \epsilon_{i,h,c,t},
\end{aligned}
\tag{F.8}
$$

where $PriceResElectNELA1920$ corresponds to a continuous variable capturing the residential price of electricity from the NELA data in each county in 1920, measured as dollars per megawatt/hour of electricity, and the rest of the notation follows Equation (2).

I present the results of this analysis in Table F.19. I find that these results are similar to the baseline results, though smaller and noisier. In particular, the results suggest that the decline in fertility triggered by electrification is larger for women who lived in areas with a higher price of residential electricity, but these effects are not statistically significant at conventional levels. This may stem from the fact that the prices of electricity used in this analysis, and corresponding to the average meter rate paid for each kilowatt/hour of electricity used, do not capture the full extent of prices paid, particularly since the low consumption of electricity in this period makes fixed charges relatively more important.

Table F.19: Heterogeneity in the Effects of Electrification on Women's Fertility by NELA Residential Price of Electricity in 1920

	No. of Children Born	No. of Own Children in HH	No. of Own Children <18 in HH
ΔCap×1920×PriceResElectNELA1920		-0.0023	-0.0028
		(0.0022)	(0.0024)
ΔCap×1930×PriceResElectNELA1920		-0.0033	-0.0041
		(0.0024)	(0.0027)
ΔCap×1940×PriceResElectNELA1920	-0.0014	-0.0027	-0.0032
	(0.0021)	(0.0024)	(0.0026)
R^2	0.78	0.63	0.58
Year Fixed Effects	Yes	Yes	Yes
Individual Fixed Effects	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes
State x Year Fixed Effects	Yes	Yes	Yes
Demographic and socioecon. controls	Yes	Yes	Yes
Cluster	County x Year	County x Year	County x Year
N	241,880	16,365,989	16,365,989

Notes: This specification corresponds to that of Equation (F.8). Some of the terms omitted due to length. The analyses encompass women in the panel sample who were 15–44 years of age in 1910. Clustered standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

F.11 Alternate Record-Linking Strategies

In the main analysis, I use the record linkages proposed in the Census Tree Project developed by Price et al. (2021) and Buckles et al. (2023) to match individual women across different census waves. Compared to other record-linking approaches, this method provides a much larger number of matches and overcomes the challenge of linking women's census records due to name changes upon marriage by leveraging private familial information entered into the genealogy platform FamilySearch.org to link records. Nevertheless, this sample also has a false positive rate of matches of about 12%.

In this section, I consider robustness of the main results to two alternate and more conservative record-linking methods matching individuals across census waves: a method that leverages the algorithm proposed by Abramitzky et al. (2012, 2014) and that thus relies on name, birth year, and state or country of birth matches to link records; and the method proposed by Althoff et al. (2023) which leverages social security application information to link records.

F.11.1 Linking Records using Name and Birth Information

First, I leverage the algorithm proposed by Abramitzky et al. (2012, 2014), and thus rely on name, birth year, and state or country of birth matches to link records across waves to build an alternate individual-level panel dataset. To allow for the possibility of nicknames or different name spellings, I first transform names into a phonetic code using the NYSIIS algorithm. Moreover, to allow for mismatches in the birth year reported, I allow matches to potentially differ in the year of birth reported by two years.

There are total of 693,450 women in the matched panel sample in this category. In Table F.20 I report average values for select variables of interest in this panel sample, along with the full repeated cross-section data (encompassing all individuals in each census wave), for individuals in the cohorts and treatment areas of interest. I find that both groups are fairly similar along all dimensions considered, except for the proportion of married women and related female outcomes like fertility and school attendance. This follows from the fact that due to maiden-to-married name changes, women who were married in the the first census wave (1910) are overrepresented in this data.

I consider the robustness of the results to this alternate record-linking strategy by estimating Equation (1) and Equation (2), respectively, while using this alternate matched sample. The results of these analyses are presented in Table F.21 and Table F.22. I find that the results are remarkably similar to the baseline results.

Table F.20: Summary Statistics in Panel (with alternate matched sample relying on name and birth information) and Repeated Cross-Section Data in 1910 (women of ages 15–44 living in areas that were not electrified in 1910)

	Panel Women	Repeated XSec Women
Avg. children born per woman	2.54	2.37
Avg. number of own children in HH per woman	1.71	1.40
Avg. number of own children <18 in HH per woman	1.65	1.34
Prop. mothers	0.80	0.78
Avg. age at first birth[70]	22.44	21.37
Labor force participation	0.14	0.2
Prop. attending school	0.07	0.12
Prop. married	0.77	0.60
Prop. urban	0.34	0.37
Avg. socioeconomic index	4.35	5.46
Prop. white	0.94	0.86
Total obs.	693,450	13,064,666

Table F.21: Heterogeneity in the Effects of Electrification on Women's Fertility by Maternal Status in 1910 (with alternate matched sample relying on name and birth information)

	No. of Children Born	No. of Own Children in HH	No. of Own Children <18 in HH
ΔCap×1920×Mom1910		0.31***	0.30***
		(0.036)	(0.032)
ΔCap×1930×Mom1910		0.59***	0.56***
		(0.042)	(0.036)
ΔCap×1940×Mom1910	0.16	0.61***	0.57***
	(0.13)	(0.041)	(0.035)
R^2	0.82	0.68	0.67
Year Fixed Effects	Yes	Yes	Yes
Individual Fixed Effects	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes
State x Year Fixed Effects	Yes	Yes	Yes
Demographic and socioecon. controls	Yes	Yes	Yes
Cluster	County x Year	County x Year	County x Year
N	30,398	2,081,622	2,081,622

Notes: This specification corresponds to that of Equation (1), but uses an alternate matched sample built using the matching algorithm proposed by Abramitzky et al. (2012, 2014). Some of the terms omitted due to length. The analyses encompass women in this alternate panel sample who were 15–44 years of age in 1910. Clustered standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table F.22: Heterogeneity in the Effects of Electrification on Women's Fertility by Residential Price of Electricity in 1917–1919 (with alternate matched sample relying on name and birth information)

	No. of Children Born	No. of Own Children in HH	No. of Own Children <18 in HH
ΔCap×1920×PriceResElect1919		-0.0043	-0.0052
		(0.0025)	(0.0026)
ΔCap×1930×PriceResElect1919		-0.0047*	-0.0059**
		(0.0024)	(0.0026)
ΔCap×1940×PriceResElect1919	-0.013	-0.0013*	-0.0034**
	(0.0078)	(0.0025)	(0.0027)
R^2	0.81	0.65	0.61
Year Fixed Effects	Yes	Yes	Yes
Individual Fixed Effects	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes
State x Year Fixed Effects	Yes	Yes	Yes
Demographic and socioecon. controls	Yes	Yes	Yes
Cluster	County x Year	County x Year	County x Year
N	30,398	2,081,622	2,081,622

Notes: This specification corresponds to that of Equation (2), but uses an alternate matched sample built using the matching algorithm proposed by Abramitzky et al. (2012, 2014). Some of the terms omitted due to length. The analyses encompass women in this alternate panel sample who were 15–44 years of age in 1910. Clustered standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

F.11.2 Linking Records using Social Security Matches

Second, I use the linkages proposed by Althoff et al. (2023), which rely on information from Social Security Number (SSN) applications to link records across waves and build an alternate individual-level panel dataset.[71] Compared to other record-linking approaches, this method overcomes the challenge of linking women's census records due to name changes upon marriage since SSN applications contain the maiden and married names of women, either as applicants or as applicants' mothers. The data ranges from 1850 to 1940, and consists of 48 million total links, half of which are women.[72] Please see Althoff et al. (2023) for further details about this data.

There are total of 721,373 women in the matched panel sample in this category. In Table F.23 I report average values for select variables of interest in this panel sample, along with the full repeated cross-section data (encompassing all individuals in each census wave), for individuals in the cohorts and treatment areas of interest. I find that both groups are very similar along all dimensions considered, which follows from the fact that the linked data obtained from the linkages developed in this method is highly representative of the population at large.[73]

Table F.23: Summary Statistics in Panel (with alternate matched sample relying on social security applications) and Repeated Cross-Section Data in 1910 (women of ages 15–44 living in areas that were not electrified in 1910)

	Panel Women	Repeated XSec Women
Avg. children born per woman	2.68	2.37
Avg. number of own children in HH per woman	1.57	1.40
Avg. number of own children <18 in HH per woman	1.54	1.34
Prop. mothers	0.85	0.78
Avg. age at first birth[74]	21.60	21.37
Labor force participation	0.18	0.2
Prop. attending school	0.12	0.12
Prop. married	0.68	0.60
Prop. urban	0.30	0.37
Avg. socioeconomic index	4.86	5.46
Prop. white	0.93	0.86
Total obs.	721,373	13,064,666

I consider the robustness of the results to this alternate record-linking strategy by estimating Equation (1) and Equation (2), respectively, while using this alternate matched sample. The results of these analyses are presented in Table F.24 and Table F.25. I find that the results are remarkably similar to the baseline results.

[71] I use the information linking records in adjacent census waves in this data, namely 1910–1920, 1920–1930, and 1930–1940 in conjunction with the personal identifiers found in the full-count census data available in IPUMS to follow individuals for the full 1910–1940 period.

[72] The SSN application database covers the near universe of applicants who died between 1980 and 2007. Importantly, these applications also contain the maiden names of applicants' parents, expanding the sample coverage back in time, and increasing representativeness by including people who never applied for an SSN.

[73] Nevertheless, a few differences remain given that the matched panel sample I focus on has information for the entire 1910–1940 period, and thus involves individuals who survive and can be identified in all census waves in this period.

Table F.24: Heterogeneity in the Effects of Electrification on Women's Fertility by Maternal Status in 1910 (with alternate matched sample relying on social security applications)

	No. of Children Born	No. of Own Children in HH	No. of Own Children <18 in HH
ΔCap$\times$1920$\times$Mom1910		0.29***	0.27***
		(0.039)	(0.036)
ΔCap$\times$1930$\times$Mom1910		0.54***	0.47***
		(0.042)	(0.037)
ΔCap$\times$1940$\times$Mom1910	0.44***	0.54***	0.49***
	(0.15)	(0.040)	(0.038)
R^2	0.78	0.64	0.64
Year Fixed Effects	Yes	Yes	Yes
Individual Fixed Effects	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes
State x Year Fixed Effects	Yes	Yes	Yes
Demographic and socioecon. controls	Yes	Yes	Yes
Cluster	County x Year	County x Year	County x Year
N	37,104	2,729,548	2,729,548

Notes: This specification corresponds to that of Equation (1), but uses an alternate matched sample built using the linkages proposed by Althoff et al. (2023). Some of the terms omitted due to length. The analyses encompass women in this alternate panel sample who were 15–44 years of age in 1910. Clustered standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table F.25: Heterogeneity in the Effects of Electrification on Women's Fertility by Residential Price of Electricity in 1917–1919 (with alternate matched sample relying on social security applications)

	No. of Children Born	No. of Own Children in HH	No. of Own Children <18 in HH
ΔCap$\times$1920$\times$PriceResElect1919		-0.0079***	-0.0088***
		(0.0024)	(0.0027)
ΔCap$\times$1930$\times$PriceResElect1919		-0.0077***	-0.0092***
		(0.0025)	(0.0029)
ΔCap$\times$1940$\times$PriceResElect1919	-0.0069	-0.0031	-0.0052*
	(0.0083)	(0.0026)	(0.0029)
R^2	0.78	0.58	0.56
Year Fixed Effects	Yes	Yes	Yes
Individual Fixed Effects	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes
State x Year Fixed Effects	Yes	Yes	Yes
Demographic and socioecon. controls	Yes	Yes	Yes
Cluster	County x Year	County x Year	County x Year
N	37,104	2,729,548	2,729,548

Notes: This specification corresponds to that of Equation (2), but uses an alternate matched sample built using the linkages proposed by Althoff et al. (2023). Some of the terms omitted due to length. The analyses encompass women in this alternate panel sample who were 15–44 years of age in 1910. Clustered standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

G Appendix: Aggregation and Equilibrium

G.1 Male and Female Labor

Female and male labor are employed to produce consumption goods. The market for labor clears within each sub-region s and time t when

$$L^D_{f,s,t} = L_{f,s,t} \quad \text{and} \quad L^D_{m,s,t} = L_{m,s,t},$$

where $L^D_{f,s,t}$ and $L^D_{m,s,t}$ denote the total number of female and male hours of labor used for the production of consumption goods, and $L_{f,s,t}$, $L_{m,s,t}$ are the total number of female and male hours of labor supplied by households to the economy:

$$L_{f,s,t} = \sum_{j=1}^{G+J} P_{j,s,t} \int_0^\infty \eta_f n^f_{j,s,t} dF(\sigma_l) \quad \text{and} \quad L_{m,s,t} = \sum_{j=1}^{G+J} P_{j,s,t}.$$

$P_{j,s,t}$ denotes the size of the cohort of age j in period t at sub-region s, and is described in detail below.

G.2 Output

Output is used for consumption and to produce electricity. The market for output clears within each sub-region s and time t when

$$Y_{s,t} = X_{s,t} + C_{s,t}.$$

$X_{s,t}$ denotes the inputs in electricity production, and $C_{s,t}$ denotes total consumption in the economy: within each sub-region s and time t

$$C_{s,t} = \sum_{j=1}^{G+J} P_{j,s,t} \int_0^\infty c_{j,s,t} \, dF(\sigma_l).$$

G.3 Cohort Size

The size of cohorts $P_{j,s,t}$ evolves through time based on the fertility choices of households. Since children spend I periods with their parents before they become adults themselves and join a couple, the evolution of the size of cohorts is given by

$$P_{1,s,t} = \frac{1}{2} \sum_{j=1}^{G} P_{j,t-I,s} \int_{0}^{\infty} f_j b_{j,t-I,s} dF(\sigma_l).$$

The factor $\frac{1}{2}$ enters the law of motion because fertility is measured in terms of individuals while cohort size is measured in terms of couples (or of men or women independently). In this expression, $f_j b_{j,t-I,s}$ is the average number of births of a couple of age j at time $t-I$ in sub-region s. Integrating over all couples of age j and multiplying by cohort size $P_{j,t-I,s}$ gives the total number of children born in period $t-I$ to parents of age j in sub-region s. Adding this over all cohorts who are of childbearing age in period $t-J$ (those aged 1 to G) yields the total number of children born in period $t-I$, and who will become adults in t. Notice also that since cohort size stays fixed throughout life, we have $P_{j+1,t+1,s} = P_{j,s,t}$ for $j < G + J$.

H Appendix: Calibration

H.1 Time spent working by men η_m and time spent working by employed women η_f

η_m and η_f are calibrated using the average hours worked by employed men and women, respectively, in 1900. I use the work hours of men and women ages 25–54 in this period compiled by Ramey and Francis (2009), and divide by the male and female labor force participation rates.[75] Using this procedure, I get that the hours worked by employed males and females were $\frac{49.4}{0.819} = 60.32$ and $\frac{7.9}{0.206} = 38.4$, respectively. Those values correspond to 53.9% and 34.3% of 112, the total waking hours, respectively. As such, I set η_f to 0.343, and η_m to 0.539.

H.2 Children Time Cost Function

ϕ and ψ_m are calibrated to match the ratio of time spent in childcare for women with different number of children in 1965 from the American Heritage Time Use Survey. First notice that I can take a natural logarithm of the time spent in childcare M in the model to get

$$\log(M) = \log(\phi) + \psi_m \log(m) - \psi_E log(E).$$

I use data on the time spent on childcare from the 1965 American Time Use Survey (available at IPUMS) to recover the parameters ϕ and ψ_E by following structure of the equation above. Although I do not observe electricity or appliance purchases, I control for household income, urban status and demographics (age, race, marital status and employment status) for each woman, which correlate with factors outside of the number of children influencing the time spent in childcare. In addition, all observations in 1965 correspond to Michigan, offering further control for location-specific factors.

The regression I estimate is:

$$\log(M_i) = \log(\phi) + \psi_m \log(m_i) + \beta X_i + \epsilon_i, \tag{H.1}$$

where i denotes each woman in the sample, M_i denotes the total time spent in childcare by woman i, m_i denotes total number of children under 18 in her household, and X_i denotes the income, location and demographic controls of this woman. I limit the estimation of this regression to women with at least one child under the age of 18 in the household, and weight

[75] Female labor force participation follows from Goldin (1990), while male labor force participation follows from Bureau of the Census (U.S. Department of Commerce) (1970).

the regression using the sampling weights provided in the data.

The time spent in childcare, M_i, is measured in four different ways: (1) time spent in childcare as a main activity, (2) time spent in childcare as a main and secondary activity (preferred specification), (3) time spent in home production activities including time spent in childcare as a main activity, and (4) time spent in home production activities including time spent in childcare as a main and secondary activity.[76]

The results from these regressions are presented in Table H.1. I find that the estimate of ϕ is 37 and 126 minutes per day, respectively, for the two dependent variables that focus on childcare time, while it hovers around 250 minutes per day for the dependent variables encompassing all home production. In the context of the model, where the time endowment is normalized to one, the value of 126.47 of the preferred specification would imply a value $\phi = \frac{126.47/60}{16}$.

Table H.1: Estimation of the level and curvature parameters on the number of children

	Log Childcare (Main)	Log Childcare (Main + Sec.)	Log Home Prod. + Childcare (Main)	Log Home Prod. + Childcare (Main+Sec)
Constant ($\log(\phi)$)	3.61***	4.84***	5.37***	5.62***
	(0.28)	(0.30)	(0.27)	(0.28)
$\log(m)$	0.52***	0.55***	0.29***	0.30***
	(0.099)	(0.093)	(0.050)	(0.051)
R^2	0.28	0.30	0.44	0.44
Demog. and Socioecon. Controls	Yes	Yes	Yes	Yes
N	497	533	638	638

The specification corresponds to that of Equation (H.1). Controls include age controls, marital status, race (black or other), household income, educational attainment, home ownership status, employment status, urban status. The regression is weighted using the sample weights provided in the data. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

I find that the estimate of ψ_E hovers around 0.52–0.55 for the two dependent variables that focus on childcare time, and around 0.29–0.30 for the dependent variables encompassing all home production. These values are in line with the value of 0.417 found by Doepke et al. (2013), who use a similar methodology and the 1975 American Time Use Survey. For the model, I take a value of 0.55 for ψ_E, following from the preferred specification.

[76] I consider the time spent in home production in addition to that spent in childcare solely because the time spent in activities such as washing clothes, washing dishes, cooking, etc increases with children as well, even if it does not correspond to childcare directly.

H.3 Differential time cost of pregnancy and caring for a young child κ

I choose the differential time cost of pregnancy and caring for baby, κ, in order to match the increased time cost of caring for a young child. To do this, I time use data from the American Heritage Time Use Survey in 1965, and estimate a regression similar to the one described in Appendix H.2, but with a few differences. First, the regression includes both the total number of children and the number of children under 5 as explanatory variables, in order to separate the time cost effect of having one child under 5 above and beyond having one extra child. Second, I estimate the regression in levels rather than logarithms. The regression I estimate is thus:

$$M_i = \alpha + \beta_1 m_i + \beta_2 m_i^{und.5} + \beta_3 X_i + \epsilon_i, \tag{H.2}$$

where $m^{und.5}$ denotes the number of children under 5, and the rest of the notation follows Equation (H.1). As before, I estimate this regression for the time spent in childcare measured in four different ways, limit the analysis to women with at least one child under the age of 18 in the household, and weight the regression using the sampling weights provided in the data.

Table H.2: Estimation of the additional time cost of young children

	Childcare (Main)	Childcare (Main + Sec.)	Home Prod. + Childcare (Main)	Home Prod. + Childcare (Main+Sec)
m	2.81	5.85	20.36***	23.41***
	(2.53)	(3.76)	(6.90)	(7.66)
$m^{und.5}$	44.7***	61.41***	78.97***	95.68***
	(4.91)	(7.28)	(13.34)	(14.82)
R^2	0.40	0.39	0.43	0.44
Demog. and Socioecon. Controls	Yes	Yes	Yes	Yes
N	640	640	640	640

The specification corresponds to that of Equation (H.2). Controls include age controls, marital status, race (black or other), household income, educational attainment, home ownership status, employment status, urban status. The regression is weighted using the sample weights provided in the data. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

The results from these regressions are presented in Table H.2. I find that the additional time cost of having one more child under the age of 5 in the household corresponds to roughly 45–60 minutes a day for the two dependent variables that focus on childcare time, while it falls between 80 to 95 minutes a dayfor the dependent variables encompassing all home production. In the context of the model, where the time endowment is normalized to one, the value of 61.41 of the preferred specification would imply a value $\kappa = \frac{61.41/60}{16}$.

H.4 Share of electricity in male labor

I choose the value of the share of electricity in male labor, ζ_m, to match the share of energy fuels and electricity expenditures in male-dominated manufacturing industries. To this end, I use data from both the 1940 population census, and the 1939 manufacturing census.

First I use industry information from the 1940 population census to find the most male-dominated manufacturing industries. I focus my attention on manufacturing industries where 95% or more of the workforce is male: logging; ship building and repairing; and cement, concrete, gypsum and plaster products.[77]

Table H.3: Estimation of the level and curvature parametesr on the number of children

Male-Dominated Manufacturing Industry	Portion Male Workforce	Expenditure in Fuels & Electricity	Value of Production	Ratio of Fuels & Electr. in Value of Prod.
Logging	98.8%	1,600,833	69,620,906	0.0230
Ship building and repairing	97.5%	4,137,536	327,387,099	0.0126
Cement, concrete, gypsum and plaster products[78]	96.7%	1,916,317	130,393,396	0.0147
Average				0.0168

Then, I compute the share of electricity in each of these industries using the census of manufactures in 1939. In particular, I take the ratio between the expenditure in all fuels and electricity and the production value in each industry. I average these values to get the mean share of electricity in production in male-dominated manufacturing industries. This average pins down the value of ζ_m, and corresponds to 0.0168.

In Table H.3 I summarize the information of these two steps in the first three columns. In particular, I tabulate the male portion of the workforce in each male-dominated manufacturing industry from the population census in 1940, along with the expenditure in all fuels and electricity, and value of production in each industry from the census of manufactures in 1939. In the last column, I include the ratio between the expenditure in all fuels and electricity and the value of production.

[77] Please note that blast furnaces, steel works, and rolling mills industries are also heavily male-dominated with 97.4% of the workforce being male, but are excluded here since their expenditure in fuels and electricity is an outlier.

[78] This category does not exist in this aggregation in the manufacturing census. Instead, I use data from concrete products.

H.5 Female and Male TFPs: A_f and A_m

I normalize the TFP of male labor, A_m, to one, and calibrate the TFP of female labor A_f to match the ratio of average male and female occupational scores in 1900. I first solve for male and female wages by considering the problem of male- and female-focused firms. Since labor is paid its marginal product, wages can be written as

$$w_{i,s,t} = A_i \left[\zeta_i E_{i,s,t}^{\frac{\gamma_i - 1}{\gamma_i}} + (1 - \zeta_i) L_{i,s,t}^{\frac{\gamma_i - 1}{\gamma_i}} \right]^{\frac{1}{\gamma_i - 1}} (1 - \zeta_i) L_{i,s,t}^{\frac{-1}{\gamma_i}} \quad \text{for } i \in \{f, m\}.$$

Further, since both female- and male-focused firms purchase electricity, the price of this must be equal to its marginal product in both firms:

$$p_{s,t}^E = A_i \left[\zeta_i E_{i,s,t}^{\frac{\gamma_i - 1}{\gamma_i}} + (1 - \zeta_i) L_{i,s,t}^{\frac{\gamma_i - 1}{\gamma_i}} \right]^{\frac{1}{\gamma_i - 1}} \zeta_i E_{i,s,t}^{\frac{-1}{\gamma_i}} \quad \text{for } i \in \{f, m\}.$$

Combining each of these equations with the corresponding wage equations above and reorganizing yields

$$E_{i,s,t} = \left(\frac{\zeta_i w_{i,s,t}}{(1 - \zeta_i) p_{s,t}^E} \right)^{\gamma} L_{i,s,t} \quad \text{for } i \in \{f, m\}.$$

Plugging this in the expression for $w_{i,s,t}$ and reorganizing we get

$$w_{i,s,t} = A_i \left[\zeta_i \left(\frac{\zeta_i w_{i,s,t}}{(1 - \zeta_i) p_{s,t}^E} \right)^{\gamma_i - 1} + (1 - \zeta_i) \right]^{\frac{1}{\gamma_i - 1}} (1 - \zeta_i). \tag{H.3}$$

Notice moreover, that from the problem of electric firms, the zero profit condition implies that

$$p_{t,r}^E = \frac{1}{A_{E,t,r}}.$$

Notice thus that once we know $p_{s,t}^E$ from the above, Equation (H.3) fully characterizes $w_{i,s,t}$ for $i \in \{f, m\}$ in every period.

I choose A_f to match the ratio of average male and female occupational scores in 1900. To compute these ratios in the data, I use the occupation information available in the 1900 census in conjunction with the Lasso-adjusted industry, demographic, and occupation (LIDO) occupational score approach proposed by Saavedra and Twinam (2020) which adjusts occupation scores by race, sex, age, industry, and geography and reduces the attenuation bias in gender earnings gaps.

I assume the old electricity technology was in place during this time period in all regions, yielding low electric productivity $A_{E,L}$ (which is symmetric across regions) and a high price for electricity. I can then solve for the wage in 1900 using the equation before. Thus, I choose A_f so that

$$\frac{{w_{f,1900}^{model}}^{model}}{w_{m,1900}} = \frac{\text{Avg. LIDO Score of Women}^{data}}{\text{Avg. LIDO Score of Men}^{data}}.$$

H.6 Regional productivity of electricity production after electrification: $A_{E,H,r}$

I calibrate the efficiency of electricity production after electrification in each region, $A_{E,H,r}$, to match (1) the fact that the relative price charged for electricity when produced by a small generator is 5 times larger on average than when produced by a large-scale plant (Institute for Energy Research (2019)); and (2) the distribution of prices of electricity observed empirically in 1917-1919 and documented in Section 3.5.2.

There are R regions in the model, creating a distribution for electricity prices. The median price of electricity in this distribution is 5 times lower than that obtained with the old technology of electricity. Therefore, we have

$$A_{E,H,\frac{R}{2}} = 5 \times A_{E,L}.$$

We can then recover the efficiency of electricity production after electrification in each region, $A_{E,H,r}$, using the R-percentile empirical distribution of the price of electricity from the individual-level data on prices. In particular we will get vector of size R with the average empirical prices per percentile:

$$[p*_1, p*_2, ...p*_R]$$

If we divide each of these by the median price $p*_{\frac{R}{2}}$, we get:

$$\left[\frac{p*_1}{p*_{\frac{R}{2}}}, \frac{p*_2}{p*_{\frac{R}{2}}}, ... \frac{p*_R}{p*_{\frac{R}{2}}}\right]$$

We can then use this to recover the efficiency of electricity production after electrification in each region $A_{E,H,r}$ by noting that

$$\frac{p*_r}{p*_{\frac{R}{2}}} = \frac{A_{E,\frac{R}{2}}}{A_{E,r}} = \frac{5 \times A_{E,L}}{A_{E,r}}.$$

We rearrange to get

$$A_{E,H,r} = 5 \times A_{E,L} \times \frac{p*_{\frac{R}{2}}}{p*_r} \; \forall r.$$

Table H.4 summarizes the values obtained from this procedure.

Table H.4: Regional efficiency of electricity production after electrification

Parameter	Value
$A_{E,H,1}$	$5 \times A_{E,L} \times \frac{1}{0.85}$
$A_{E,H,2}$	$5 \times A_{E,L} \times \frac{1}{0.91}$
$A_{E,H,3}$	$5 \times A_{E,L}$
$A_{E,H,4}$	$5 \times A_{E,L} \times \frac{1}{1.09}$
$A_{E,H,5}$	$5 \times A_{E,L} \times \frac{1}{1.18}$

H.7 Model and Data Moments targeted by the Method of Moments

Table H.5: Moments in Model and Data (targeted by the Method of Moments)

Moment	Data	Model
Average fertility in 1900	3.79	3.66
Female LFP in 1900	0.21	0.24
Average time in childcare in 1900	0.12	0.18
Average female leisure time in 1900	0.71	0.73
DDD Coefficient of differential decline in # of own children in HH due to electrification for young mothers in 1930	0.15	0.15
DDD coefficient of differential decline in # of own children in HH for young women due to electrification by price of electricity in 1930	-0.0031	-0.0030

Notes: The DDD coefficients of the differential change in fertility due to electrification follow from results in the empirical analysis. See Section 3 for details.

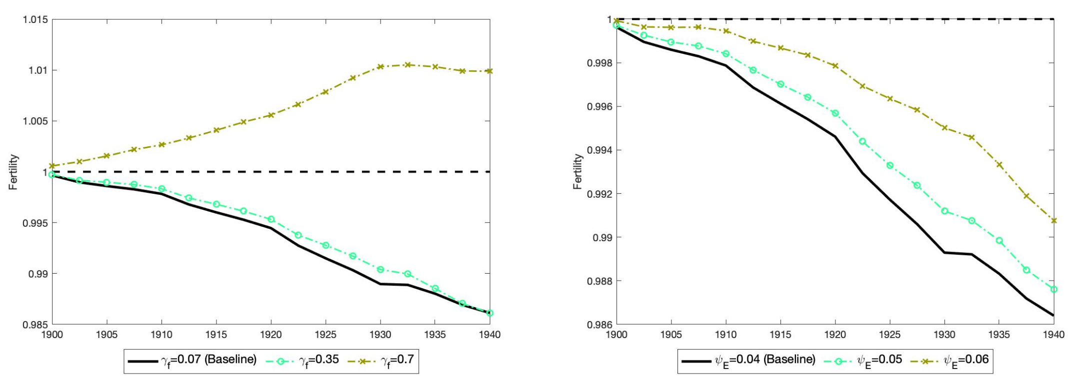
In the model, variables for women are constructed from ages 20 to 65. To match this, I use data moments for similar age groups whenever available. The data on fertility comes from Haines (2006), who computes the total fertility rate for women of different races, combined with proportion of women by race from the Census. The data on female LFP in 1890 comes from Goldin (1990), who constructs these statistics for women ages 15 and above and carefully accounts for methodological and other changes in the labor force participation definition across time. The data on leisure corresponds to information from individuals ages 25–54, as estimated by Ramey and Francis (2009). The data on childcare time comes from Ramey (2009) (Table 4), who computes the increase in home production hours (which encompasses childcare) stemming from having children of different ages using data from the early 20th century, combined with proportion of women with and without children from the census, along with the average number of children in each age category. In order to match the structure of the model where women spend time on work, childcare, and leisure, the data on leisure and childcare hours is normalized using the sum of time spent in these three activities, where work hours correspond to those of women ages 25–54 as estimated by Ramey and Francis (2009).

H.8 Discussion of Key Parameters and Sensitivity Results

In this section, I examine the role of different parameters in shaping the aggregate decline in fertility stemming from electrification. In order to highlight the importance of the time savings and opportunity cost channels of electrification, I focus on the following parameters which mediate their strength: (1) the elasticity of substitution between electricity and female labor, γ_f; and (2) the elasticity of the time cost of children to electricity purchases time, ψ_E. In order to examine the sensitivity of the results to these parameters, I re-estimate the model after subsequently changing their value. I keep the rest of the parameter values fixed at the baseline calibration and examine how the evolution of fertility predicted by the model changes in each of these cases.

Figure H.1: Fertility, Sensitivity to Parameters

(a) Sensitivity to γ_f (b) Sensitivity to ψ_E



Notes: This plot depicts the trajectory of (aggregate) fertility in the model with different parameter values. Fertility follows the demographic definition, and thus captures the number of children that would be born to each woman if she were to live to the end of life, and give birth to children according to age-specific birth rates. Data Source: Haines (2006), combined with proportion of women by race from Census. Normalized 1900=1.

I plot the results for each of the parameters of interest in Figure H.1. First, I find that lower complementarity between electricity and female labor captured by larger values of γ_f moderates the decline of fertility in the model. This stems from the fact that this parameter helps determine the increase in female wages and thus the rise in the opportunity cost of children after electrification. For example, and as evidenced in the figure, a high enough value of γ_f will trigger an increase in fertility since female wages don't increase very much in this case, weakening the opportunity cost channel. The fraction of the decline in fertility the model can explain decreases to 2.82% when $\gamma_f = 0.35$, and to -3.03% when $\gamma_f = 0.7$.

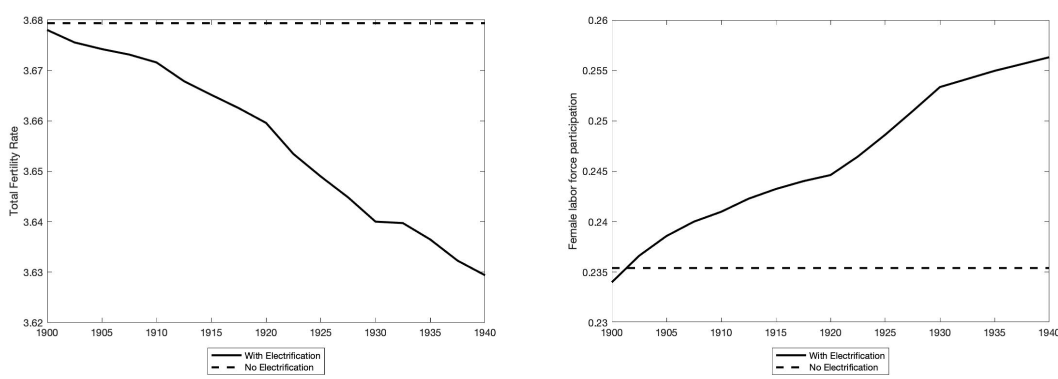
Second, I find that a larger value of the elasticity of childcare time to electricity purchases, ψ_E, moderates the decline in fertility in the model. This stems from the fact that ψ_E dictates the scope of electricity in reducing childcare time needs, implying that if ψ_E is high, childcare needs will be very sensitive to electricity prices, and as such fertility will decrease less with electrification since this moderates the time burden of childcare more. The fraction of the decline in fertility the model can explain decreases to 2.56% when $\psi_E = 0.05$, and to 1.46% when $\psi_E = 0.06$.

These results suggest that the quantitative results can be quite sensitive to the values of these parameters, and motivates the use of the well-identified empirical estimates of Section 3 to calibrate the model and quantify the importance of electrification on fertility.

I Appendix: Model Simulations

Figure I.1: Fertility and Female LFP

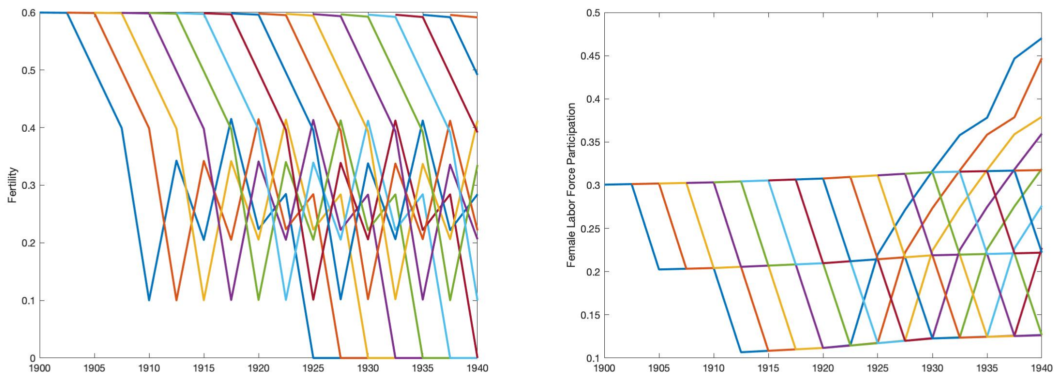
(a) Fertility (b) Female LFP



Notes: This plot depicts the trajectories of fertility and female LFP in the model. Fertility follows the demographic definition, and thus captures the number of children that would be born to each woman if she were to live to the end of life, and give birth to children according to age-specific birth rates. Female LFP captures the proportion of women in each period who participate in the labor force.

Figure I.2: Fertility and Female LFP by Cohort

(a) Age-specific Fertility Rate　　　(b) Age-specific Female LFP



Notes: This plot depicts the trajectories of fertility and female LFP across the lifecycle of different cohorts in the model. Each colored line represents the life trajectory of a different cohort. The age-specific fertility rate and LFP capture, respectively, the average number of births per woman of each age in each period, and the proportion of women of each age engaging in the labor force in each period.