The Demographic Effects of Household Electrification in the United States, 1925 to 1960

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1. **Introduction**

The transformation of women's economic and demographic outcomes led *The Economist* to christen the past 100 years the "female century".[1] While many studies have linked increases in women's labor force participation to demand side factors including technology-driven shifts and reductions in discrimination (see, inter alia, Smith and Ward 1984, 1985; Goldin 1990; Black and Juhn 2000; and Welch 2000), recent studies have claimed a greater role for changes on the supply side. Specifically, changes in women's entry into the labor force due to technologies that mitigated constraints from childbearing may have played a significant role (see, inter alia, Angrist and Evans 1998; Goldin and Katz 2002; Greenwood, Seshadri and Yorukoglu 2005; Bailey 2006).

From this perspective, the U.S. baby boom is not only a fascinating demographic event but also a significant challenge for economic theory and economic history. Between 1939 and 1957, births per 1,000 white women (age 15 to 44) departed from their long-run decline and increased by more than 50 percent (see figure 1). Over the same period, women's labor force participation jumped by 50 percent (from 24 to 36 percent) and the same statistic for married women more than doubled (from 16 to 33 percent).

The baby boom was not merely a short-lived, statistical aberration reflecting postponed births from the Depression or returning servicemen from World War II. Rather, it stretched over two decades and was driven primarily by women too young to have been directly affected by the Depression or World War II. During this time women married and bore children at younger ages, reduced the intervals between births, and had significantly more children over their lifetimes (Ryder 1980, Rogers and O'Connell 1984). In fact, women born during the 1930s had completed fertility rates as high as those among cohorts born in the late nineteenth century.

More than half a century after it began, the ultimate causes of the baby boom remain in dispute. There are two leading hypotheses. Easterlin (1968, 1980) emphasizes the importance of a cohort's actual labor market earnings relative to the cohort's parents' earnings in driving fertility swings. Children who grew up in the Depression, for example, may have formed material aspirations that were far exceeded by their actual adult experience in the later 1940s and 1950s. Consequently, they may have had more children. More recently, Greenwood, Seshadri, and Vandenbrouke (2005, henceforth referred to as "GSV") cite great improvements in household production technologies and the introduction of low-cost market-produced goods (e.g., frozen foods) that substituted for

[1] *The Economist*, "Dorothy's Dream," (9 September 1999).

traditionally home-produced goods. In their view, such labor-saving inventions effectively lowered the cost of raising children and led to the baby boom.

To date, the GSV model provides the most mathematically rigorous theoretical conception of the baby boom. It is a dynamic general equilibrium framework with agents who choose fertility optimally. Moreover, a calibrated version of the model can match the main features of the U.S. fertility time-series, and cross-country correlations are consistent with its central tenets. Finally, the model has great appeal in that it provides a plausible explanation for both the baby boom and the seemingly incongruous rise in married women's labor force participation – that appliances significantly raised household productivity, freeing time for other activities (hence the title and topic of Greenwood, Seshadri, and Yorukoglu 2005, "Engines of Liberation").[2]

Our paper is the first part of a larger project to assess the origins of the baby boom, the rise of women's market work, and the decline of household service employment. We start by reviewing some of the main empirical features of the baby boom and the diffusion of appliances in the United States. Then, we summarize the logic and implications of the GSV (2005) model. Finally, we collect and analyze a great deal of data on fertility and appliance diffusion in the United States to test the central implications of the "appliance-fertility" hypothesis. We emphasize that our current work is quite preliminary.

Before summarizing the results, it is worthwhile to set out some of the main data-related challenges to the investigation. To pursue this line of inquiry, one might imagine an (almost) ideal data set with annual household-level information on income and wealth, the number and timing of children, the intentions of parents with respect to the target number and timing of children, the allocation of family members' time to specific household chores, and the date of acquisition of various appliances. Unfortunately, we are constrained in almost all dimensions. In this period, nationally representative household-level information is available in public microdata samples from the Census at ten-year intervals, but not annually. Moreover, neither the 1940 nor the 1950 microdata samples include appliance information, let alone information on exactly when the appliance was acquired. Finally, we have precious little information about time allocation to various household chores, although we review the existing evidence from historical time-use studies.

Nonetheless, there is a great deal of data on local appliance diffusion, electrical service, and fertility rates that can be brought to bear on the questions at hand. From published Census volumes

[2] The potential link between appliances and labor force participation is also discussed by Long (1958, p. 120) and Oppenheimer (1970, pp. 29-33).

and Haines (2004), we assembled data from 1930 to 1960 that describe each county's economic and demographic characteristics as well as the proportion of housing units with various kinds of appliances (e.g., electrical lighting, refrigerators, modern stoves, and washing machines). This gives us a base dataset with over 3,000 counties and with considerable cross-county variation in terms of appliance diffusion and fertility. Additionally, using publications of the Edison Electric Institute, we calculated state-level, annual estimates of the proportion of households with electrical service from 1925 to 1960. This information is useful because the lack of electrical service clearly constrained many households' ability to adopt modern appliances.[3] From the Integrated Public Use Microdata Series (Ruggles et al. 2004), we calculated completed fertility rates (based on a Census question regarding "children ever born") for each state-by-year birth cohort of women. This allows an examination of the empirical link between a measure of access to electrical service (from age 15 to 30) and children-ever-born.

Taken together, the data allow for a more thorough empirical assessment of the "appliance-fertility" hypothesis than previously undertaken. We leave for future research a more careful assessment of Easterlin's hypothesis and further consideration of the baby boom's implications for women's labor force participation rates.

2. A Closer Look at Mid-Century Fertility and the Diffusion of Household Technology

Popular views often associate the baby boom with the return of soldiers from World War II or with postponed fertility from the Great Depression. While both events might have influenced demographic patterns, the notion that the baby boom was short-lived, concentrated in families with husbands returning from war, or pronounced among women who delayed childbearing during the Depression is inaccurate. The baby boom was a long-term and pervasive event – it stretched over two decades (trough to peak); women who were far too young to have postponed fertility during the Depression or War made major contributions to the overall rise in fertility; and women married to non-veterans had just as many children (per woman) as those married to veterans.

This will not come as a surprise to many scholars. More than 25 years ago, Easterlin wrote, "Let me dispose first of some mistaken notions. One is that the baby boom was the result of deferred childbearing during World War II, with the subsequent bust being a return to the prewar trend. As mentioned briefly earlier, those in the 1950s who were principally responsible for the baby boom –

[3] The New Deal's Rural Electrification Administration, established in 1935, was a direct response to this constraint. See Brown (1980).

young adults in their twenties – were in their teens or preteens during World War II. The reproductive careers of these people were not interrupted by World War II, and their behavior in the 1950s clearly cannot be attributed to the war" (1980, p. 54). GSV (2005a) make a similar point with respect to the Depression and World War II.

Fertility and the Baby Boom

Figure 1 provides a brief overview of fertility trends from 1870 to 1880. First, it is striking that fertility did not decline by much during the Depression. In fact, the decline was far steeper during the comparatively prosperous 1920s, and so the notion that the baby boom was simply a post-Depression reversion to normal fertility levels carries little weight. If the baby boom were purely a matter of timing in which women postponed children until particular events had passed and then clustered their births in better times, then we would expect to see spikes (both downward and upward) in the time series of fertility corresponding to such events, but there is no such evidence surrounding the Depression. Second, although the sharp movements in fertility between 1943 and 1947 were associated with the mobilization of men into and out of military service for World War II, they appear to be movements around a pre-existing upward trend. Finally, it is clear that fertility rates peaked in the late 1950s, long after the economy had recovered from the Depression and more than ten years after troops were demobilized from the war effort.

Using the Integrated Public Use Microdata Series (IPUMS), figure 2A shows that the mean number of children-ever-born increased among women who were born from 1915 to 1935.[4] This rise in cohort fertility is a key aspect of the baby boom and a significant departure from the decline among earlier birth cohorts of women. Similarly, the proportion of women who remained childless (shown in figure 2B) declined dramatically and secularly from the 1905 to the 1937 birth cohort. As shown in figure 2C, it is clear that the large increase in period rates from 1940 to 1960 reflect large declines in the proportion of women with 0 or 1 child, as well as a significant rise in the proportion of women who had 3 or more children. Overall, the birth cohorts of the mid 1930s had the twentieth century's highest completed fertility, and their lifetime fertility far exceeds the trend one would predict based on the trend for pre-Depression era cohorts.

Finally, to the extent that one views the baby boom as an unusual rise in completed fertility, the wives of returning veterans cannot be said to have made an especially large contribution. Figure 2D splits the women in figure 2A into two groups: those married to World War II veterans and those married to non-veterans (at the time of observation). For comparison, we also plot the proportion of all women in each cohort married to veterans (read from right hand axis), which peaks around 1924, ten years before the peak in cohort fertility. The key points are that women married to veterans did not have larger families than those married to non-veterans, and cohort fertility continued to rise long after the proportion married to veterans started declining sharply.

How, then, can we account for the baby boom? It is a mid-century anomaly characterized by increases in completed fertility and an increasing "tempo", as successive cohorts married earlier, entered into motherhood sooner, and spaced subsequent children more closely (Ryder 1980). Particularly when viewed against the sharp rise in the labor-force participation rates of married women, the causes of this aberration remain a matter of scholarly debate almost fifty years later. Easterlin (1980), as described above, emphasizes the role of "relative income" in driving marriage and fertility, a model in which young people compare their actual economic prospects to those they came to expect on the basis of their parents' experience. GSV (2005) suggest that the diffusion of time-saving household appliances played a key causal role in the baby boom. We plan to consider Easterlin's hypothesis at length in future work, and in this paper we closely examine the correspondence of GSV's argument with the national time series below.

Appliance Diffusion in the United States

Figure 3 shows the U.S. national time series pattern of adoption for electrical service, refrigerators, and clothes washers.[5] Most of the series that we plot are the product of "market saturation" estimates (expressed per wired home) and the proportion of homes that were wired according to Bowden and Offer (1994). We added a second series for electrical service based on figures from the *U.S. Historical Statistics* volume (U.S. Department of Commerce 1975), which in turn is based on a combination of Census-based benchmarks and Edison Electric Institute data. The implied levels of service diverge somewhat after 1930 (for as yet unknown reasons).

The steep and steady rise in electrical service and appliances up to the 1930s is clear. Lights and electric irons were among the first appliances bought by households that acquired access to electrical service, and therefore they should track the electrical service series fairly closely. The Depression seems to have slowed the pace of electrical service expansion, but not the pace of appliance accumulation. World War II, on the other hand, entailed a break in the production of

[4] These women were observed at the end of their childbearing years, ages 41 to 70. See figure notes for more details.
[5] See Day (1992) for a description of appliance diffusion in Ontario.

consumer durables, hence the flatness of the washer and refrigerator series from 1941 to 1945. The strong upward trend in household electrification resumed in the post-war period.[6]

The national trends mask enormous variance across places in the diffusion of electrical service and appliances. For example, figure 4 provides a sense of the geographic disparities using state-level figures for electrical service in Pennsylvania and Tennessee from 1925 to 1960, based on Edison Electric Institute data. In 1940 nearly 90 percent of homes in Pennsylvania had electrical service, compared to about 50 percent in Tennessee.[7] This 40 percentage point gap was present as early as 1925. Because few homes had electrical service in 1900, it follows that within the first 25 years of the century, Pennsylvania raced far ahead of Tennessee in household electrification and maintained that large lead until World War II. From the late 1930s onward, Tennessee closed the gap very quickly. By 1960, roughly the same proportion of households in Pennsylvania and Tennessee had electric service. Although it is more difficult to trace appliance diffusion rates (as opposed to electrical service) at the state level before 1940, it is clear that the gaps between Pennsylvania and Tennessee were large in this regard as well. According to Census of Housing data, in 1940, 50 percent of homes in Pennsylvania owned refrigerators, whereas only 28 percent did Tennessee. Moreover, within each state, there is again a great deal of variation in electrical service and appliance diffusion. After considering the theoretical links between the number of children and household appliances, we explore the correlation of changes in fertility with the prevalence of different household appliances using both county-by-decade and state-by-year variation.

3. History, Housework, and the Appliance-Fertility Hypothesis

The general character of home-produced goods has not changed much since 1900 – laundry,

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[6] Some care must be taken in interpreting the figures because it is difficult to assess the quality of the underlying time-series data sources. Bowden and Offer's figures are derived from a 1972 issue of *Merchandising Week*, a trade publication that based its market saturation estimates on sales data from associations of manufacturers and electricity providers. The figures are not based on household surveys, but rather appear to be the ratio of an estimate of the stock of appliances divided by an estimate of the number of homes with electrical service. The number of homes with electrical service are likely based on residential customer counts from the Edison Electric Institute. The basis for calculating the appliance stock, however, is less clear. Cumulative sales figures from manufacturing firms would be a logical place to start, but the extent to which depreciation was taken into account (if at all) is unknown. The saturation figures are the same as those published in earlier years in *Electrical Merchandising*, which appears to be the antecedent of *Merchandising Week*.

[7] Tennessee and Pennsylvania are not at the extremes of the national distributions. Rather, we selected them for comparison because they are large states with diverse economic and demographic characteristics and are reasonably representative of northern and southern regions. Tennessee is of additional interest given the role of the Rural Electrification Administration and the Tennessee Valley Authority in bolstering its electrical supply. In future work we may develop an in depth case study of Tennessee.

meal preparation, child care, house cleaning – but the methods, standards, and labor-intensity of production have changed dramatically.[8] Ruth Schwartz Cowan writes, "modern technology enabled the American housewife of 1950 to produce singlehandedly what her counterpart of 1850 needed a staff of three or four to produce: a middle-class standard of health and cleanliness for herself, her spouse, and her children" (1983, p. 100). Hot and cold running water, electric lights and irons, washing machines, vacuum sweepers, refrigerators, and cleaner cooking equipment are the hallmarks (and the capital goods) of the revolution of household production.

Electrification and Appliances in the Macro-Demographic Literature

To incorporate changes in household production into a dynamic, general equilibrium macroeconomic model, GSV build on the work of Becker (1965), Razin and Ben-Zion (1975) and Galor and Weil (2000).[9] They show that, in theory and in a simulated time series, their hybrid vehicle can approximate the course of American demographic history, including the major twentieth-century departure from trend:

> The idea here is that the successful production of kids is subject to technological progress, just like other goods. It will be argued that technological advance in the household sector, due to the introduction of electricity and the development of associated household products such as appliances and frozen foods, reduced the need for labor in the child-rearing process. This lowered the cost of having children and should have caused an increase in fertility, other things equal. This led to the baby boom (p. 185).

They generate these results based upon some conventional theoretical assumptions: 1) adults derive utility from having children and consuming goods; 2) children are costly because their "production" requires time that could otherwise be devoted to market work (and the purchase of consumption goods); 3) adults face a life-time budget constraint in which consumption equals income net of the cost of children. An optimizing adult therefore chooses a bundle of consumption and children such that the marginal benefits derived from children equal the marginal costs in terms of foregone consumption utility. Holding quality constant, in the wake of household productivity improvements,

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[8] Perhaps the biggest change in the range of household-produced goods is in the area of entertainment, starting with the radio. But even in this case, one could view the radio as a substitute for "live" music or storytelling.

[9] Becker (1965) describes how families optimally allocate their time over various activities (e.g., market work, home production, and leisure). Razin and Ben-Zion (1975) construct a model in which the current generation derives utility from current consumption and from the size and (discounted) utility of future generations; the current generation optimally chooses the rate of population growth, consumption, and saving. Galor and Weil (2000) emphasize connections between technological change, income, and demographic change in modeling the demographic transition.

substitution and income effects may lead families to consume more household-produced goods. Because children might be viewed as one type of "good" produced at home, labor saving appliances, in this scenario, may lead families to have more.

To see whether their model can mimic the actual course of American fertility, GSV select a number of parameters to characterize tastes (to value and discount consumption goods and children), market technology (for the production of goods with capital and labor as inputs), and home technology (for the production of children with time as an input).[10] For a baby boom to occur in this framework, the home productivity parameter must rise substantially between 1940 and 1960. Otherwise, the secular trend is strongly downward over American history, as children are continually more expensive to rear.

While the model is able to simulate the upward swing in fertility of the Baby Boom quite well, the authors note the difficulty in generating the dramatic decline in fertility rates after 1960. They suggest that incorporating different types of modifications such as changes in the labor-force participation decisions of women and public education might match the data better. Section IV of their paper modifies the model by incorporating the quality and quantity of children and demonstrates how well simulated steady states match observed outcomes in the U.S. data at four points in time.

The Quantity-Quality Tradeoff in Household Production

Similar to allowing for changes in the quality and quality of children, the GSV framework has implications for the quality and quantity of other goods that are produced in the household. By renaming the variable for "children" as a composite commodity for all goods produced at home, the GSV model leads to an argument that is similar to that of notable historians of housework. For instance, Cowan (1983) and Vanek (1974, 1978) claim that the addition of "labor-saving" technologies to homes did not imply fewer hours of work for women. Instead, they claim that women used the extra time to produce higher quality outputs – women washed clothes "whiter", sanitized bathrooms more frequently, and hosted more elegant dinner parties. That is to say, although higher labor productivity in housework allowed women to spend less time per quality unit

[10] Some of these parameter estimates can be based on observations of American macroeconomic data (e.g., TFP change, capital depreciation, a discount factor, and capital's share of income). Other parameters are estimated by minimizing the sum of squared residuals between the actual and predicted fertility levels at 20 points in time between 1800 and 2000. Exogenous change in the level of total factor productivity is a key aspect of the model because it drives the rise in market-sector productivity that constantly pushes fertility downward.

output, families may have substituted toward higher quality household output more generally rather than just producing more and/or higher quality children (Willis 1973, Becker and Lewis 1973). In fact, one can argue that higher standards of cleanliness and meal quality were considered inputs into the production of higher quality kids (Mokyr 2000). In general, labor-saving appliances may facilitate higher qualities of household output, higher quantities of household output, or both.

Viewing household production more broadly implies that the theoretical predictions in GSV depend critically upon the fact that preferences in the model are only defined over one dimension of household output – children. Allowing households to allocate labor to other household output (higher quality or quantity), the same model could predict no baby boom at all or an even more rapid decline in fertility than witnessed in the decades before 1940. The predictions with respect to children depend completely upon how preferences over children and other household outputs (with imperfect market substitutes) are defined.

In the analysis that follows, we cannot measure changes in the quality of household goods. However, the conception of household output in terms of both quantity and quality provides a theoretical framework for interpreting the empirical patterns that emerge from the time series and the panel data.

4. Evidence on the Appliance-Fertility Link

As an empirical matter, it is impossible to characterize fully changes in the quality and quantity of household produced goods and, therefore, to distinguish changes in the quality of children from that of other commodities produced in the household. Aside from narrative histories, we have very little information on changes in the quality of commodities produced at home. The best information in this regard comes from time use studies, which document the evolution of time inputs into housework over the twentieth century. While we do not place great weight on the comparability or representativeness of these studies, they provide the only quantitative information on how households adjusted their time inputs in response to new, labor-saving appliances.[11] In this section, we begin by presenting a brief overview of time use research. Then, we examine the relationship between the quantities we can observe and measure: the number of children and the prevalence of appliances.

[11] Although these studies span the period of interest, they are not directly comparable in terms of geographic coverage or methodology (see Robinson and Converse 1972 for discussion).

Changes in Time Inputs in Household Production

Work by Robinson and Converse (1972), Vanek (1974, 1978), and Cowan (1983) are often the point of departure for discussions of the consequences of the "industrial revolution of the household" (Gershuny and Robinson 1988; Bowden and Offer 1994; Bittman, Rice and Wajcman 2003; Gershuny 2004). Each of these works feature information from earlier time use studies that described how much time people spent on household chores at various points in time during the twentieth century.

The broad trends that emerge suggest that married women who were not in the labor force spent nearly as much time on household work in the 1960s as they did before the mass diffusion of appliances.[12] For example, despite the introduction of automatic washing machines, Vanek claims that the amount of time spent on laundry increased slightly from the 1920s to the 1960s, explaining that "people have more clothes now than they did in the past and they wash them more often" (1974, p. 117). Time spent on child care also seems to have risen. In this case, Vanek suggests a postwar shift in standards regarding child supervision, although she does not discuss the potential significance of the baby boom (rising quantity).

An Empirical Strategy to Relate Changes in the Number of Children to Changes in the Prevalence of Household Appliances

The Census of Population includes detailed age breakdowns by county in each census year, and we use this information to calculate the number of infants (age 0) and the number of children (age 0 to 4) per 1,000 women ages 15 to 44. Between 1940 and 1960, more than 95 percent of US counties had increases in these measures of fertility. In this sense, the baby boom was widespread, but it was not evenly spread. Across counties, the coefficient of variation in fertility change was over 50 percent.

Starting in 1940, the federal Census of Housing began collecting information on appliances used for household production, including the presence of electrical service (as indicated by having electric lights), ownership of refrigerators, and the type of cooking fuel used (e.g., electric, gas, coal, wood).[13] In 1960, the Census also inquired about washing machines for clothing. These data are available from the published volumes of the Census at the county level, thereby providing a fairly

[12] Although Lebergott (1993) suggests a massive decline in housework time between 1900 and 1975, Bryant (1996) argues for a much smaller decline. We are still weighing the evidence regarding the time use studies.

disaggregated view of the diffusion of appliances across places during a critical period in American demographic and economic history.[14] As with the baby boom, the diffusion of appliances was widespread, but it was not evenly spread.

Table 1 reports unweighted summary statistics for the proportion of households in each county with various appliances and measures of fertility from 1940 to 1960. The average number of infants per 1,000 women aged 15 to 44 increased from 80 in 1940 to 121 by 1960.[15] Over the same period, the Census records the rapid diffusion of modern household appliances. In 1940, only 27 percent of homes in the average county had a "mechanical" refrigerator, but by 1950 nearly 67 percent did. The proportion of homes with modern stoves (gas or electric) increased from 25 percent to 87 percent between 1940 and 1960.

The mid-century coincidence of the baby boom and appliance diffusion is clearly evident in table 1, as it is figures 1 and 3.[16] We begin by exploring the correlation between the prevalence of appliances in 1940 with the number of per woman. The model in GSV indicates that the derivative of the optimal number of children with respect to the state of household technology is unambiguously positive (2005, p. 205), and they also argue that in practice the improved technology was embedded in household appliances and complementary goods, especially between 1940 and 1960. We examine this hypothesized relationship by running regressions of the following general form,

1A) $$I_{ist} = a + b_1A_{ist} + b_2X_{ist} + f_s + e_{ist}$$

1B) $$\Delta I_{is} = c + d_1\Delta A_{is} + d_2\Delta X_{is} + u_{is},$$

where I is the number of infants (or children) per 1,000 women age 15 to 44 in county *i*, A represents the proportion of households with a particular appliance, and f_s is a state fixed effect. X denotes a set of control variables including (depending on the specification) pre-1940 fertility; the county's urban proportion, population density, racial composition, median educational attainment, and median property value (for owner occupied housing); the proportion of the county's workers employed in agriculture and manufacturing, and the proportion of women in the labor force; and state fixed effects. When available (1950 and 1960), we add the log of median family income to the list of X

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[13] The Census counted a home as having electrical lighting as long as there was a light that was wired to an electrical source (even if service was temporarily suspended).
[14] See the data appendix for more information on the data sources. For some years and appliances, we used files compiled by Haines (2004) from the census volumes; for others, we collected the data from the published volumes.
[15] The change is somewhat larger when counties are weighted by the population of women (15 to 44). The number rises from 63 in 1940 to 114 in 1960.

variables.

Equation 1A represents a cross-section regression that we estimate separately for the years *t*, equal to either 1940, 1950 and 1960. Equation 1B is a within-county differenced version of 1A. For d_1 to accurately reflect the "causal" effect of appliances on fertility, within-county changes in appliance ownership must be randomly assigned after conditioning on observable changes in economic, social, and demographic characteristics. This assumption, however, is not valid if omitted factors at the county-level change and influence both the prevalence of appliances and the fertility rates.

Before presenting these regression results, we should emphasize that we do not interpret the results as causal estimates for three main reasons. In fact, our results are consistent with a variety of models of household behavior. First, reverse causality is certainly an important consideration. Families may purchase more appliances because they have more children to rear. Or families with children might purposefully seek residence in areas with electrical utility service (e.g., parents might want to be in close proximity to schools, doctors, churches, and shopping in towns). This would lead to a positive correlation between observed fertility rates and appliance ownership using variation across locations, but would not imply a causal link running from appliances to children.

Second, omitted variables may bias the results. One might hypothesize that the post-war wave of prosperity allowed families to afford more consumer durables, more housing, and more children. In this case, unobserved changes in economic development, affluence or optimism might induce families to have more children. Alternatively, our discussion above highlighted the possibility that shifts toward high quality children could overwhelm any positive response in terms of quantity.

Third, one might believe that social and economic changes opened new employment opportunities for married women and induced the purchase of more appliances (as women spent more time in the labor market), while also raising the opportunity cost of staying home to care for children. While the first scenario predicts a positive bias, the second scenario has ambiguous implications, and the third scenario implies a spurious negative correlation between appliances and the number of children.

Although we are currently working on a quasi-experimental strategy for estimating these

[16] It is worth noting that although appliances and fertility both trended upward between 1940 and 1960, they trended in opposite directions for the first four decades of the twentieth century. In GSV this is explained by an especially strong change in household production technology from the mid 1930s onward.

relationships, we present suggestive results here, which control for a variety of potential confounders. For instance, we include proxies for income, employment, property value and changes in the demand for married women's work. Because we cannot control for optimism or preference changes at the county level, we include state fixed effects in some specifications and account for time-invariant, within-county unobservables in our first-differenced specification (equation 1B).

Therefore, the regressions provide insight into the following questions: After conditioning upon a rich set of observable characteristics, did counties with higher rates of appliance ownership also have high fertility rates? How do changes in the fertility rates in these counties correspond to the diffusion of household appliances?

Empirical Results: The Relationship Between Modern Appliances and Fertility

Table 2A reports several regressions that correspond to equation 1A for counties and appliances observed in 1940. The raw correlations between each appliance (refrigerators and modern stove) and the level of fertility is negative (columns 1 and 6), and there is little change in the coefficients after adding state fixed effects (columns 2 and 7). Adding a long list of relevant covariates reduces the magnitude of the coefficients on appliances (columns 3 to 5 and 8 to 10), but the negative relationship remains even after conditioning on 1930 fertility and on women's labor force participation.

Table 2B repeats a similar series of regressions for counties and appliances observed in 1950. Again, the correlations are negative and statistically significant (columns 1 and 6). Neither the state fixed effects (columns 2 and 7) nor the bulk of the county-level controls eliminate the negative cross-sectional relationship between fertility and refrigerators or modern stoves. However, the specifications in columns 9 and 10 do suggest a positive relationship between modern stoves and the number of infants. Finally, table 2C repeats the analysis with washing machines and modern stoves, the two appliances available in the 1960 data. The coefficients on the modern stove variable are now uniformly negative (columns 6 to 10). However, the relationship between washing machines turns positive (columns 3 to 5), albeit statistically insignificant as more county-level controls are added (columns 4 and 5). On the whole, the regressions in table 2 provide mixed support for the appliance-fertility hypothesis. Although we observe many more negative coefficients than positive ones, unobserved county-level effects could easily confound the estimates.

Difference regressions presented in table 3, corresponding to equation 1B, narrow the scope for omitted variable bias. Unfortunately, the Census did not collect information on the same appliances in 1940, 1950, and 1960, so this limits the possibilities for cross-year comparisons. Table 3A presents the results for refrigerators (collected in both 1940 and 1950) and table 3b presents the results for modern stoves (collected in 1940, 1950 and 1960). These regressions examine whether or not counties with relatively large increases in appliance ownership also had large increases in fertility after 1940. In column 1 of table 3A, the correlation is positive and insignificant in the regression with the least controls, but adding state-fixed effects and county-level covariates in columns 2 to 4 controls for several sources of positive bias, and the coefficient becomes increasingly negative. Interestingly, this negative coefficient persists even after controlling for changes in women's labor force participation, implying that the negative appliance coefficient is not merely picking up the influence of better labor market opportunities for women. The relationship between modern stoves and the number of infants appears uniformly negative and large, and the coefficients increase in significance as more county-level covariates are added.

An interesting aspect of these findings is that in both 1940 and 1960, places with more appliances had fewer children (in most regressions), after conditioning upon a rich set of observable characteristics. Yet, as labor-saving household appliances diffused widely and rapidly, fertility rose sharply between 1940 and 1960. Places that had high levels of appliance ownership in 1940 should have had relatively little scope for updating their household technologies because they had already adopted "modern" methods. Under the model in GSV, this implies that counties with higher appliance prevalence in 1940 should have experienced smaller changes in fertility post-1940. However, the reverse appears to be true. In fact, the change in fertility was larger in the places in locations with higher initial appliance ownership rates. In order to square these facts with the GSV model one must argue that appliances had their effect on fertility with a very long lag or that our appliance diffusion measures do not capture the relevant changes in household technology.

As they stand, these preliminary results are not consistent with the hypothesis that the mid-century diffusion of appliances strongly and positively influenced childbearing decisions. In fact, the data suggest a relationship running in the opposite direction. At this point, it is difficult to gauge the potential scope of bias associated with omitted variables. We intend to extend and refine the analysis in future work.

5. Evidence on Electricity and Fertility

In this section, we take one step back from the appliance data and focus instead on households' access to electrical service. The provision of electrical service is a clear constraint on one's ability to use electrical appliances, and it has two potential advantages over appliance ownership rates. First, electrical service rolled outward from cities in ways that were idiosyncratic in term of geography and timing, and we hope to exploit this variation in future work. Second, the provision of electrical service to certain areas depends upon a number of local and federal government decisions as well as both the constraints implied by local topology and perhaps proximity to natural resources. As such, it is less of a leap to imagine the electrification of an area as something plausibly exogenous to childbearing decisions. Virtually no families that had electrical service available to them declined to have lights, but the decision to purchase large consumer durables might have been caused by shifts in the demand for more children (see our earlier discussion). Thus, whereas appliance prevalence reflects both the supply of electric power to an area and the demand for these durables, the availability of electric service provides a relevant and binding constraint on an area's families' ability to use new technologies.

We have two main data sources on electrical service. First, the Census of Housing inquired about lighting, and the published volumes report the proportion of homes with lights at the county level. With the county data, our analysis parallels that using appliance prevalence in the previous section. Second, the Edison Electric Institute (EEI) published an annual statistical bulletin that included detailed information on the number of "customers" on residential and rural rates in each state at the end of each year (customer counts appear to be based on billing information). We use these data to assign women, by birth cohort and state of birth, a probability of having access to electricity during childbearing years. We discuss this procedure at more length below.

Empirical Results: County-level Electricity and Fertility Rates

Table 4 reports cross-section regressions for 1940 (columns 1 to 4) and 1950 (columns 5 to 10) of infants per 1,000 women aged 15 to 44 on the proportion of homes with electric lights, state fixed effects, and a number of relevant covariates. In each column the correlation is negative. Places with more electrical service had fewer children even after adding state fixed effects and controls for education levels, property values, income, women's labor force participation, the distribution of employment across sectors, and pre-1940 fertility levels.

Table 5 reports difference regressions for 1940 to 1950 and 1940 to 1960. As in the previous section, each of the regressions with state fixed effects control for state-specific trends in fertility. Coefficients are estimated using within state variation in changes in electrical lighting and changes in fertility across counties. Every coefficient on electrical lighting is strongly negative in cross-county comparisons of trends.[17]

Empirical Results: Exposure to Electricity and Children-Ever-Born

For a different empirical perspective, we shift to the information in the Edison Electric Institute publications and in the IPUMS data. We located issues of the EEI Statistical Bulletin with annual state-level information on the number of residential electrical customers from 1925 to 1960.[18] To calculate the proportion of homes receiving electrical service, we use the housing unit count from the census (interpolated between dates) as the denominator.[19] Then, we formed a large sample of women from the 1900 to the 1930 birth cohorts from the public use microdata series for the 1960 to 1990 Censuses (Ruggles et al. 2004). Each woman in the census samples reported the number of children she had ever had, and each was over 44 years old when we observe her; hence we view the children-ever-born response as a measure of completed fertility. Finally, we assigned each woman an "exposure index" based on her age and state of birth. The index is the average proportion of households in that state that had electrical service during the years in which the woman would have been ages 15 to 30.[20]

Table 6 reports regressions of children-ever-born on the exposure index with state-of-residence and birth-cohort fixed effects. The first specification has only state fixed effects, and the positive coefficient simply reflects the fact that completed fertility and electrical service both trended upwards over time. Including only cohort fixed effects, thereby estimating the coefficient on exposure using within cohort variation, yields a negative coefficient. This also effectively eliminates the time trend. Even after including both state and year of birth fixed effects (column 4), an binary variable indicating nonwhite (column 5), and a set of binary variables for educational attainment (column 6), the negative point estimate on exposure to electricity suggests that women within a given birth cohort who were more likely to have had electricity in their homes at the peak of their childbearing years had fewer children over their lifetimes.

[17] We caution that the 1940 to 1960 results depend on an assumption that 100 percent of homes had electrical lighting in 1960. This is a bit of an exaggeration, but more than 98 percent of homes in the U.S. did have electrical service by 1960. We will add some sensitivity analysis with respect to this assumption in a future draft of the paper.
[18] In the EEI data, Maryland and Washington DC customers are always counted together. North Carolina and South Carolina customers are often counted together, and for consistency we have summed their counts for all years.
[19] We divided the EEI customer counts by the Census of Housing counts of families (1920 and 1930) or occupied dwelling units (1940-1960) in each state to calculate the proportion of families with electrical service (imperfectly)This choice of denominator follows convention established in the *Historical Statistics of the United States* (1975 and 2005).
[20] This approach is similar to that used by Card and Krueger (1992).

6. Outen the Lights: The Baby-Boom and the Amish

We present one final piece of evidence as a potential falsification test. The Amish are particularly appropriate for our purposes, because, as a matter of religious principle, they have refused to take up many modern appliances, especially those powered by electricity.[21] They live in distinct communities and are easily identified (in person) on the basis of their dress and mode of transport, but they are not economically isolated from their neighbors. They produce agricultural and various other goods for outside markets and sometimes find employment outside their own community. Through the middle of the century, their way of life was relatively unaffected by the diffusion of labor-saving, household appliances, but they were exposed, more or less, to the same mid-century macroeconomic environment that other rural residents experienced.[22]

A striking features of Amish demographic history is that they experienced a baby boom that was comparable to that in the general U.S. population. Markle and Pasco (1977) and Ericksen, et al. (1979) both examine patterns of fertility among the (conservative) Old Order Amish during the twentieth century. Markle and Pasco rely on the Indiana Amish Directory from 1971 (specifically for Lagrange County) for vital statistics information. The sample includes 523 families. Between 1935-39 and 1960-64, Markle and Pasco document a large increase in the birthrates of women in their 20s.[23] Between 1935-39 and 1955-59, average age at marriage for women fell from 22.8 to 20.8 years, and the average time between marriage and first birth declined. In other words, Markle and Pasco show that the Amish in Indiana experienced a baby boom at the same time as the general U.S. population despite tightly constricted use and access to modern appliances.

Ericksen et al. gathered population data from the four largest Amish settlements in the United States: Lancaster, Pennsylvania; and Elkhart, Indiana. Their analysis examines the fertility data by

[21] The Amish began settling in Pennsylvania in the early 1700s, and later settled in parts of Ohio, New York, Indiana, Illinois, and Ontario. For background on the Amish, see Hostetler (1963) or Nolt (1992).
[22] We caution against supposing that the Amish were completely isolated from new appliances. It appears that some Amish adopted gas-powered appliances and farm equipment, but the timing and extent are difficult to document precisely because different communities of Amish have adopted different (and unwritten) conventions with respect to new technologies. In the early 1960s, Hostetler wrote, "There are variations in what is allowed from one community to another in the United States and Canada. Custom is regional and therefore not strictly uniform. The most universal of all Amish norms across the United States and Canada are the following: no electricity, telephones, central-heating systems, automobiles, or tractors with pneumatic tires…" (1963, p. 61). Much later in his study, he notes that some Amish used gas-powered kitchen and farm equipment (p. 305). Even so, it is clear that among the Amish appliance diffusion was slow, the extent of appliance use was highly constrained, and the overall impact on household production was small compared to the general U.S. population between 1925 and 1960.
[23] The birthrate for women aged 20-24 increased from approximately 0.30 to 0.52; for women 25-29, the birthrate increased from about 0.38 to 0.48 (Markle and Pasco 1977, p. 274, figure 1).

the birth cohort of the Amish women (rather than by period, as in Markle and Pasco). Between the 1909-18 birth cohort of Amish women and the 1929-38 cohort, they find a decline in the proportion of childless women, a rise in age-specific marital fertility for 20-24 and 25-29 year olds, and a rise in cumulative marital fertility by about 0.6 children (at age 35) (1979, p. 260). Again, it appears that timing of the Amish baby boom coincides with that of the general U.S. population. Moreover, although the level of fertility is much higher among the Amish, the 0.6 rise in cumulative births is very similar to our measure of the change from the 1913 to the 1933 birth cohorts of all US women.

As a further test of the appliance-Baby Boom hypothesis, we identify 166 likely Amish women in Pennsylvania and Ohio who reported that the language spoken at home is Pennsylvania Dutch in the 1980 and 1990 IPUMS (Ruggles et al. 2004).[24] Owing to the small sample size, the resulting group were slightly older (ages 49 to 60) and born from 1920 to 1931 (although we would have included women ages 41 to 60 in our sample had they been observed in the census). Figure 5 presents trends in children-ever-born for the likely Amish women (thick line presents a three year moving average), all women residing on farms in Pennsylvania and Ohio, and the U.S. as a whole for comparison. As expected, women residing on farms had, on average, more children over their lifetimes than the U.S. average. Amish women had even more births on average, and the increase over time appears slightly larger than among women residing on farms in Pennsylvania and Ohio.

Using this sample we repeat the analysis for "exposure to electricity" inferred in the same manner as in the state-level analysis for all women. The results are reported in panel A of table 7. Column (1) includes only the exposure measure, column (2) adds a time trend, and column (3) adds year-of-birth fixed effects. In each specification, this regression suggests that despite the isolation of the Amish from electricity and most modern appliances, they are the only group of any considered in our analysis for whom our measure of exposure to electricity is positively correlated with the number of children ever born.

To gauge whether or not this effect arises solely due to specific conditions governing the agricultural community in rural Pennsylvania and Ohio, we repeat the same analysis for farmers in those states born in the same years. Contrary to this intuition, the results reported in panel B of table 7 reveal no correlation between exposure to electricity and completed fertility. Despite the fact that the coefficients are much more precisely estimated (the standard errors are roughly one tenth the size

[24] Unfortunately, this information on the language spoken at home was only collected in the 1980 and 1990 censuses. Because we cannot identify individuals who are residing in strict Amish enclaves, we limit the analysis to the residents of Pennsylvania and Ohio. This excludes 39 observations with information on children ever born.

of those in panel A), we fail to reject that the point estimate is equal to zero in each case.

7. Conclusions

The mid-century rise and fall in fertility is a compelling puzzle not only because it was a dramatic departure from the previous two hundred years (at least) of American demographic history, but also because it unfolded against a background of rapid income growth, urbanization, educational increases, infant mortality declines, and rising women's labor force participation – many of the factors that economists and demographers typically associate with declining fertility. Between the 1900 and 1935 birth cohorts, women started marrying younger, having their first child sooner, and having more children over their lifetimes. But the underlying reasons for these trends are not clear.

Easterlin (1968, 1980) proposed one plausible interpretation of the national time series – that the material aspirations of certain cohorts were far exceeded by the actual economic environment, and that they responded by having more children. A different hypothesis, which does not exclude the possibility of Easterlin's hypothesis, has recently been proposed by Greenwood, Seshadri, and Vandenbrouke (2005). They argue that rapid improvements in household production technologies significantly lowered the costs associated with having children, and that consequently parents decided to have more children. For this paper, we assembled as much empirical evidence as we could find to address the plausibility of this hypothesis. Our preliminary regressions did not uncover correlations that strongly support it. In fact, most of our results suggest a negative correlation between appliance and electrical service diffusion and fertility change in the United States. From a different empirical vantage point, we found a negative correlation between estimates of women's access to electrical service (based on age and state figures) and lifetime fertility.

Finally, demographers who have studied the Amish have documented a rise in mid-century fertility that is remarkably similar to that of the general population, despite many restrictions on Amish household production technologies. We confirm this with individual-level data from the IPUMS, where we identify women as "likely Amish" if they reported speaking Pennsylvania Dutch as the primary language in their homes. Interestingly, the Amish are the only group, which appears to increase lifetime fertility in response to electrification. Given that the Amish object to the use of modern electrical appliances on religious grounds, this relationship is certainly not causal.

Having pointed out avenues for potential bias and the possibility of multiple interpretations, we do not attach causal interpretations to these findings, and we hope to extend and improve upon this preliminary analysis. We can suggest several plausible interpretations of the negative correlations we find between appliance diffusion and fertility. First, appliance diffusion may proxy for changes in income that are associated with changes in the demand for child quality rather than quantity as described in Willis (1973) or Becker and Lewis (1973). Second, appliances may have been adopted in response to increasing demand for higher quality children (Mokyr 2000).

We do not have an alternative explanation for the baby boom itself. In addition to finding more empirical perspectives on the appliance-fertility link in future work, we would like to find avenues for testing Easterlin's view, for explicitly considering the role of housing market reforms that made it easier for young couples to own homes after 1935 (in the U.S. at least), and for considering the role of health and healthcare improvements that might have manifested themselves in fertility rate trends (Cutright and Shorter 1979).

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Appendix 1: Appliance Data at the State and County Level

U.S. Census of Housing

The federal census of housing began asking about home appliances in 1930 when it inquired about ownership of a radio. Because radios in the early 20th century were often battery powered, we did not use them to proxy for access to electrical service or other kinds of electrical appliances. In 1940, however, the census asked about whether the housing unit had electric lighting, mechanical refrigeration, and about the type of fuel used for cooking (wood, coal, liquid fuel, gas, electric, or other). This information is not revealed in the household-level public use samples, but it is available in the published census volumes at the county level. Lighting and refrigeration figures are available in computer readable form from Haines (2004). We collected the cooking fuel information from the published volumes and matched it with the Haines data. In 1950, the census again asked about lighting, refrigeration, and cooking fuel, and again, the information is not available in the public use micro data. Haines (2004) includes the refrigeration figures. We collected the lighting and cooking fuel data from the published census volumes. In 1960, the census did not ask about lighting or refrigeration, but it continued to ask about cooking fuel and added a question about washing machines. Haines (200x) includes the washing machine information, and again we collected the cooking fuel information from the published census volumes.

Edison Electric Institute

The Edison Electric Institute (EEI) succeeded the National Electric Light Association in the 1930s and continued publishing an annual statistical bulletin that includes detailed information on the number of "customers" on residential and rural rates in each state at the end of each year (customer counts appear to be based on billing information). We have located issues with annual information from 1925 to 1960. To calculate the proportion of homes receiving electrical service, we use the housing unit count from the census (interpolated between dates) as the denominator. Electrical service is a strong proxy for appliance ownership in both cross-sections and time-series. Our reading suggests that lighting and electric irons were typically the first appliances acquired once electric service was established.

Electrical Merchandising

Electrical Merchandising was a trade journal/magazine for the electrical appliance sales industry.

Once a year, it published statistical information on sales and “saturation rates”. Saturation rates were estimates of the proportion of “wired homes” that had particular appliances in each state. The exact method of estimation is unclear, but it appears that the numerator was based on cumulative sales over a number of preceding years whereas the denominator was based on the number of electrical customers. We have located consistent information for refrigerators, electric washing machines, and electric ranges from 1941 to 1951. We have also located information for lighting from 1926 to 1931.

Table 1: Summary Statistics, County Data

	1940	1950	1960	Δ1940-1950	Δ1940-1960
Infants per woman	80.1	106	121	25.6	40.4
	(17.8)	(17.8)	(20.9)	(15.6)	(21.5)
Children per woman	419	549	600	130	180
	(87.7)	(79.8)	(91.4)	(53.6)	(96.7)
Prop. with lights	54.4	84.7	-----	30.3	-----
	(24.9)	(13.2)		(15.4)	
Prop. with refrigerator	26.9	66.7	-----	39.9	-----
	(14.9)	(17.8)		(12.6)	
Prop. with modern stove	25.2	54.3	87.4	29.1	62.2
	(25.0)	(24.0)	(13.5)	(21.7)	(23.1)
Prop. with washing machine	---	---	78.2	-----	-----
			(12.5)		

Notes: These are unweighted averages.
Sources: Infants and children per woman, proportion of homes with lights (in 1940), refrigerators, and washing machines are from Haines (2004). Lights in 1950 and stoves in all years are from the published volumes of the Census of Housing.

Table 2A: Cross Section, Appliances and Fertility 1940

	1	2	3	4	5	6	7	8	9	10
Pct with refrigerator	-0.691	-0.663	-0.085	-0.088	-0.083					
	[0.020]	[0.025]	[0.036]	[0.033]	[0.034]					
Pct with modern stove						-0.310	-0.391	-0.012	-0.024	-0.025
						[0.015]	[0.014]	[0.019]	[0.016]	[0.015]
Pct urban			-0.045	-0.018	-0.004			-0.046	-0.015	0.000
			[0.017]	[0.014]	[0.014]			[0.018]	[0.015]	[0.015]
Ln density			-1.795	-0.699	-0.724			-1.817	-0.681	-0.700
			[0.324]	[0.267]	[0.269]			[0.332]	[0.274]	[0.276]
Pct nonwhite			-0.086	0.063	0.089			-0.081	0.068	0.095
			[0.024]	[0.025]	[0.021]			[0.024]	[0.026]	[0.021]
Pct agriculture.			0.183	0.075	0.064			0.210	0.099	0.085
			[0.029]	[0.028]	[0.026]			[0.027]	[0.025]	[0.022]
Pct manufacturing			0.067	-0.005	0.009			0.071	-0.002	0.013
			[0.028]	[0.023]	[0.026]			[0.028]	[0.023]	[0.025]
Median education			-0.463	-0.149	-0.152			-0.478	-0.158	-0.160
			[0.470]	[0.216]	[0.217]			[0.492]	[0.233]	[0.233]
Ln median prop. value			-10.584	-6.125	-5.737			-11.330	-6.796	-6.331
			[0.814]	[0.888]	[0.797]			[0.773]	[0.767]	[0.687]
Fertility 1930				0.407	0.400				0.407	0.401
				[0.044]	[0.045]				[0.043]	[0.044]
Pct women in lab. force					-0.184					-0.195
					[0.083]					[0.082]
Constant	98.798	98.064	162.479	89.020	89.877	88.114	90.155	164.883	90.968	91.667
	[0.621]	[0.726]	[5.769]	[9.146]	[9.193]	[0.444]	[0.453]	[5.661]	[8.742]	[8.720]
State fixed effects	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Observations	3094	3094	3033	3032	3032	3094	3094	3031	3030	3030
R-squared	0.34	0.49	0.60	0.73	0.73	0.19	0.45	0.60	0.73	0.73

Notes: The dependent variable is the number of infants (under 1 year) per thousand women ages 15-44. Each county is an observation. Robust standard errors are in brackets. The urban variable generally measures the proportion of the population residing in incorporated places with more than 2,500 residents. The density measure is the log of residents per square mile. Nonwhite includes both black and "other" racial categories. The proportion of workers employed in agricultural and manufacturing industries are expressed relative to total employment. Fertility in 1930 is defined in the same way as the dependent variable. The percent of women in the labor force is the ratio of all women in the labor force divided by the number of women over age 14. The "median education" variable in 1940 table is for women over age 24. In later tables it is for both men and women. The sample loses Shannon County, SD, when 1930 values are added to specification.
Sources: Haines (2004) and various published census volumes for cooking fuel.

Table 2B: Cross Section: Appliances and Fertility, 1950

	1	2	3	4	5	6	7	8	9	10
Pct with refrigerator	-0.342	-0.337	-0.399	-0.230	-0.236					
	[0.021]	[0.031]	[0.046]	[0.043]	[0.043]					
Pct with modern stove						-0.191	-0.238	-0.001	0.053	0.052
						[0.013]	[0.018]	[0.028]	[0.025]	[0.025]
Pct urban			-0.036	-0.003	0.007			-0.023	0.001	0.009
			[0.019]	[0.018]	[0.018]			[0.019]	[0.018]	[0.018]
Ln density			-1.567	-0.875	-0.872			-2.071	-1.179	-1.182
			[0.377]	[0.348]	[0.348]			[0.383]	[0.350]	[0.350]
Pct nonwhite			0.166	0.355	0.367			0.246	0.411	0.422
			[0.026]	[0.030]	[0.031]			[0.025]	[0.029]	[0.030]
Pct agriculture.			0.196	0.132	0.133			0.177	0.116	0.117
			[0.037]	[0.032]	[0.032]			[0.037]	[0.032]	[0.032]
Pct manufacturing			-0.095	-0.107	-0.093			-0.101	-0.107	-0.096
			[0.035]	[0.030]	[0.030]			[0.036]	[0.030]	[0.031]
Median education			-3.604	-2.622	-2.596			-4.287	-3.035	-3.020
			[0.462]	[0.441]	[0.444]			[0.477]	[0.457]	[0.460]
Ln median prop. value			-0.567	0.922	1.396			-3.805	-1.253	-0.901
			[1.365]	[1.295]	[1.295]			[1.390]	[1.300]	[1.302]
Ln median family inc.			23.530	18.868	19.500			14.370	11.977	12.386
			[2.173]	[1.997]	[2.019]			[1.980]	[1.782]	[1.804]
Fertility 1930				0.328	0.320				0.352	0.345
				[0.021]	[0.022]				[0.021]	[0.022]
Pct women in labor force					-0.146					-0.119
					[0.069]					[0.068]
Constant	128.632	128.274	-11.533	-42.182	-47.445	116.206	118.743	66.145	12.752	9.270
	[1.505]	[2.174]	[15.716]	[14.721]	[14.771]	[0.809]	[1.048]	[14.877]	[13.936]	[14.031]
State fixed effects	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Observations	3099	3099	3030	3026	3026	3098	3098	3028	3024	3024
R-squared	0.12	0.35	0.48	0.55	0.55	0.07	0.34	0.46	0.55	0.55

Notes: The dependent variable is the number of infants (under 1 year) per thousand women ages 15-44. Each county is an observation. Robust standard errors are in brackets. The urban variable generally measures the proportion of the population residing in incorporated places with more than 2,500 residents. The density measure is the log of residents per square mile. Nonwhite includes both black and “other” racial categories. The proportion of workers employed in agricultural and manufacturing industries are expressed relative to total employment. Fertility in 1930 is defined in the same way as the dependent variable. The percent of women in the labor force is the ratio of all women in the labor force divided by the number of women over age 14. The “median education” variable in 1940 table is for people over age 24.

Sources: Haines (2004) and various published census volumes for cooking fuel.

Table 2C: Cross Section, Appliances and Fertility 1960

	1	2	3	4	5	6	7	8	9	10
Pct wash machine	-0.186	-0.31	0.191	0.079	0.026					
	[0.040]	[0.053]	[0.060]	[0.054]	[0.055]					
Pct modern stove						-0.223	-0.419	-0.344	-0.223	-0.214
						[0.034]	[0.040]	[0.045]	[0.045]	[0.045]
Pct urban			-0.028	0.001	0.029			-0.031	0.001	0.029
			[0.022]	[0.021]	[0.021]			[0.022]	[0.021]	[0.021]
Ln density			-2.256	-1.032	-1.263			-1.777	-0.77	-1.008
			[0.450]	[0.454]	[0.458]			[0.461]	[0.460]	[0.462]
Pct nonwhite			0.683	0.751	0.753			0.502	0.665	0.688
			[0.046]	[0.042]	[0.042]			[0.035]	[0.036]	[0.037]
Pct agriculture.			0.082	0.159	0.193			0.183	0.204	0.228
			[0.052]	[0.047]	[0.046]			[0.050]	[0.047]	[0.047]
Pct manufacturing			-0.203	-0.171	-0.123			-0.199	-0.18	-0.139
			[0.047]	[0.044]	[0.043]			[0.046]	[0.044]	[0.043]
Median education			-3.631	-2.2	-2.164			-3.249	-2.163	-2.096
			[0.589]	[0.606]	[0.611]			[0.586]	[0.592]	[0.598]
Ln median prop. value			13.36	11.243	12.235			12.452	11.101	12.041
			[3.020]	[2.625]	[2.737]			[2.936]	[2.592]	[2.700]
Ln median family inc.			12.647	17.478	20.392			22.624	23.112	25.13
			[2.925]	[2.641]	[2.694]			[2.994]	[2.788]	[2.818]
Fertility 1930				0.293	0.270				0.284	0.26
				[0.023]	[0.024]				[0.023]	[0.023]
Pct women in labor force					-0.443					-0.398
					[0.081]					[0.075]
Constant	135.438	145.104	-80.044	-141.83	-157.114	140.023	157.106	-115.077	-161.614	-175.504
	[3.276]	[4.210]	[21.759]	[19.524]	[19.852]	[3.082]	[3.560]	[20.870]	[19.268]	[19.711]
State fixed effects	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Observations	3124	3124	3050	3021	3021	3102	3102	3021	3012	3012
R-squared	0.01	0.33	0.46	0.47	0.47	0.02	0.32	0.44	0.47	0.48

Notes: The dependent variable is the number of infants (under 1 year) per thousand women ages 15-44. Each county is an observation. Robust standard errors are in brackets. The appliance variables measure the number of housing units with a particular appliance as a proportion of all units reporting such information. The urban variable generally measures the proportion of the population residing in incorporated places with more than 2,500 residents, with some exceptions (see published volumes for exceptions). The density measure is the log of residents per square mile. Nonwhite includes both black and “other” racial categories. The proportion of workers employed in agricultural and manufacturing industries are expressed relative to total employment. The median income variable measures total family income. Fertility in

1930 is defined in the same way as the dependent variable. The percent of women in the labor force is the ratio of all women in the labor force divided by the number of women over age 14. The "median education" variable is for men and women over age 24. The "washing machine" variable is available only in 1960.
Sources: Haines (2004) and various published census volumes for lighting in 1950 and for cooking fuel in all years.

Table 3A: Difference Regressions, Refrigerators and Fertility, 1940-1950

	1	2	3	4
Δ Pct. with refrigerator	0.039	-0.036	-0.111	-0.106
	[0.035]	[0.047]	[0.043]	[0.043]
Δ Fertility 1930-40			-0.132	-0.133
			[0.024]	[0.024]
Δ Pct. urban			0.057	0.059
			[0.029]	[0.029]
Δ Density			0.002	0.002
			[0.001]	[0.001]
Δ Pct. nonwhite			-0.875	-0.855
			[0.137]	[0.138]
Δ Pct. agric.			-0.069	-0.067
			[0.023]	[0.023]
Δ Pct. manufact.			-0.025	-0.022
			[0.030]	[0.030]
Δ Median education			0.239	0.241
			[0.156]	[0.157]
Δ Median prop. val.			-6.916	-6.859
			[1.215]	[1.219]
Δ Pct. women in labor force				-0.115
				[0.080]
Constant	23.989	26.989	37.889	37.973
	[1.485]	[1.959]	[2.161]	[2.149]
State fixed effects	No	Yes	Yes	Yes
Observations	3094	3094	3028	3028
R-squared	0.000	0.170	0.240	0.240

Notes: The dependent variable is the change in the number of infants per thousand women aged 15-44. Each county is an observation. Robust standard errors are in brackets. For comparability, we calculated the change in educational attainment using an average of men and women's attainment in 1940 subtracted from the reported educational attainment for men and women (together) in 1950.

See notes to tables 2 for more description of the variables.

Sources: Haines (2004).

Table 3B: Difference Regressions, Modern Stoves and Fertility, 1940-1960

	1	2	3	4
Δ Pct. with modern stove	-0.032	-0.245	-0.261	-0.227
	[0.021]	[0.022]	[0.027]	[0.027]
Δ Fertility 1930-40			-0.002	-0.014
			[0.033]	[0.033]
Δ Pct. urban			0.144	0.172
			[0.027]	[0.027]
Δ Density			0.000	0.000
			[0.001]	[0.001]
Δ Pct. nonwhite			-0.976	-0.868
			[0.141]	[0.140]
Δ Pct. agric.			0.017	0.047
			[0.048]	[0.047]
Δ Pct. manufact.			-0.054	-0.008
			[0.048]	[0.047]
Δ Median education			0.882	0.872
			[0.678]	[0.679]
Δ Median prop. val.			-4.838	-4.666
			[1.233]	[1.238]
Δ Pct. women in labor force				-0.558
				[0.080]
Constant	42.293	55.538	61.839	64.250
	[1.389]	[1.376]	[2.892]	[2.931]
State fixed effects	No	Yes	Yes	Yes
Observations	3093	3093	2990	2990
R-squared	0.000	0.270	0.320	0.340

Notes: The dependent variable is the change in the number of infants per thousand women aged 15-44. Each county is an observation. Robust standard errors are in brackets. For comparability, we calculated the change in educational attainment using an average of men and women's attainment in 1940 subtracted from the reported educational attainment for men and women (together) in 1960. See notes to tables 2 for more description of the variables.
Sources: Haines (2004) and various published census volumes cooking fuel in all years.

Table 4: Cross Section, Electricity and Fertility, 1940 and 1950

	------------------------	------------------------1940	------------------------		----------------------	----------------------1950	----------------------	
	1	2	3	4	5	6	7	8
Pct. with elec. lights	-0.414	-0.516	-0.242	-0.113	-0.506	-0.536	-0.381	-0.184
	[0.011]	[0.015]	[0.029]	[0.025]	[0.026]	[0.030]	[0.052]	[0.049]
Pct. urban			-0.035	-0.003			-0.022	0.014
			[0.017]	[0.014]			[0.019]	[0.018]
Ln density			-1.459	-0.622			-1.434	-0.852
			[0.320]	[0.266]			[0.383]	[0.352]
Pct. nonwhite			-0.130	0.066			0.138	0.362
			[0.024]	[0.022]			[0.028]	[0.032]
Pct. agric.			0.080	0.034			0.144	0.106
			[0.030]	[0.025]			[0.036]	[0.032]
Pct. manufact.			0.056	0.006			-0.146	-0.121
			[0.027]	[0.025]			[0.036]	[0.031]
Median education			-0.414	-0.147			-4.288	-2.985
			[0.430]	[0.219]			[0.461]	[0.453]
Ln median prop. val.			-8.369	-5.262			-2.176	0.228
			[0.811]	[0.710]			[1.348]	[1.267]
Ln median family income							20.994	17.22
							[2.123]	[1.970]
Fertility 1930				0.391				0.324
				[0.044]				[0.022]
Pct. women in labor force				-0.170				-0.13
				[0.082]				[0.068]
Constant	102.805	108.304	160.527	92.118	148.663	151.272	34.752	-16.725
	[0.694]	[0.903]	[5.373]	[8.616]	[2.241]	[2.619]	[13.493]	[12.932]
State fixed effects	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Observations	3094.000	3094.000	3033.000	3032.000	3098	3098	3028	3024
R-squared	0.340	0.540	0.610	0.730	0.14	0.39	0.48	0.55

Notes and sources: See table 5.

Table 5: Difference Regressions, Electricity and Fertility, 1940-1950 and 1940-1960

	1940-1950				1940-1960			
	1	2	3	4	5	6	7	8
Δ Pct with elec. lights	-0.278	-0.331	-0.375	-0.373	-0.280	-0.312	-0.368	-0.362
	[0.018]	[0.027]	[0.035]	[0.035]	[0.016]	[0.021]	[0.028]	[0.028]
Δ Fertility 1930-40			-0.141	-0.142			0.014	-0.003
			[0.023]	[0.023]			[0.032]	[0.032]
Δ Pct urban			0.066	0.068			0.123	0.157
			[0.028]	[0.028]			[0.027]	[0.027]
Δ Density			0.001	0.001			0.001	0.001
			[0.001]	[0.001]			[0.001]	[0.001]
Δ Pct nonwhite			-0.902	-0.885			-0.831	-0.729
			[0.132]	[0.132]			[0.138]	[0.134]
Δ Pct agric.			0.070	0.071			0.184	0.238
			[0.028]	[0.028]			[0.050]	[0.049]
Δ Pct manufact.			-0.044	-0.040			-0.063	-0.004
			[0.029]	[0.029]			[0.046]	[0.046]
Δ Median education			0.194	0.195			0.832	0.801
			[0.127]	[0.128]			[0.645]	[0.631]
Δ Ln median prop. val.			-3.925	-3.884			-1.159	-0.679
			[1.218]	[1.222]			[1.159]	[1.140]
Δ Women in labor force				-0.103				-0.679
				[0.077]				[0.082]
Constant	33.970	35.582	37.058	37.265	53.051	54.482	53.670	58.016
	[0.557]	[0.825]	[1.589]	[1.592]	[0.654]	[0.917]	[2.654]	[2.711]
State fixed effects	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Observations	3092	3092	3026	3026	3093	3093	2992	2992
R-squared	0.070	0.220	0.280	0.280	0.110	0.300	0.340	0.360

Notes: The dependent variable is the change in the number of infants per thousand women aged 15-44. Each county is an observation. Robust standard errors are in brackets. For comparability, we calculated the change in educational attainment using an average of men and women's attainment in 1940 subtracted from the reported educational attainment for men and women (together) in 1950 or 1960. See notes to table 2 for more description of the variables. The measure of change in lighting between 1940 and 1960 is an approximation because county-level electrical lighting is not reported in the census. For preliminary results, we assume that in each county all housing units are wired for electrical lighting in 1960; nationally, according to Historical Statistics of the United States (1975), more than 98 percent of all housing units were wired in 1960, and more than 95 percent of farm dwellings were wired. So the scope for cross-county variation in electrical lighting in 1960 seems small.
Sources: Haines (2004)., except for lights in 1950 which we collected from the published census volumes.

Table 6: Children Ever Born and Exposure to Electrical Service, 1900-1930 birth cohorts

	1	2	3	4	5	6	7
Exposure	-0.003	0.011	-0.012	-0.010	-0.009	-0.011	-0.011
	[0.002]	[0.002]	[0.002]	[0.001]	[0.001]	[0.001]	[0.001]
Constant	3.491	2.891	3.686	3.649	3.721	3.847	3.845
	[0.146]	[0.126]	[0.107]	[0.076]	[0.076]	[0.088]	[0.088]
State of birth controls	No	Yes	No	Yes	Yes	Yes	Yes
Year of birth controls	No	No	Yes	Yes	Yes	Yes	Yes
Race dummy	No	No	No	No	Yes	Yes	Yes
Race and education dummies	No	No	No	No	No	Yes	Yes
Above and husband's education	No	No	No	No	No	No	Yes
Observations	918842	918842	918842	918842	918842	713273	713273
R-squared	0.001	0.018	0.016	0.024	0.071	0.073	0.074

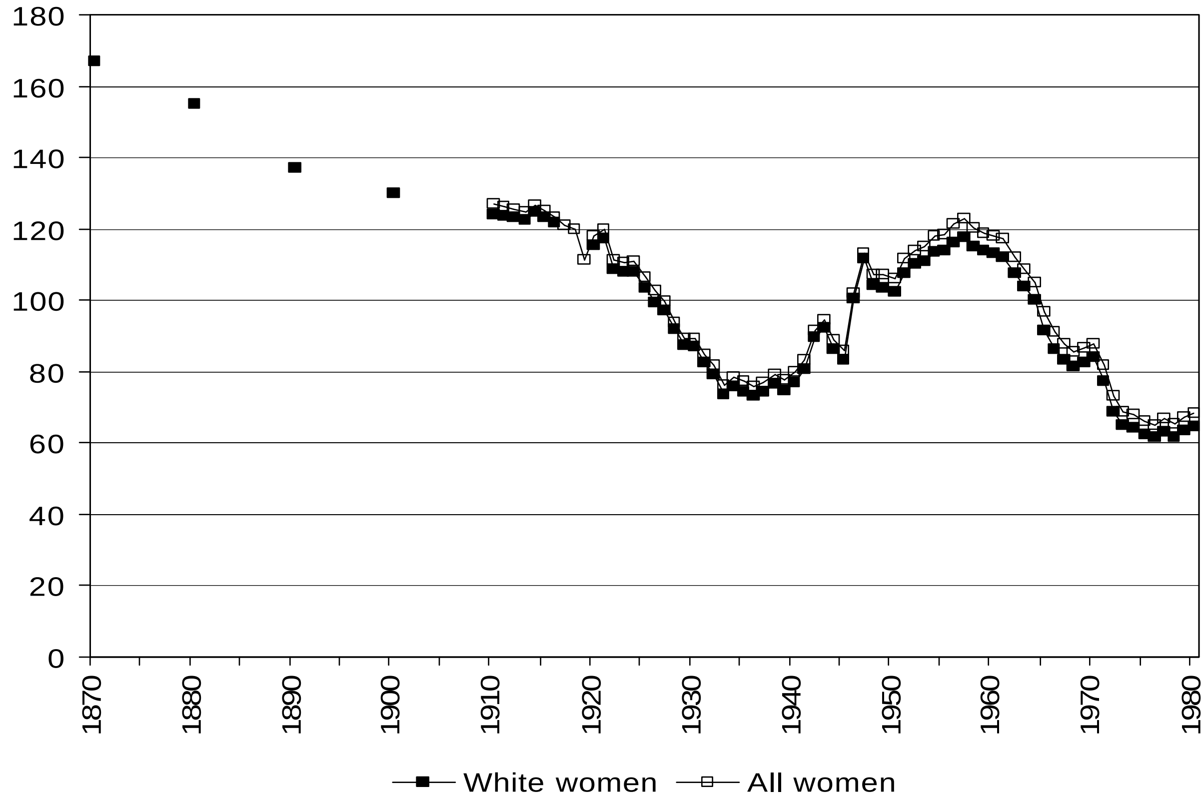
Table 7. A Falsification Test: Children Ever Born, Exposure to Electricity, and the Amish

	(1)	(2)	(3)
Panel A: Amish women born 1920-1931			
(Observations = 164)			
Mean exposure to electricity x 100	0.197	0.234	0.622
	(0.069)	(0.073)	(0.287)
R-squared	0.040	0.050	0.130
Panel B: Women born 1920-1931 and residing on farms in Pennsylvania or Ohio			
(Observations = 2083)			
Mean exposure to electricity x 100	0.008	0.006	-0.003
	(0.008)	(0.008)	(0.009)
R-squared	0.001	0.001	0.010
Linear trend in year of birth	No	Yes	No
Year of birth fixed effects	No	No	Yes

Notes: The dependent variable is self-reported children-ever-born. Robust standard errors are in parentheses. Women for panel A are selected on the basis of their reporting "Pennsylvania Dutch" as "language spoken at home". See table notes for [this should refer to the tables on children ever born for women and electricity exposure] for an explanation of the construction of "mean exposure to electricity".

Sources: Edison Electric Institute *Statistical Bulletin* (various years) and 1980 and 1990 *IPUMS* (Ruggles et al. 2004).

Figure 1: U.S. General Fertility Rate, 1870-1980



Notes: Figures are number of births per 1,000 women aged 15 to 44 in each year.
Sources: Data are from U.S. Department of Commerce (1975, p. 49, series B8 and B9) for 1900 to 1970, and from www.cdc.gov/nchs/data/statab/t001x01.pdf for 1971 to 1980.

Figure 2A: Mean Children Ever Born, by Birth Cohort of Women

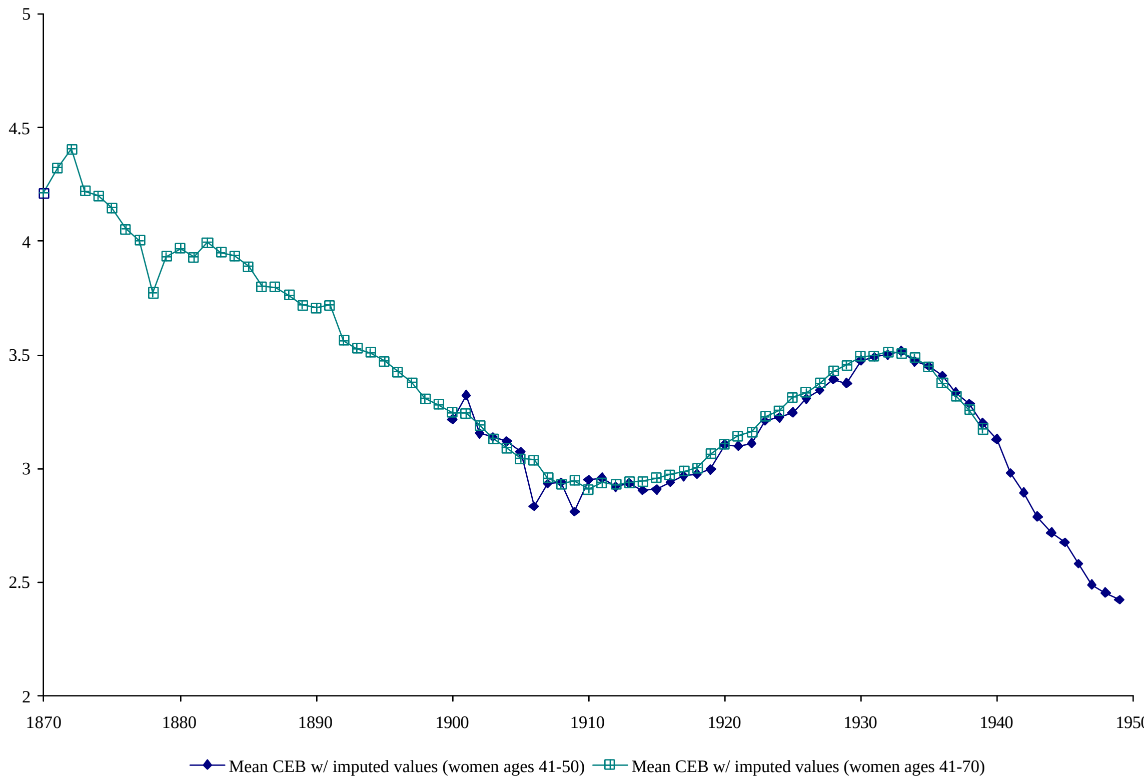


Figure 2B: Childlessness, by Birth Cohort of Women

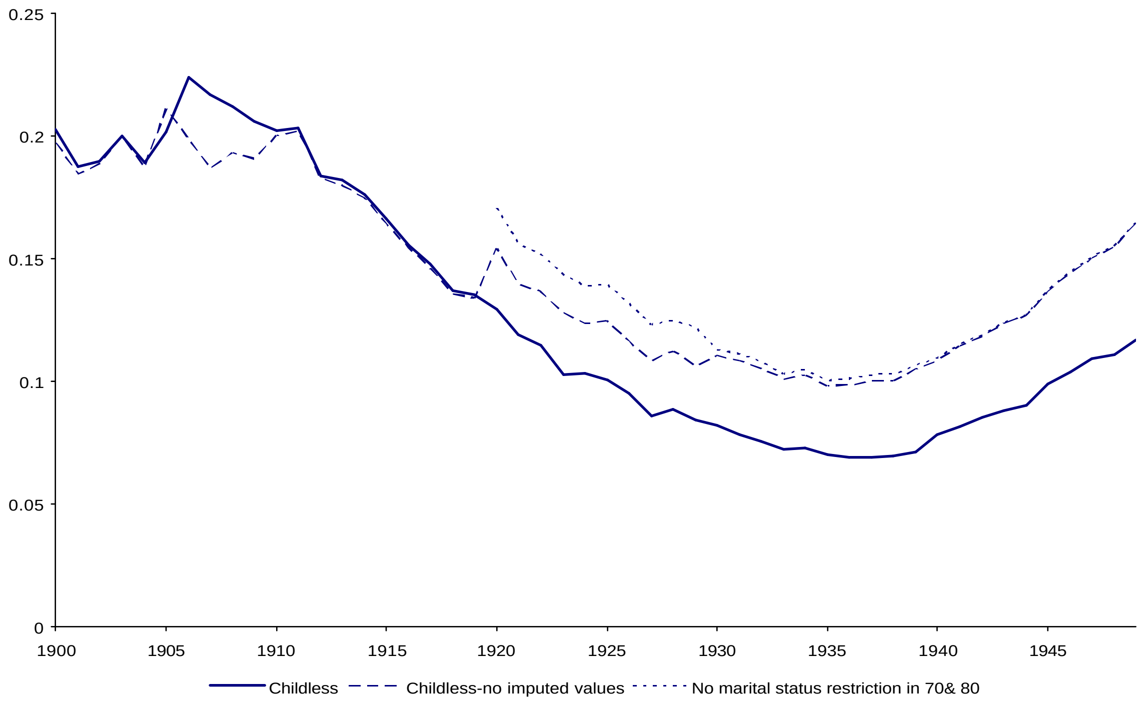


Figure 2C: Distribution of Children Ever Born, by Birth Cohort of Women

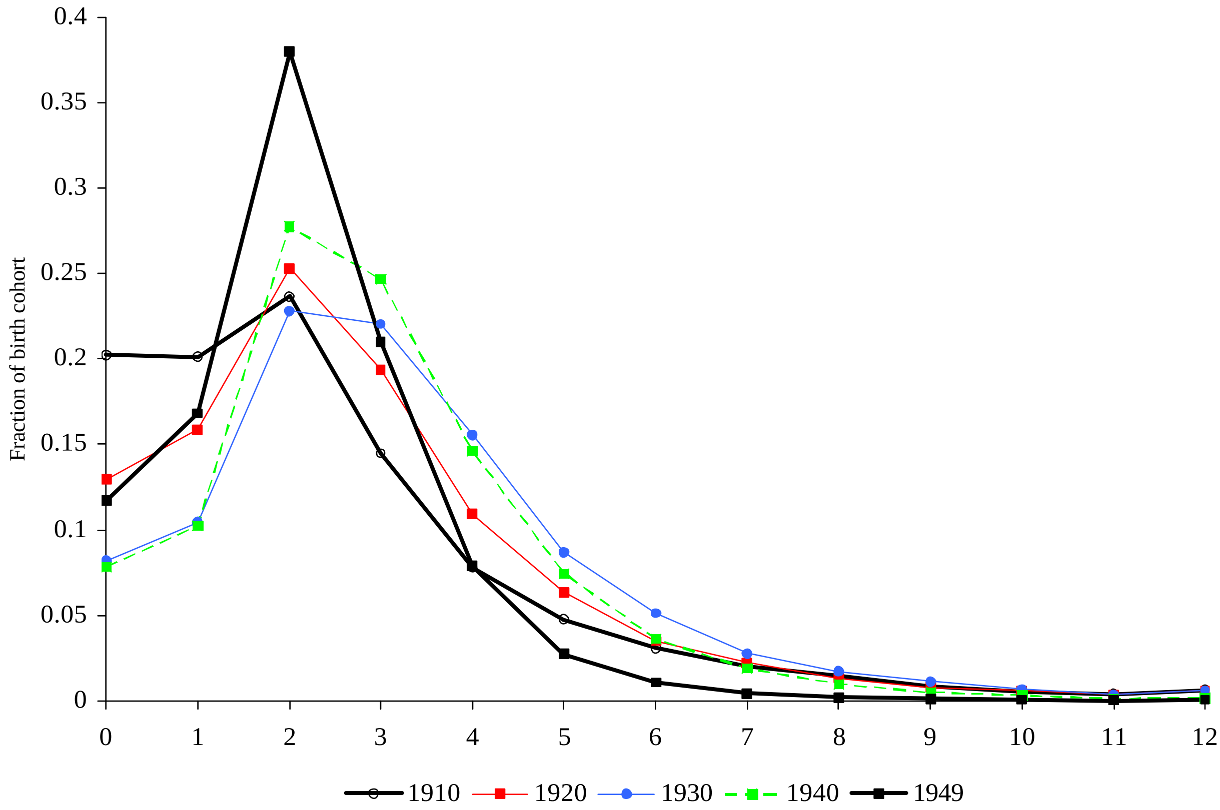


Figure 2D: Children Ever Born, by Cohort and Husband's Veteran Status

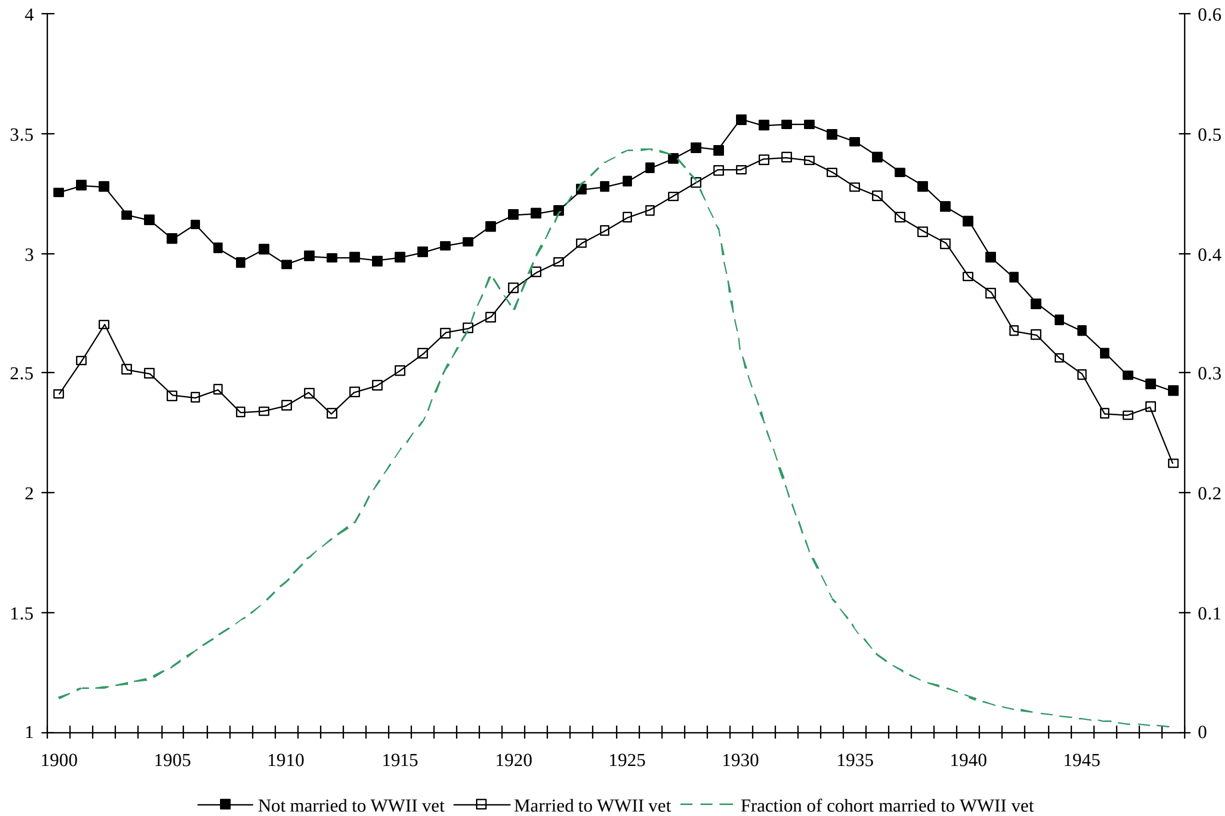
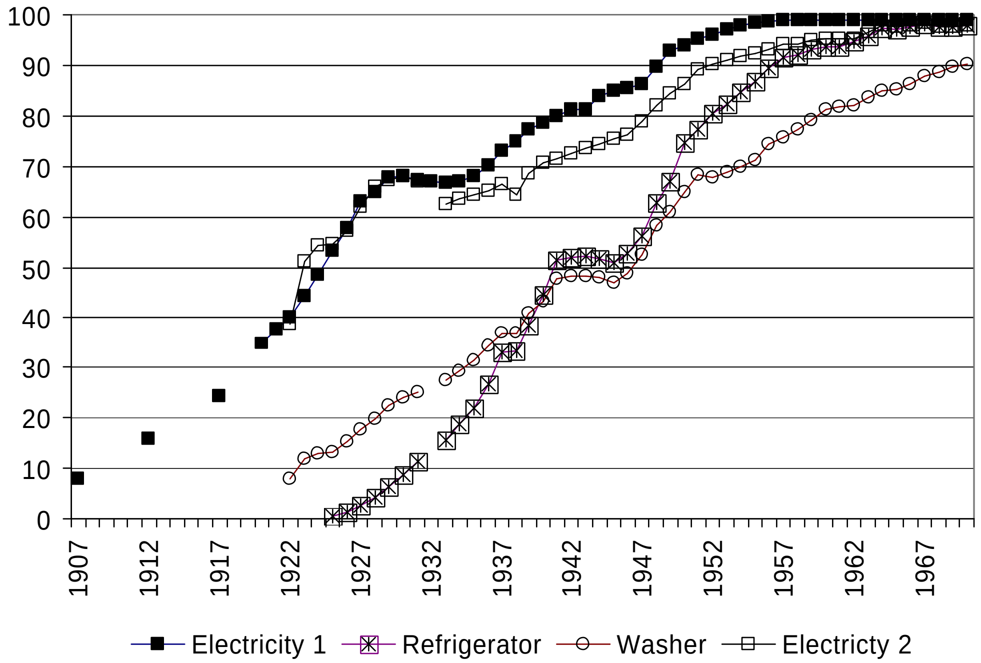
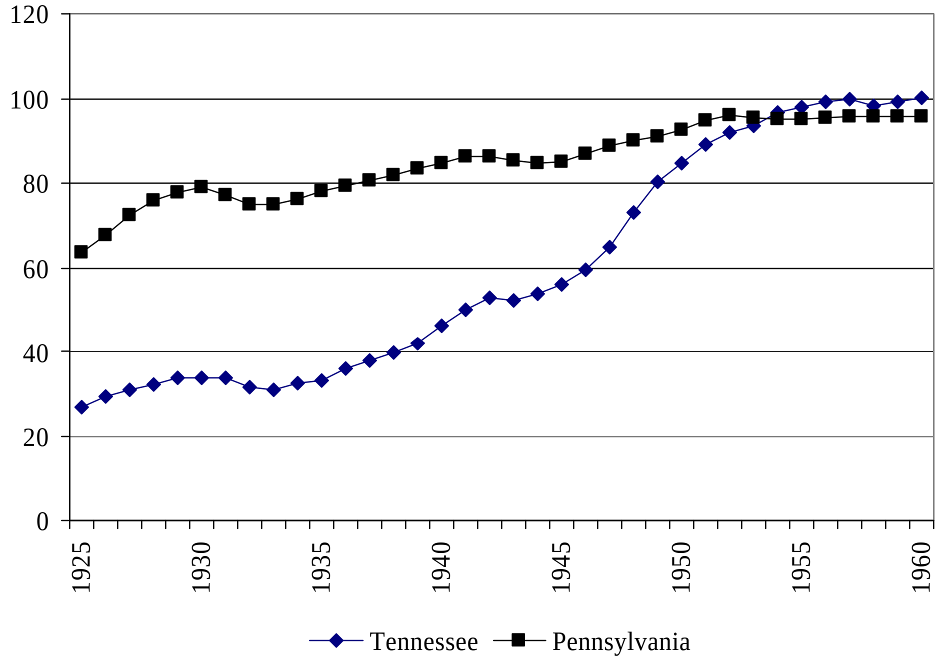


Figure 3: Electrical Service, Washer, and Refrigerator Diffusion, 1907-1970



<u>Notes</u>: The "electricity 1" series is from U.S. Department of Commerce (1975, p. 827, series 109). The "electricity 2" series is from Bowden and Offer (1994). Bowden and Offer's figures ultimately derive from those reported for residential customers by the Edison Electric Institute's *Statistical Bulletin*. The Department of Commerce series is adjusted in an unspecified way to be more consistent with census figures (1975, p. 814). The reason(s) for the divergence of the series after 1930 is not clear, but may relate to the difference between "housing units" (census) and "customers" (EEI) and the manner in which farms are counted.

Figure 4: Electrical Service in Pennsylvania and Tennessee, 1925-1960



Notes and Sources: The number of customers in each states is taken from annual publications of the Edison Electric Institute. The number of homes is estimated using census counts of families (1920 and 1930) and occupied dwellings (1940-1960). This follows convention in *U.S. Historical Statistics*. See Snowden (2006, p. 4-500). Between Census dates, we interpolate the home count assuming constant growth rates.

Figure 5: Children Ever Born, by Farm Residence, Amish Status, and Birth Cohort