SAVING BABIES: THE IMPACT OF PUBLIC EDUCATION PROGRAMS ON INFANT MORTALITY

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ABSTRACT

We take advantage of unique data on specific activities conducted under the "Sheppard-Towner" Act from 1924-1929 to focus on how public health interventions affect infant mortality. Interventions that provide one-on-one contact and opportunities for follow-up care such as home visits by nurses and the establishment of health clinics reduce infant deaths more than classes and conferences. These interventions are particularly effective for non-whites, a population with limited access to physicians and medical care.

***** The authors thank seminar participants at the 2011 Cliometric Society meetings, the University of Colorado, the University of Michigan, the University of Chicago, and Chapman University. The authors assume all responsibility for any errors or omissions.

Introduction

Infant mortality in the United States declined significantly over the first part of the twentieth century, as shown in Figure 1, which plots infant mortality rates in the Birth Registration Area (BRA) from 1915 to 1940.[1] Rising incomes, improved nutrition and housing conditions, and public infrastructure improvements such as water sanitation and sewer systems all contributed to the decline in infant mortality rates, particularly in urban areas (see McKeown 1976; Fogel 1994; Haines 2001; Cutler and Miller 2005; Ferrie and Troesken 2008). In addition, government expenditures on public health and education increased dramatically over this period. Miller (2008) finds that increases in state and local public health and education expenditures caused by the enactment of women's suffrage decreased mortality from infectious diseases between 1900 and 1936. Fox (2011) uses municipal data on public health expenditures over the period 1923-1932 and also concludes that public health spending lowered infant mortality, although the effect is diminished by the inclusion of city-specific time trends in his model.

The literature on infant mortality in developing countries today similarly provides mixed findings on the effectiveness of public health expenditures. Several studies have shown that public health expenditures have a minor or statistically insignificant impact on infant and child mortality (Kim and Moody 1992; Mcguire et al., 1993; Aiyer et al. 1995; Musgrove 1996; Filmer and Pritchett 1997; Filmer et al. 1998), while others (Anand and Ravallion 1993; Hojman 1996; Gupta et al 2002; Anyanwu and Erhijakpor 2009) suggest that such expenditures cause

[1] Infant mortality trended strongly downward despite the fact that the BRA continued to expand until 1932 and many of the states that entered later had higher mortality rates than earlier entrants. Figure 1 also plots infant mortality for only those states that were in the BRA as of 1915 to show that the addition of later states does not obscure the strong downward trend.

substantial decreases in infant deaths. However, expenditures levels are very crude measures of the extent of public health interventions. Governments may engage in a wide range of public health activities and these activities may vary greatly in their effectiveness. For instance, home visits by nurses may be expected to have a different effect than conducting health fairs or conferences. Focusing on only expenditure measures misses this important variation. The mixed findings in the literature may reflect the variation in how public health dollars are spent.

We take advantage of unique data on the number and types of specific public health education activities that occurred during a 1920s U.S. federal program called "Sheppard-Towner" to shed light on the effectiveness of public health education programs in reducing infant mortality. While most of the expansion in public health programs in the U.S. in the early part of the twentieth century occurred at the state and local levels, the federal government was also involved in public health initiatives. The U.S. Children's Bureau conducted studies of infant mortality in a variety of areas in the U.S. and compared its findings to data on infant mortality in other advanced economies. After declaring 1918 as the "Children's Year," the Bureau sought to reduce infant and child mortality by distributing literature and by providing education on health and hygiene at fairs. Efforts to implement a broader and more permanent program aimed at providing prenatal and infant care education finally succeeded in 1921, when Congress passed the Promotion of the Welfare and Hygiene of Maternity and Infancy Act, more commonly known as the "Sheppard-Towner" Act.[2]

[2] Prior to Sheppard-Towner, the federal government had also provided money to states to assist in venereal disease control and prevention under the Chamberlain-Kahn Act of 1918.

Sheppard-Towner provided matching money to states to spend on public health programs targeted at reducing infant and maternal mortality. Each participating state received $5,000 outright and then received dollar-for-dollar matching funds up to an explicit cap determined by its population. States used funds from the program in a variety of ways. Some states used Sheppard-Towner money to organize conferences where physicians and other health professionals would examine children and pregnant women or provide demonstrations on maternal and infant care and hygiene. Many states provided classes for midwives and classes for girls about infant care. Nearly all states sent "prenatal letters" to pregnant women, while others paid public health nurses to visit new and expectant mothers. Some also used the funds to establish public health clinics.

Even though the program was short-lived, the Children's Bureau heralded it as a success and concluded that "the value of maternity and infancy work is reflected in the decrease in infant and maternal death rates in 1928 as compared with those in 1921" (U.S. Children's Bureau 1931a: 6).[3] This claim has been echoed by historians such as Molly Ladd-Taylor, who writes, "A further indication of the program's success was the significant decrease in infant mortality during the Sheppard-Towner years" (Ladd-Taylor 1994: 187). On the other hand, infant mortality was trending strongly downward even before 1920. Opponents to Sheppard-Towner

[3]The passage of Sheppard-Towner occurred after a highly politicized battle about the role of government and states' rights. Evidence suggests that politicians afraid of newly enfranchised women finally passed Sheppard-Towner, but repealed it when it came up for reauthorization because they no longer feared the women's vote. For discussion about the political economy of the passage of Sheppard-Towner and its repeal, see Moehling and Thomasson (2012).

disputed its effect and attributed the decline in infant mortality to its pre-existing trend. A 1932 editorial in the *Journal of the American Medical Association* (JAMA) highlights this view:

> During the seven and one-half years that the Sheppard-Towner Act was in effect, it cost the people about eleven million dollars in taxes. During that entire time it did not develop a single new idea in the field of maternal and infant hygiene. As shown by the official mortality statistics, it did not accelerate the rate of decline in either the maternal or the infant death rates, by even a fraction of a point per annum (JAMA 1932: 404).

An important feature of Sheppard-Towner for the purposes of this study is that states were required to file annual reports with the Children's Bureau detailing the activities undertaken under the program's auspices. For each program year between 1924 and 1929, we know not only the amount of the grant accepted but also the number of home nurse visits made, the number of prenatal and child health conferences organized, the number of health centers established, the number of midwives enrolled in classes, and even the number of prenatal letters distributed. These activities involved very different levels of interaction with mothers and children and therefore may have had differential impacts on infant mortality. Thus, we separately analyze the effects of these activities rather than just looking at aggregated expenditure levels.

To account for the persistent differences in mortality environments across states and the strong downward trend in infant mortality of the period, we include state fixed effects and state-specific time trends in all our models. We find that the type of public health intervention mattered. More direct and personal interventions such as nurse visits were most effective at reducing infant mortality, while conferences and classes had little impact. Moreover, we find a

differential effect of Sheppard-Towner interventions on non-white and white infant mortality. Specifically, building public health centers and funding nurse visits to mothers generated much larger reductions in infant mortality for non-whites than for whites. In addition, while prenatal letters reduced white infant mortality, they did not reduce black infant mortality.

The limitation of the Sheppard-Towner data is the lack of data on costs per activity. Although many at the Children's Bureau believed such cost estimates would be valuable, attempts to collect such data from the states were not successful.[4] Ideally, we would like to calculate the effects of a dollar spent on different activities. While we are not able to do this systematically for all activities, we are able to make such a calculation for one of the most

[4]In 1926, the directors of state divisions of child hygiene were asked to provide data on the costs involved in different activities with the hope that a "proper cost-accounting system" could be developed. S. Josephine Baker reported on the responses at the Fourth Annual Conference of State Directors in Charge of the Local Administration of the Maternity and Infancy Act. Her report stresses the wide variety of cost estimates obtained from the states and the difficulties in coming up with standardized measures. In her own words, "the factors of population density, areas to be covered, the number of mothers and babies who can be reached within any given limit of time, and the complicated elements of ignorance or social and racial maladjustment provide a background which is so complex that it has not yet been possible for us to speak of standardized unit costs for this type of work with any degree of assurance or finality" (U.S. Children's Bureau 1927a: 109). In the discussion following Baker's report, many state administrators, as well as Grace Abbott, the Chief of the Children's Bureau, expressed the sentiment that producing such costs estimates would be complicated and costly, and the potential benefits small (Ibid: 115).

effective, but expensive, interventions: home visits by nurses. We find that one infant death could be averted for every $1600 (about $20,400 in 2010 dollars) spent on home visits by nurses.

We also use our results to estimate the overall effectiveness of the Sheppard-Towner program. Educational programs, like those funded by Sheppard-Towner, are still promoted today as ways to decrease infant mortality, yet we do not know if and how such activities contributed to the dramatic reduction in infant mortality that occurred in the U.S. during the early twentieth century. [5] We conclude that while much of the reduction in infant mortality during the 1920s must be attributed to other factors, activities funded by Sheppard-Towner account for between 9 and 21 percent of the decline.

Infant Mortality and the U.S. Children's Bureau

Created in 1912, the Children's Bureau was charged with investigating and reporting "upon all matters pertaining to the welfare of children and child life among all classes of our people" (42 U.S.C. Ch. 6. April 9, 1912). In the 1910s, the Children's Bureau focused on studying causes of infant and maternal mortality, and creating a birth registration area where all births would be accurately and consistently reported. An examination of nearly 23,000 infants in 8 cities led the Children's Bureau to conclude that the overall infant mortality rate in the U.S. was 111.2 deaths per 1,000 live births, a rate higher than those of many other industrialized countries. Moreover, many of these deaths were believed to have been preventable. For example, the study revealed that the mortality rate for artificially fed infants in the first nine months of life was 4.8 times greater than for breastfed infants (Woodbury 1925: 91). Overall,

[5] See for instance Bill and Melinda Gates Foundation, 2009.

about 29 percent of the deaths were attributable to gastric and intestinal causes, many due to improper feeding and hygiene (Woodbury 1925: 14).

The Children's Bureau investigations also revealed that large numbers of rural women had limited access to medical care during childbirth. In its study area in rural Wisconsin, the Bureau found that half of confinements were attended by midwives and 8 percent were attended by neighbors or relatives without any training. Moreover, in a number of cases classified as attended by a physician, the physician had arrived after the birth. In one case, a new mother had to wait two hours for the doctor to arrive to cut the cord (Children's Bureau 1919a: 28-30). In a homesteading county in Montana, the conditions were even worse: more than half of the new mothers studied lived more than 20 miles from the nearest physician (Children's Bureau 1919b: 27)

As a result of these studies, the chief of the Children's Bureau, Julia Lathrop, proposed a plan for the "public protection of maternity and infancy" with federal funds (Fifth Annual Report of the Chief, Children's Bureau 1917: 49). The plan called for greater instruction of mothers on the care of infants and greater availability of physicians and hospital care. Instruction could be provided through public health nurses, universities, and extension teaching (Fifth Annual Report of the Chief, Children's Bureau 1917: 47-48). Lathrop suggested that the Smith-Lever Act of 1914 provided a precedent by which the federal government could fund the program using matching grants to states (Fifth Annual Report of the Chief, Children's Bureau 1917: 49).

While the first bill of what finally became the Sheppard-Towner Act was introduced in 1918, it was not until after women's suffrage that the program finally became law.[6] The political debate did not end after enactment, however. When the program came up for renewal in 1926, it met with increased opposition. Ultimately, a compromise was reached in which the program was extended for an additional two years, but then automatically repealed in 1929.[7]

Under the auspices of Sheppard-Towner, states had the autonomy to engage in a variety of different activities designed to reduce infant and maternal mortality and improve the health of

[6] The primary opponents to the bill were the AMA (who feared non-medical control of medicine) and anti-suffragists. Historians argue that Sheppard-Towner passed because members of Congress feared the new, unknown voting power of women. The effectiveness of the women's lobby and the fear of the House and Senate was noted by Senator Kenyon (R-Iowa), who stated, "If the members could have voted on that measure secretly in their cloak rooms it would have been killed as emphatically as it was finally passed in the open under the pressure of the Joint Congressional Committee of Women" (*Ladies Home Journal* XXXIX (April 1922: 95)). The idea that Congress had at least some fear of the women's vote is supported by Lott and Kenny (1999) and Miller (2008). Lott and Kenny (1999) find that suffrage coincided with immediate increases in state government expenditures for functions women generally supported, such as education, sanitation and hospitals. Suffrage also generated more liberal voting patterns among federal representatives. Miller (2008) similarly finds that suffrage laws generated large increases in public health spending. Moehling and Thomasson (2012) also find that time since suffrage had a large impact on the level of state participation in the Sheppard-Towner program.

[7]For more discussion of the political economy of Sheppard-Towner, please see Moehling and Thomasson (2012), Ladd-Taylor (1994), Lemons (1969), and Lindenmeyer (1997).

children and mothers. During the seven year period in which the Act was in force, physicians conducted 144,777 conferences where they examined children and pregnant women, and nurses and dentists held nearly 40,000 more conferences where they provided general instruction on maternal and child care. At these itinerant conferences, health professionals provided instruction on infant and child care using lectures, motion pictures, and exhibits. They also examined infants and preschoolers and referred those with problems to physicians (Children's Bureau 1925, 1926b, 1927b).

In addition, states and counties set up 2,978 permanent child and/or prenatal health centers where mothers could bring children to be examined and receive follow-up care.[8] Public health nurses also visited over 3 million women and their children in the last six years of the act. During these visits, field nurses would advise women on child care and examine children. Nurses could provide demonstrations in the household "… with the equipment the home affords," and make additional recommendations upon seeing the living conditions of the family (Children's Bureau 1926a: 7). The Children's Bureau noted that the informal setting of the visits also may have enabled mothers to feel freer to ask questions, and may have been particularly useful in isolated communities with a lack of access to medical care and where it was difficult to arrange conferences (Children's Bureau 1926:7).

Sheppard-Towner funds were also used to provide literature on prenatal and child care to expectant women and mothers. The Children's Bureau studies in the 1910s had found that many

[8] These permanent health centers were not necessarily newly constructed, stand-alone clinics. They often were just regularly scheduled sessions where physicians and nurses would see patients in a given location. For example, some states used rooms in municipal buildings or schools (Children's Bureau 1926b: 10).

mothers, especially those in rural areas, looked to printed material for guidance on child care (Apple 2006:77-78). Over 22 million pieces of literature (such as instructional pamphlets and prenatal letters) were distributed nationwide when the Act was in force. Overall, in the last four years of the Act alone, the Children's Bureau estimated that more than 4 million infants and children and about 700,000 pregnant women were reached by some form of the public health work conducted under Sheppard-Towner (Children's Bureau 1931).

Data and Methods

The overall U.S. infant mortality rate in 1922 was 76.2 deaths per 1,000 live births. By the time Sheppard-Towner was repealed in 1929, the infant mortality rate had fallen to 67.6 (Linder and Grove 1947: 574-75). How much, if any, of this decline can be attributed to the activities in which states engaged under the Sheppard-Towner program? Although Sheppard-Towner was passed in 1921, it took many states a couple of years to gear up to accept federal grants and establish programs. Not until its report on the Sheppard-Towner Act for the 1924 fiscal year was the Children's Bureau able to give a systematic accounting of the activities of the states. The Children's Bureau published these data in tabular form and provided state-by-state reports on an annual basis starting in 1925 (U.S. Children's Bureau 1925, 1926b, 1927b, 1928, and 1931b). These reports allow us the rare opportunity to construct a dataset on state public health education activities rather than just expenditure levels. For periods before and after Sheppard-Towner, the only systematically collected state-level data on public health programs are the cost outlay data provided in the U.S. Census Bureau's *Financial Statistics of the States*.

We use state-level Vital Statistics data for the period 1924-1929 on the infant mortality rate (defined as the number of deaths of children under 1 year of age per 1,000 live births) to test

whether the public health activities funded by the Sheppard-Towner program had the life-saving effects the Children's Bureau claimed.[9] The infant mortality rate in a state will depend on demographic characteristics of the state's population such as racial composition and the fraction living in large cities, public infrastructure such as water and sewer systems, industrial activities, as well as the climate. For the most part these characteristics are fixed or subject to only small changes over the six years of our study. Therefore, we deal with these factors empirically by including state fixed effects in our model. These fixed effects will capture any differences in infant mortality across states that do not vary over time, such as the effect of climate. Because infant mortality was trending downwards before and after the Sheppard-Towner period, we also include state-specific time trends to allow for differences across states in these trends in infant mortality. For example, it is possible that some states engaged during this period in public infrastructure projects related to sanitation that may have affected infant mortality while others did not. Finally, we include year fixed effects to capture any temporal variation that was common across states, such as the state of medical technology.

Our basic model is:

$$(1) \qquad IMR_{it} = \alpha + \beta * ST_{it} + \delta_i + \delta_t + \delta_i * t + \varepsilon_{it}$$

[9] We have also estimated the model over the period 1922-1929 and 1915-1929 (excluding the years of the influenza pandemic) assuming that all public health activity levels were zero for the years prior to 1924 and get similar results to those reported in the paper. However, we know this assumption is false; a number of states were engaged in public health educational programs prior to Sheppard-Towner. Our preferred specification, therefore, is for the period from 1924 to 1929 when we know we have a full accounting of public health education activities.

Where IMR_{it} represents the infant mortality rate in state i in year t, ST_{it} represents the measure of Sheppard-Towner activity for state i in year t, δ_i and δ_t are the state and year fixed effects, and δ_i*t represents the state-specific linear time-trend. Since this model accounts for differences across states in both levels and trends in mortality rates, the effects of Sheppard-Towner activities are identified from the deviations from those trends. In the fully saturated specification, β is identified by the within-state deviations from trend in Sheppard-Towner activities.

One concern may be that the measure of Sheppard-Towner activity is endogenous; a state's decision to participate in Sheppard-Towner or to engage in a particular activity may have been influenced by its infant mortality rate. In other words, the error terms for models of a state's Sheppard-Towner activity levels may be correlated with the error term in equation (1). It is important to note, however, that this will only be a problem for the estimation of β in equation (1) if the correlation is due to do something other than state and year fixed effects and the state specific linear time-trend.

As noted above, states engaged in a wide range of activities with Sheppard-Towner funds. States utilized Sheppard-Towner money to build health clinics, conduct prenatal and child health conferences (where physicians or nurses would examine children and provide information about hygiene and nutrition), and to send public health nurses into homes to examine children and educate mothers. In addition, states used Sheppard-Towner funds to provide training for midwives and to disseminate free literature on prenatal and infant care. These different types of activities involved very different types of interactions with mothers and their children, and we might expect that some would have a greater impact than others on mortality

rates. We first examine the impact of each of these activities (in per capita terms) separately and then estimate a model including all of them.

We also look at more commonly used financial measures of public health engagement so that we may compare our results to previous studies. First, we consider the federal Sheppard-Towner grant amount accepted per capita. Due to the $5,000 unmatched component of the program and the variation in participation, this measure varies substantially across states. However, it may be a poor measure of the impact of Sheppard-Towner on state public health initiatives because some states may have simply shifted expenditures from existing public health categories into Sheppard-Towner to qualify for the federal match.[10]

As a result, we also estimate models in which we use data from the U.S. Census Bureau's *Financial Statistics of the States* on outlays for the "conservation of child life" and the broader category of "health and sanitation" as measures of public health spending. Programs that would fall in the category of the "conservation of child life" would include most of the Sheppard-Towner funded activities, but would also include programs aimed at school-age children. The "health and sanitation" category includes the full range of public health programs and sanitation projects in which a state engaged.

[10] The state of New Jersey was quite open about the fact that it used the federal grants to replace state appropriations. For instance, in 1922, the New Jersey legislature appropriated almost $100,000 less for the Department of Health than it had in 1921. This move was explained in the Department's annual report in quite plain terms: the appropriations for the Bureau of Child Hygiene and the Bureau of Venereal Disease Control were being reduced because both would be receiving federal monies for their work (New Jersey Department of Health 1922, 19).

We estimate equation (1) for all infants, and also separately for whites and non-whites. Vital Statistics data only provide infant mortality rates for states in the BRA. At the start of our study period in 1924, 33 states were in the BRA; by 1929, that number had jumped to 46.[11] In order to make the most of the available data, we estimate equation (1) using the unbalanced panel of all states in the BRA for at least one year of the study period.[12]

The non-white infant mortality rate at the beginning of the period was nearly twice that of white infants, as shown in Figure 2. Despite the fact that more states with high non-white infant mortality rates were entering the BRA during this period, the racial gap in infant mortality rates did not widen appreciably. *A priori*, we do not know whether Sheppard-Towner spending would affect blacks and whites differently. Sheppard-Towner initiatives were targeted at smaller cities and rural areas. Some interventions, such as classes to train midwives, may have benefited blacks more than whites, since the vast majority of Southern blacks used midwives (Ladd-Taylor

[11]To be included in the BRA, a state had to have a systematic procedure in place for recording all births. When the BRA was established in 1915, it consisted of only 10 states. Following is a list of the states that entered the BRA during the study period with their years of entry: West Virginia (1925); Arizona (1926); Alabama, Arkansas, Louisiana, Missouri, Tennessee (1927); Colorado, Georgia, Oklahoma (1928); Nevada, New Mexico (1929). South Carolina was part of the BRA in 1924, was dropped in 1925, and then readmitted in 1928. The two states not part of the BRA by 1929 were South Dakota and Texas (Linder and Grove 1947: 97).

[12] We have also estimated all models using the balanced panel consisting of states in the BRA for all five years and the basic findings do not change. All estimated models presented in the paper include the three states that did not participate in Sheppard-Towner: Connecticut, Illinois, and Massachusetts. Excluding these states does not alter the basic findings.

1988: 263). On the other hand, the structure of Sheppard-Towner may have limited the effectiveness of the interventions for blacks. For example, while stricter regulation of midwives and midwife classes may have improved the quality of some midwives, the regulations may have served to drive many underground and out of business, thus limiting the ability of blacks to find birth attendants (Ladd-Taylor 1988: 269-70).

Of further concern is that the decentralization of Sheppard-Towner administration may have reinforced the ability of racist public health workers to discriminate against blacks at the local level. By helping whites and not blacks, these practices may have increased the racial gap in infant mortality.[13] Perhaps surprisingly, though, state reports to the Children's Bureau documented efforts to target blacks as well as other minority groups rather than to exclude them. In 1924, for instance, Alabama paid for a black nurse to join the Tuskegee Movable School. The nurse joined a carpenter, instructor and agriculturist who traveled around the state teaching black rural families how to improve their homes and their health (U.S. Children's Bureau 1924: 21). In the same year, Florida reported making more prenatal visits to black women (4,033) than to white women (2,406) (ibid: 24).

Results

Summary statistics are provided in Table 1. The mean of the white infant mortality rate in the BRA over the period is about 70 deaths per 1,000 live births, while the non-white infant mortality rate is 128. The means hide considerable variation, so we report the minima and

[13] Later in the twentieth century, the widening of the racial gap in infant mortality can be attributed to the fact that whites had better access to improved medical care than blacks (see Almond, Chay and Greenstone 2007).

maxima of the variables as well. For example, for those states that did spend money sending public health nurses into homes, the mean value of nurse visits per 1,000 population is 12.60, with a minimum of 0.02 and a maximum of 138.

Table 2 reports the results of the estimation of equation (1) for overall infant mortality rates from 1924-1929. The first two columns present the estimated coefficients and elasticities from eight separate regressions, each including only one measure of public health activity; the third and fourth columns represent the results from a single regression that includes all the activity measures and the two expenditure measures as explanatory variables. The elasticities are calculated at the means of the public health measures, conditioned on being positive values. All models include state fixed effects, year fixed effects, and state-specific time trends.

The first three rows of the table describe the effect of the financial variables on infant mortality. The Sheppard-Towner accepted grant amount per capita has no statistically significant impact on infant mortality rates during the period, and in fact the estimated coefficient on this variable is positive. Based on this result alone, one would have to argue that Sheppard-Towner had no beneficial effect on infant mortality. However, as discussed above, the amount a state accepted from the federal government may be a poor measure of its efforts to improve infant and child health during the period. Although states had to match federal funds above the initial $5000 grant, some states may have already had expenditures that exceeded the match amount.

State spending on “child life” per 1,000 population as well as overall state spending on health and sanitation (also per 1,000) both reduce infant mortality. While the elasticity of health and sanitation expenditures is about twice the size of that of child life expenditures, this difference reflects the much different scales of the two expenditure measures rather than the relative effectiveness in reducing infant deaths. The estimates indicate that a dollar (per 1000 in

the population) spent on child life activities reduced infant mortality by 0.09 per 1000 births compared to only 0.02 for a dollar spent on health and sanitation expenditures. Another way of describing this finding is to say that to avert one death, expenditures per 1,000 population on child life activities had to increase by about $11 whereas overall health and sanitation expenditures would have to increase by about $49 per 1000 population. These results seem at odds with those of Fox (2011) who finds that public health expenditures by cities have no effect on mortality rates once allowing for city time trends. This contrast may reflect the fact that many of the state-level public health initiatives during this time period -- and particularly Sheppard-Towner programs-- were targeted at rural areas.

Finding that greater expenditures on child life programs, and health and sanitation more generally, reduced infant deaths suggests that the public health initiatives of the period had beneficial effects. Yet, we are still left with the question of what specific activities generated these effects. Many different types of activities fall within the "child life" activity category. We want to know whether some of these activities were more effective than others.

We report results (all per 1,000 population) for nurse visits to homes, the number of child health conferences conducted, the number of midwives enrolled in classes, the number of public health centers constructed, and the number of prenatal letters distributed. These are the most common activities states engaged in using Sheppard-Towner funds, and are consistently reported for the years 1924 to 1929. All of the estimated coefficients with the exception of midwife classes and child health conferences are statistically significant and generate meaningful reductions in the overall rate of infant mortality. Looking at the magnitudes of the estimated coefficients, Table 2 shows that a one standard deviation increase in the number of home nurse visits reduced infant mortality by about 1.8 deaths per 1,000 live births (a decrease of about 2.6

percent when calculated at the mean of the dependent variable). A one standard deviation increase in the number of health centers (per 1,000) lowers infant mortality by 2.25 deaths, and a one standard deviation increase in the number of prenatal letters distributed (an increase of 36 letters per 1,000 population) reduces infant mortality by about 0.2 deaths per 1,000 live births. These results hold even when all the measures are included in the same regression model (columns 3 and 4).

These findings suggest that it was the more direct and personal interventions that were effective in reducing infant mortality during the period. Providing child health and prenatal clinics increased access to medical care and instruction. Likewise, sending nurses to visit the homes of new mothers likely had a greater impact on the care of infants in an area than could be achieved by holding a child health conference and inviting new mothers to attend.[14] By all accounts, the prenatal and child health conferences were well attended. Building on the experiences during the "Children's Year," many states made them the centerpiece of their maternal and infant health programs. However, even at the time, some in the public health community questioned their effectiveness. The staff at the conferences had limited contact with mothers and their children and could not always assess the health challenges they faced. There was also no way to ensure that conference attendees received the follow-up care recommended. In the 1930s, the Wisconsin Bureau of Maternal and Child Health (MCH) decided to only conduct conferences in counties where there were county nurses who could follow up with

[14] We can also not discount the possibility of selection bias; it could be that mothers who were more aware of the value of hygiene were more likely to attend child health conferences than other mothers.

families. Rural physicians, the MCH found, were often not interested in providing preventive care and some poor families could not even afford emergency care (Apple 2011: 175).

Perhaps the most surprising result is the effect of prenatal letters, but these too were more personal interventions than activities like health conferences. These letters provided basic information about prenatal care and cost little to distribute. Similarly, they enabled pregnant mothers to gain access to this information at very low cost, which may help to explain their effectiveness.[15]

Table 3 reports the results of estimation of equation (1) separately by race. Panel A reports results for whites while Panel B reports results for non-whites. The story that emerges is that public health interventions had different effects on non-white and white infant mortality. Spending on both child life and health/sanitation reduced infant mortality for whites, but did not have statistically significant effects on the non-white infant mortality rate. For whites, a one standard deviation increase in child life spending reduces infant mortality by 1.5 deaths per 1,000 births, while a one standard deviation increase in spending on health and sanitation reduces infant mortality by 3.8 deaths. Strikingly, the Sheppard-Towner grant accepted per capita has a *positive* and statistically significant effect on non-white infant mortality. One likely explanation for this is that the bulk of expenditures on public health during the period were aimed at whites rather than non-whites, which is also corroborated by the lack of significance of the other spending measures as well.

[15] In results not presented, we find that the impact of prenatal letters is most pronounced in states with larger rural populations, suggesting that it was women with limited to access to medical care that benefited most from this intervention.

While the results suggest that non-whites did not benefit from public health spending, the data in Table 3 do indicate that non-whites did benefit from certain types of Sheppard-Towner activities. Again, classes for midwives and child health conferences appear to have no impact on either whites or non-whites. The variable measuring public health nurse visits per 1,000 population is statistically significant for whites, but is only marginally statistically significant for non-whites (p-value of 0.106). Nevertheless, the estimated coefficient is much larger in magnitude for non-whites. A one standard deviation in nurse visits per 1,000 population reduces black infant mortality by 8.7 deaths per 1,000 births (a decrease of about 6.8 percent when calculated at the mean of black infant mortality). For whites, the same increase generates a decrease in infant mortality by 1.2 deaths, or 1.7 percent. We find similar results when looking at the impact of a one standard deviation increase in the number of health centers constructed per 1,000 population. For whites, this increase reduces infant mortality by 1.9 deaths, but the same increase reduces non-white infant mortality by 8.4 deaths per 1,000 live births. The distribution of prenatal letters reduces white infant mortality by 0.3 deaths per 1,000 live births, but has no statistically significant effect on non-white infant mortality rates.

Non-white infant mortality appears to have been more responsive to nurse home visits and the construction of public health clinics than white infant mortality. To the extent that even rural whites may have been better educated about hygiene than blacks, this makes sense. In addition, since blacks had lower literacy rates than whites, the fact that distributing pamphlets about prenatal care did not lower black infant mortality is not surprising. According the 1920 census, the illiteracy rate for black females ages 10 and older was 22 percent compared to only 4 percent for white females (U.S. Census Bureau 1922, 1151). Overall, the results do not provide support for the idea that Sheppard-Towner resources were used to discriminate against blacks,

although the results do suggest that increases in broader categories of state spending (child life and health/sanitation) did not reduce non-white infant mortality rates. We can only speculate as to the mechanism underlying these differences, but one possible explanation is that blacks were much less likely than whites to have access to quality health care initially and thus reaped greater benefits when they finally met with physicians and nurses (Smith 1999; Almond et al 2001; Thomasson and Treber 2008).

Discussion

When the Sheppard-Towner act was repealed in 1929, the U.S. Children's Bureau strongly asserted that Sheppard-Towner was responsible for the decline in infant mortality during the 1920s. Between the inception of Sheppard-Towner in 1922 and its repeal in 1929, the overall infant mortality rate fell from 76.2 to 67.6 deaths per 1,000 live births. To get a sense of the magnitude of the total effect of Sheppard-Towner activities, we use the results of multi-measure regressions from Tables 2 and 3 to calculate counterfactual infant mortality rates by setting all Sheppard-Towner activity measures to zero. We calculate lower and upper bound estimates. Our lower bound estimates set the outlays on conservation of child life programs and health and sanitation to their sample means. We view these as lower bound estimates because they assume that Sheppard-Towner grants did not affect a state's expenditures on child health or other public health programs. In contrast, Moehling and Thomasson (2012) find that per capita expenditures on child life increased approximately one for one with the per capita level of the Sheppard-Towner grant a state received (pp. 95-96). Therefore, our upper-bound estimates of the impact of the Sheppard-Towner program on infant mortality reduce outlays on child life programs and health and sanitation by the sample mean of the Sheppard-Towner grant accepted.

Our estimates indicate that the overall mortality rate would have been between 0.7 and 1.9 deaths per 1000 births higher in the absence of any Sheppard-Towner activities, suggesting that Sheppard-Towner explains between 9 and 21 percent of the decline. This aggregate effect, however, is driven primarily by the experiences of non-whites. The white infant mortality rate would have been 0.15 to 1.0 deaths higher whereas the non-white rate would have been 9.9 to 13 deaths higher. While the non-white model is estimated with less precision so the error bounds around this prediction are much wider than that for whites, the large difference by race is striking. Blacks do not seem to have been excluded from these programs and in fact, benefited more than did whites.

Our findings suggest that the Children's Bureau was a bit too optimistic about the contribution of its programs to the decline in infant mortality. Much of the decline in infant mortality in this period seems to be best explained by a continuation of the trend that began at the turn of the century and was driven by improvements in nutrition, water supplies, and sanitation. Nonetheless, our results do show that a number of the activities in which states engaged using Sheppard-Towner funds reduced infant deaths. They also point to which activities generated the most impact, knowledge that policymakers could use to guide modern interventions targeted at reducing infant mortality. Specifically, interventions that were less personal and did not provide a means to follow up with women and children had little impact for both blacks and whites. Itinerant health conferences, where physicians and nurses gave lectures and examined children on a one-time basis and without means for follow-up care did not reduce infant deaths. On the other hand, health centers that provided women and children with an on-going source of care, and home visits from public health nurses did reduce infant mortality, particularly among blacks.

Providing educational literature that women could keep in their homes also reduced infant mortality, but not among black women who were less literate.

Further, our counterfactual calculations do not take into account any cumulative effect of the educational programs provided by Sheppard-Towner. The knowledge a woman gained from a home nurse visit after the birth of her first child likely improved the health of her subsequent children as well. Moreover, to the extent that mothers armed with new information passed this information onto their children, subsequent generations also benefited from Sheppard-Towner.

Unfortunately, we do not have good data on how much these specific interventions cost, so we cannot systematically calculate cost-benefit ratios. We can, however, make some speculative calculations based on the pieces of data that are available. For instance, Ohio paid its 5 public health nurses $9,000 each in 1927. Assuming that the state spent $45,000 annually on public health nursing, the 19,146 visits by public health nurses that year would have cost $2.35 per visit on average (Ohio Director of Finance 1927: 88). Our findings suggest that increasing nurse visits by one standard deviation (or 23 per 1,000 population) reduced infant mortality overall by 1.8 deaths per 1000 births. Given the population and fertility rate of Ohio in 1927, this would mean that an additional infant could be saved for about $1600 (about $20,400 in 2010 dollars).

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Table 1: Descriptive Statistics of State-level Variables Used in Regression Models, 1924-1929

Variable	Obs.	Mean	Std. Dev.	Min	Max
Infant mortality rate (per 1000 births)					
Overall	231	69.99	14.00	46.60	145.50
White	231	65.65	12.38	45.20	142.00
Non-white[a]	219	128.25	45.96	47.60	318.20
Sheppard-Towner activities (per 1000 in pop.)					
Home nurse visits	231	6.65	17.62	0.0000	138.85
Conditional on > 0	122	12.60	22.68	0.0190	138.85
Midwives enrolled in classes	231	0.15	0.59	0.0000	6.90
Conditional on > 0	57	0.60	1.08	0.0044	6.90
Health centers established	231	0.0050	0.0136	0.0000	0.1045
Conditional on > 0	127	0.0090	0.0174	0.0002	0.1045
Child health & prenatal conferences	231	0.37	0.81	0.0000	6.22
Conditional on > 0	200	0.42	0.85	0.0012	6.22
Prenatal letters distributed	231	1.94	21.74	0.0000	330.26
Conditional on > 0	85	5.28	35.72	0.0058	330.26
Expenditure data ($ per 1000 in population)					
Sheppard-Towner grant accepted	231	12.14	11.49	0.00	92.95
Conditional on > 0	206	13.62	11.31	0.76	92.95
Outlays on the conservation of child life	231	30.44	27.11	2.17	180.14
Outlays on health and sanitation	231	304.70	188.52	81.83	1092.49

[a] Data for non-whites excludes observations from New Hampshire and Vermont. The non-white populations in those states during the sample period were very small and for some years the non-white infant mortality rates are reported as zero.

Notes: Annual population estimates used to calculate per capita figures were constructed by linearly interpolating between the census years of 1920 and 1930.
Sources: Infant mortality rates are from Linder, Forrest E. and Robert D. Grove. (1947). *Vital Statistics Rates in the United States 1900-1940*. Washington: U.S. Government Printing Office, 1947.Sheppard-Towner activities and accepted grant amounts: U.S. Children's Bureau (1924-1928 and 1931); outlay data: U.S. Bureau of the Census (1925-1930).

Table 2: State-level Regression Models for Overall Infant Mortality Rates, 1924-1929

	Separate regressions by public health measure:		Combined regression:	
	Coefficients (1)	Elasticities (2)	Coefficients (3)	Elasticities (4)
Sheppard-Towner grant accepted	0.2377	0.0460		
	(0.2042)	(0.0393)		
Outlays on the cons. of child life	-0.0922	-0.0401	-0.0721	-0.0317
	(0.0483)	(0.0210)	(0.0295)	(0.0130)
Outlays on health and sanitation	-0.0206	-0.0896	-0.0212	-0.0934
	(0.0084)	(0.0364)	(0.0121)	(0.0531)
Home nurse visits	-0.0793	-0.0144	-0.0813	-0.0148
	(0.0111)	(0.0020)	(0.0192)	(0.0035)
Midwives enrolled in classes	0.3983	0.0034	0.3764	0.0033
	(0.7974)	(0.0068)	(0.9695)	(0.0084)
Health centers established	-129.5825	-0.0168	-113.0442	-0.0147
	(41.5531)	(0.0054)	(45.0550)	(0.0059)
Child health & prenatal conferences	-0.8724	-0.0052	0.8729	0.0053
	(2.1105)	(0.0127)	(0.8626)	(0.0052)
Prenatal letters distributed	-0.0059	-0.0004	-0.0058	-0.0004
	(0.0031)	(0.0002)	(0.0032)	(0.0002)
Number of states	46		46	
Number of state-year observations	231		231	

Notes: Standard errors in parentheses. Dependent variable for all models is the overall infant mortality rate. Independent variables are all scaled to be per 1000 persons in the population. All models include state fixed effects, state-specific linear time trends, and year fixed effects. Elasticities are calculated at the means of the independent variables conditioned on being non-zero values. Standard errors calculated to allow for clustering by state.

Table 3: State-level Regression Models for Infant Mortality Rates by Race, 1924-1929

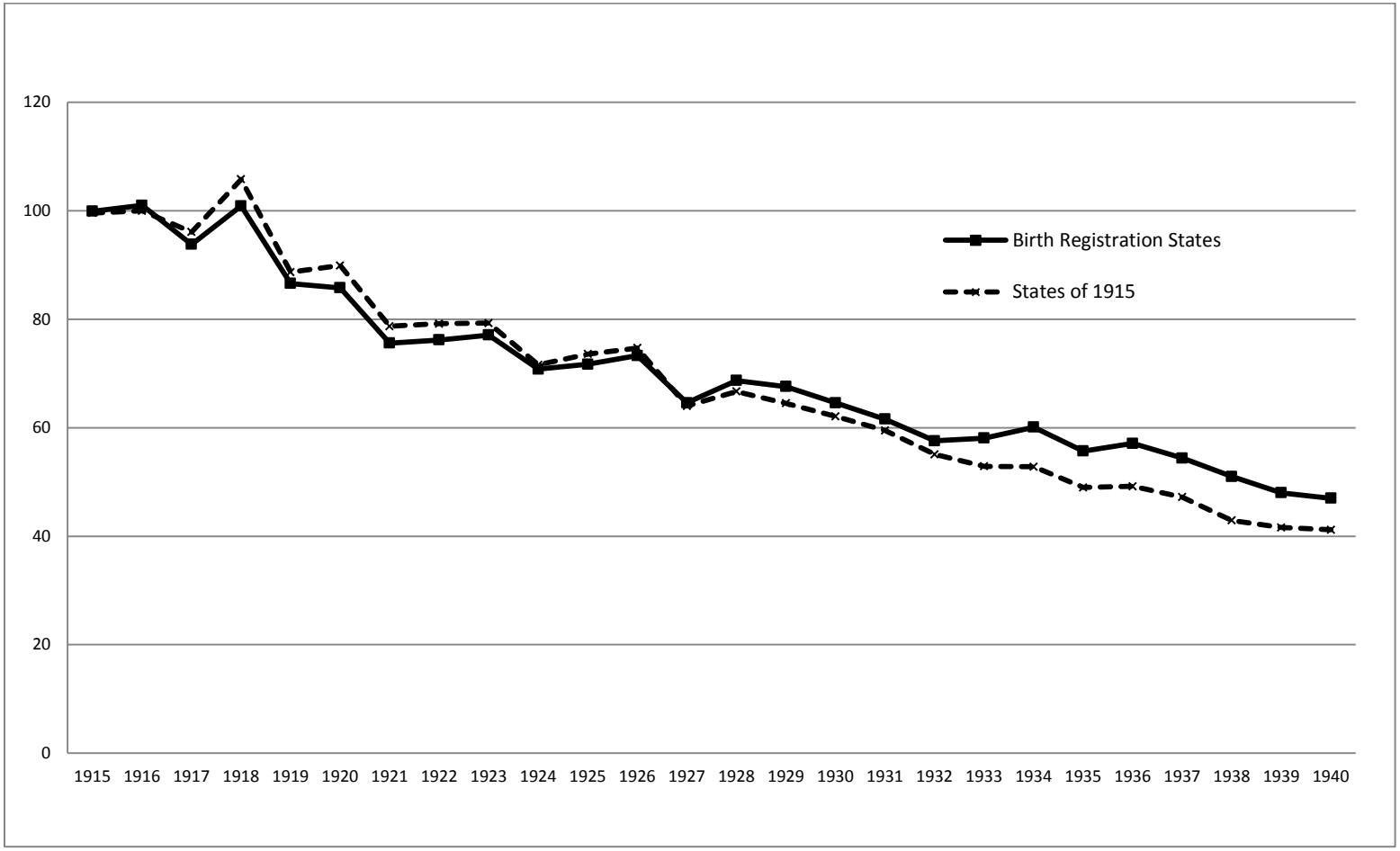
	Separate regressions by public health measure		Combined regression	
	Coefficients (1)	Elasticities (2)	Coefficients (3)	Elasticities (4)
Panel A: Whites				
Sheppard-Towner grant accepted	0.1487	0.0307		
	(0.1848)	(0.0381)		
Outlays on the cons. of child life	-0.0539	-0.0250	-0.0472	-0.0221
	(0.0317)	(0.0147)	(0.0190)	(0.0089)
Outlays on health and sanitation	-0.0202	-0.0936	-0.0203	-0.0953
	(0.0077)	(0.0357)	(0.0108)	(0.0507)
Home nurse visits	-0.0535	-0.0103	-0.0758	-0.0147
	(0.0117)	(0.0023)	(0.0189)	(0.0037)
Midwives enrolled in classes	0.2915	0.0027	0.2080	0.0019
	(0.9917)	(0.0090)	(1.1177)	(0.0103)
Health centers established	-106.3994	-0.0147	-91.2937	-0.0126
	(54.6157)	(0.0076)	(60.1847)	(0.0084)
Child health & prenatal conferences	0.6372	0.0041	2.1352	0.0138
	(1.5350)	(0.0098)	(0.8013)	(0.0052)
Prenatal letters distributed	-0.0072	-0.0006	-0.0064	-0.0005
	(0.0028)	(0.0002)	(0.0031)	(0.0003)
Number of states	46		46	
Number of state-year observations	231		231	

Table 3: ***Continued***

	Separate regressions by public health measure		Combined regression	
	Coefficients (1)	Elasticities (2)	Coefficients (3)	Elasticities (4)
Panel B: Non-whites				
Sheppard-Towner grant accepted	2.8709	0.2922		
	(0.9547)	(0.0932)		
Outlays on the cons. of child life	-0.5083	-0.1210	-0.2805	-0.0726
	(0.4025)	(0.0962)	(0.4352)	(0.1100)
Outlays on health and sanitation	0.0225	0.0533	0.0263	0.0682
	(0.0907)	(0.2143)	(0.0868)	(0.2260)
Home nurse visits	-0.3820	-0.0382	-0.2250	-0.0241
	(0.2317)	(0.0236)	(0.2719)	(0.0304)
Midwives enrolled in classes	0.9505	0.0044	1.2003	0.0061
	(2.3294)	(0.0108)	(2.0373)	(0.0104)
Health centers established	-481.6074	-0.0343	-469.8142	-0.0359
	(239.2452)	(0.0173)	(270.7977)	(0.0216)
Child health & prenatal conferences	-13.0057	-0.0428	-8.3336	-0.0297
	(8.8946)	(0.0294)	(6.0999)	(0.0227)
Prenatal letters distributed	-1.1595	-0.0499	-1.6296	-0.0731
	(1.8158)	(0.0816)	(1.6960)	(0.0816)
Number of states	44		44	
Number of state-year observations	219		219	

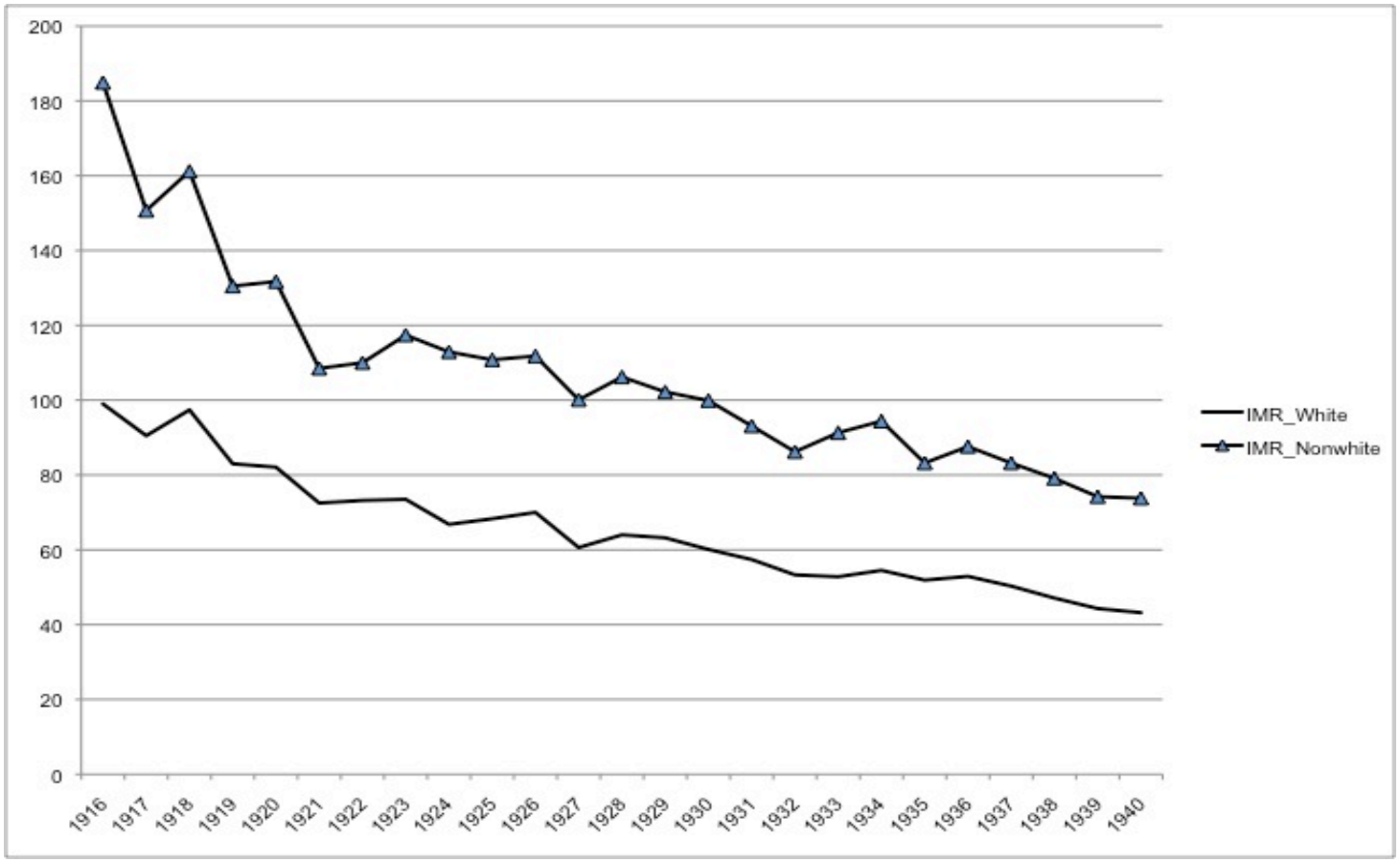
Notes: Standard errors in parentheses. Independent variables are all scaled to be per 1000 persons in the population. All models include state fixed effects, state-specific linear time trends, and year fixed effects. Elasticities are calculated at the means of the independent variables conditioned on being non-zero values. Standard errors calculated to allow for clustering by state.

Figure 1: Infant Mortality in the Birth Registration States and for the Registration States of 1915, 1915 -1940



Notes: Data are from Linder and Grove (1947). The chart shows the overall infant mortality rate (deaths of children one year of age per 1,000 live births).

Figure 2: White and Nonwhite Infant Mortality: 1916-1940



Notes: Data are from Linder and Grove (1947). The chart shows the overall infant mortality rate calculated as deaths of children under 1 year of age per 1,000 live births.