The Trials of Job: The Impact of Climate and Weather on Infant and Non-Infant Death Rates During the Great Depression

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Global warming has become a watchword for environmental policy over the past three decades. Daily temperature highs were thought to have reached the highest levels in recorded history within the past decade. Each month there are reports of new studies of melting glaciers, thinning of ice caps on mountains, and warming in various areas throughout the world. Al Gore shared an Academy Award for his association with the "An Inconvenient Truth," a film warning of global warming and its potential dire consequences. He then shared a Nobel Peace Prize with a group of scientists warning of the dangers of Global warming. Much of the force of Al Gore's warnings about global warming comes from his predictions about the impact of warming on human populations and the economy. Yet, the large volume of studies of climate change has not been matched by studies of the impact of climate and weather on populations and economies, or how populations and economies will respond. If the claims that global temperatures will warm over the next few decades no matter what policy steps we take today, such studies are invaluable.

Here is a situation where history can serve as a guide to the impact of climate and sharp deviations in weather from the norm on populations. A recent World Health Organization (2004) survey article suggests that Leonard Rogers (1923, 1925, 1926) was the first to try to forecast the likelihood of epidemics using climate variables. "Based on his conclusions, it was recommended that climatic variables be used for forecasting epidemics of TB, smallpox, and pneumonia and for mapping worldwide incidence of leprosy. However, such systems were never implemented on a wide scale (WHO, 2004, 12)."

In this paper, we do not focus on specific diseases. Instead, we measure the impact of climate on infant mortality and non-infant mortality in United States counties throughout the Great Depression. We have developed a data base that combines information on mortality rates, daily high temperatures and inches of precipitation, and a rich set of socio-economic correlates for over 3,000 counties in the United States for each year between 1930 and 1940. We focus on infant mortality because the infant mortality has long been seen as key non-income measure of standards of living, the death of an infant is an extra-ordinarily painful event, and infants are likely the most sensitive of populations to variations in conditions. We also examine the non-infant death rate to see if the patterns seen for infant deaths carry over to death rates for people in all age groups.

A focus on the Great Depression has several advantages. First, it is arguably one of the hottest decades in the 130 years in which the time-of-day adjusted temperature records have been readily available throughout the United States.[1] Second, the Great Depression was a period of great economic vulnerability. Unemployment rates were higher than 9 percent in every year between 1930 and 1940, over 14 percent in nine of those years, and exceeded 20 percent in the four years from 1932 through 1935. Annual real GDP in America was roughly 30 percent below its 1929 peak by 1932 and 1933. Based on the distribution of personal income across the states at the time, it was if the entire economy west of the Mississippi River had stopped producing goods and services. We might expect that the influence of climate on infant deaths would be greater during hard times. Third, the Great Depression was like the Trials of Job in terms of

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[1] Steve McIntyre of www.climateaudit.org discovered an anomaly in the temperature data circa 1999-2000 that caused NASA to readjust its temperature rankings. In the United States 1934 ranks slightly above 1998 as the hottest year on record. The years 1931, 1938 and 1939 also rank in the top 10. See http://www.climateaudit.org/?p=1880 and http://data.giss.nasa.gov/gistemp/graphs/Fig.D.txt.

Weather events. Large parts of the country were hit by droughts in several years, dust storms swept through the western plains on several occasions, and several areas experienced major floods that led to some of the largest relief efforts by the Red Cross in the first half of the twentieth century. Finally, the decade of the 1930s offers better data than earlier decades. It is the first decade when infant mortality data were collected on a consistent basis for all states, and the amount of interpolation in the weather station data is reduced a great deal after 1931.

In discussing the effect of weather and climate on death rates, it is important to note that definitions of weather and climate, particularly the division between the two, are somewhat fluid. Climate is often defined by long term weather patterns, while some people define weather as short-term deviations from those patterns. A shift in climate occurs when deviant weather patterns last for an extended period of time. In our analysis we will use the term climate to describe situations where the analysis uses both cross-sectional and time series variation as the source of identification of the relationship between temperature and precipitation and mortality. We will use the term weather fluctuations when we use differencing to control for time-invariant features of the counties, and thus the source of identification is variation across time in the same county.

The Influences of Climate/Weather on Mortality

Do differences in daily high temperatures and precipitation influence infant mortality rates without controlling for other factors? The influences are likely to come in several ways. Higher heat in the absence of air conditioning during the 1930s would have been expected to create greater likelihood of death from heat stroke. Extreme cold potentially would also put pressure on health, although heating technology in the 1930s was likely effective enough to offset the extremes. However, cold weather might create problems for mortality to the extent that people spend more time indoors and there is greater possibility of transmission of disease from the sick to infants.

Temperature and precipitation also have been shown to influence a number of diseases, particularly those borne by mosquitoes and other insects. Surveys of studies of climates and diseases show that malaria outbreaks occur following periods of increased rain and temperatures due to effects on insect vector breeding, development rates, Meningococcal meningitis is an air-borne bacterial disease which shows a highly seasonal pattern during the hot dry season and declines in the rainy season in sub-Saharan Africa. Dengue fever is associated with high rainfall and elevated temperatures, as are yellow fever and Rift Valley fever. Ross River virus is associated with excess summer and winter rainfall. The changes in viral antigenic proteins associated with influenza are related to seasonal fluctuation in temperature. Noncholera diarrhea hits hardest with rising temperatures in hotter seasons. Thus far, few studies have explicitly linked the childhood diseases of measles, pertussis and poliomyelitis with climate. However, there is evidence that colder temperatures and weather that forces people to remain indoors is associated with greater spread of these diseases (WHO, 2004).

We estimate the relationships between climate/weather and death rates using a series of Ordinary Least Squares (OLS) regressions with White-corrected robust standard errors clustered at the state level. The regressions take the basic form:

$$DR_{it} = \beta_0 + \beta_1 W_{it} + \beta_2 X_{it} + \varepsilon_{it} ,$$

Where DR is the death rate in county i in year t. We estimate separate regressions for infant mortality rates, the number of infant deaths per 1000 live births, and for the non-infant death rate, the number of deaths of people over the age of one per 1000 people. W_{it} is a vector of climate/weather variables in county i in year t. We use several different measures of weather that either focus on annual averages and totals or averages and totals for each month throughout the year. The X_{it} vector refers to a wide range of correlates that include demographic, economic, New Deal spending, and geographic variables describing county i in year t. Appendix Table 1 contains a list of the correlates.

The data set for estimation is annual data for 3054 counties (or groupings of counties designed to match up with New Deal spending information) each year for the years 1930 through 1940. The data on daily high temperatures and precipitation are aggregated from information originally collected by the United States Historical Climatology Network from 1062 observation stations between 1871 and 2005. To match the weather stations to counties, we used a subset of 362 weather stations that were operational by 1930 and had complete daily weather data between 1930 and 1960. We used the daily weather between 1940 through 1960 as a "baseline" to compare the weather during the 1930s due to a lack of operational stations prior to 1930. To measure the daily weather at each county seat, we used the Haversine formula to convert information on latitude and longitude from two locations to measure the distances between weather stations and county seats. The daily weather at the nearest weather station was used as a proxy for the weather at the county seat.

The information on the Palmer Drought Severity Index came from the National Climatic Data Center (NCDR) and was accessed from ftp://ftp.ncdc.noaa.gov/pub/data/cirs/ (August 2003). The NCDR reports historical monthly data by climate division within each state, so each county's climate information pertains to its respective climate division. In some cases a county was located within two or three divisions. In these cases, the county's climate information was calculated as the average across the climate divisions in which it was located.

The information on infant deaths, non-infant deaths, and births used to construct death rates and are from annual volumes of *Birth, Stillbirth and Infant Mortality Statistics for the Continental United States* and *Mortality Statistics* (U.S. Bureau of Census, various years). The sources for the correlates are in the Data Appendix.

We start with an analysis of the role of climate/weather on infant mortality that takes into account both cross-sectional and time-series variation. Below we discuss the impact of weather changes when we incorporate geographic fixed effects to control for long term climate. The initial analysis starts with an OLS regression of infant mortality as a simple linear function of annual average high temperature and annual precipitation. Table 1 shows a series of OLS regressions with and without correlates. In the sparest specification (1) the number of infant deaths rises by a statistically significant 0.72 per 1000 live births with an increase of 1 degree Fahrenheit in annual average temperature. Meanwhile, greater precipitation has a small and imprecisely estimated negative effect on infant mortality of -0.12 deaths per life birth for a one inch increase in annual precipitation.

The most interesting feature of Table 1 is what happens to the impact of temperature as correlates are added to the analysis. The sizeable effect of temperature on infant mortality largely goes away when we add one correlate to the analysis, the percentage illiterate. Just the addition, of that one variable cuts the effect of high temperature from 0.72 in specification 1 to a statistically insignificant 0.095 in specification 2. Meanwhile, the percent illiterate in the population has a strong and statistically significant impact of raising the infant mortality rate by two deaths per thousand for a one percent increase. The combination of the strong effect of illiteracy and the drop in the temperature coefficient is consistent with a view that literate, wellinformed people were better able to cope with higher temperatures in ways that limited their effect on infant mortality.

The importance of knowledge is reinforced by the addition of two more measures of access to information to the analysis, the share of households with radios and the per capita circulation of 15 news magazines in 1929. When both are added to the analysis, the coefficient of temperature falls from 0.09 in specification 2 to -0.06 in specification 3.. While the presence of the radio is associated with reductions in infant mortality, the impact of the magazine circulation variable is unexpectedly positive. However, there appears to be a positive omitted variable bias to this coefficient, because when a full set of income, demographic, and geographic correlates is added to the analysis, the coefficient has the expected negative effect.

It is dicey to argue for the importance of a small number of variables by adding them to the analysis without the other correlates because of cross-correlations between correlates. In this case, however, the importance of the information variables stands out when all of the other correlates are included. Specification 4 of Table 1 shows the climate coefficients when all of the correlates except for the information variables are included in the analysis. The inclusion of the other correlates as a group cuts the impact of the average high temperature in half from 0.72 to 0.427. When the information variables are added to the rest of the correlates in specification 5, the temperature coefficient is cut dramatically from 0.427 to -0.183. In this specification the coefficients of the information variables are all statistically significant with the expected signs: infant mortality is positively related with illiteracy, less access to radios, and less readership of magazines.

There are a huge number of potential specifications for the temperature and precipitation variables that could be tried. We explored a number of higher-order polynomial specifications with squared, and cubed terms. However, there is relatively little gain to this with the annual average data primarily because average annual temperatures only ranged from 47 degrees to 91 degrees Fahrenheit in the sample. Given the small range and the relative inflexibility of the polynomials, other approaches are preferred.

We estimated a model with a relatively flexible formulation for temperature by using the share of days of the year that the daily high temperature was in different temperature bands. Table 2 shows the relationships between infant mortality and climate with and without the information variables and the remaining correlates. Since the shares of the temperature bands sum to one, we excluded a reference temperature band for days with daily highs at or above 50 degrees and below 60 degrees. The simplest specification is somewhat surprising. We anticipated that more days above 100 degrees would lead to higher infant mortality. The coefficient was positive 2.4 but the effect was not statistically significant. Relative to the 50-60 range, higher infant mortality was associated with a higher share of days with temperatures in the 70s and less than zero. Greater precipitation was also associated with lower infant mortality.

The effects of climate/weather are transformed once again when we include additional correlates, but the story is not as simple as the one told above. The inclusion of all but the information variables in specification 4 in Table 2 leads to a sharp rise in the effect of shares of days over 100 degrees from 2.4 to 38.7, such that a one percent increase in the share raises the infant mortality rate by 0.387, but the effect is statistically insignificant. Many of the effects in in the spare specification 1 are weakened sharply. Adding the information variables in specification 5 cuts the impact of days over 100 degrees roughly in half to 23.9, while leading to a statistically significant effect of the share of days with temperatures in the 40s. In general, most of the temperature bands do not have much effect on infant mortality rates.

A focus on annual information on temperature and precipitation likely misses the importance of the timing of temperature and precipitation fluctuations during the year. A number of diseases, particularly those associated with infections borne by mosquitoes and bacteria display seasonal patterns and are affected by temperature and rainfall. Malaria and encephalitis outbreaks have occurred following periods of increased rain and temperature. On the other hand meningococcal meningitis, an airborne bacterial disease in sub-Saharan Africa rises during the hot and dry season. Weather also influences human behavior in ways that can increase the transfer of diseases. Wet and cold weather often pushes people indoors and the close contact may lead to greater spread of influenza and infections (WHO, 2004, 51-55).

To try to capture some of these relationships, the infant mortality regressions are estimated using information on average high temperatures and precipitation in each month of the year. We still use the infant mortality rate for the entire year as the dependent variable to take into account the fact that climate/weather conditions during one part of the year might lead to growth in bacteria or the development of insect vectors that could lead to infection and death at other times in the same year. Table 3 shows the results of the regression.

In the simplest specification (1) higher temperatures are associated with statistically significantly higher infant mortality in November (0.53), June (0.32), February (.305), March (0.15) and January (0.11), and statistically significantly lower infant mortality in October (-0.75). Here again, the inclusion of the three information variables mute the effects of temperature on infant mortality, as all of the positive monthly temperature coefficients decline in value with their inclusion. After adding the information variables to specification 1 to obtain specification 3, the November coefficient is nearly cut in half (0.53 to 0.28), the February cut by more than three-fourths (0.30 to 0.07), and the January coefficient by 80 percent (0109 to 0.016). A similar effect is found when moving from specification 4 with all correlates except the information variables to specification 5 with all correlates. The February coefficient falls from 0.252 to -0.008, and the November coefficient falls from 0.44 to 0.127.

The one temperature effect that does not fall sharply with the inclusion of the information variables as well as the inclusion of the remaining correlates is the June coefficient. Throughout the specifications in Table 3, the June coefficient remains statistically significant at the 10 percent level and greater than 0.254. At this stage we are uncertain why the June temperature has this effect. June is often one of the hottest months of the year. During a period when air conditioning was not available, temperature increases in June may have put more pressure on the health of mothers in the later stages of pregnancy or recently born infants. We do not think that this is a result of improved breeding conditions for mosquitoes because the optimal mosquito breeding temperature is roughly 77 to 81 degrees Fahrenheit and the rise in temperatures in June would typically be pushing temperatures higher than that range.

The precipitation effect on infant mortality was negative but imprecisely estimated in Table 1 and more strongly negative and statistically significant in Table 2. The results in the simplest precipitation by month specification in Table 3 suggest that precipitation has a negative and statistically significant effect on infant mortality in February, April, May, June, and December, while an extra inch of July precipitation raised infant mortality by 0.47 deaths per thousand live births. The inclusion of the information variables sharply reduces the July impact on infant mortality rates, just as it reduced the impact on temperatures. When all correlates are included in specification five, the February, April, May, and December precipitation coefficients remain negative and statistically significant and there are no positive and statistically insignificant coefficients.

We are uncertain why greater precipitation has this negative effect on infant mortality in these months. Modern WHO summaries of the relationship between climate and major diseases suggest that mosquito-borne diseases, like malaria, tend to thrive on rainfall and standing water, which aid in mosquito breeding. On the other hand, heavy rainfall can reduce mosquito populations by flooding areas where the insects lay their eggs (WHO, 2004, 10). There are diseases, like St. Louis encephalitis, which was first identified in 1933, that are associated with hot, dry weather.

Infant Mortality and Annual Fluctuations in Temperature and Precipitation

The prior section focused on the impact on infant mortality of the notion of climate-weather because so much of the variation in the analysis was cross-sectional across counties. In this section we perform difference-in- difference analysis that controls for time-invariant features of each county and for common shocks to infant mortality throughout the country that occurred in specific years. The equation estimated takes the following form.

$$DR_{it} – DR_{it-1} = \alpha_0 + \alpha_1 (W_{it} - W_{it-1}) + \alpha_2 (X_{it} – X_{it-1}) + \alpha t + \varepsilon_{it} – \varepsilon_{it-1},$$

Where ($DR_{it} – DR_{it-1}$) is the change in the mortality rate (infant or non-infant) infant mortality from the previous year, ($W_{it} - W_{it-1}$) is a vector of changes in weather from the previous year, ($X_{it} – X_{it-1}$) is a vector of changes in other correlates from year to year, t is a vector of year dummies, and ($\varepsilon_{it} – \varepsilon_{it-1}$) is the change in unobservable factors that vary across time.

By estimating the relationship between the change in infant mortality and the change in weather, the analysis controls for factors that vary across counties but did not change over time. To the extent that the climate in the area is considered time-invariant, the analysis controls for the climate, and the vector of α_1 coefficients captures the relationship between changes from year to year in the weather and changes in infant mortality. An alternative description is that the analysis captures the effects of deviations in weather from the long run climate on infant mortality. The differencing also controls for time-invariant features of the geography. The inclusion of a vector of year dummies controls for factors like the introduction of sulfa-drugs in 1936 and 1937 that would have affected all of the counties simultaneously (Thomasson and Treber 2008).

A number of the variables that we included as controls in the prior section were based on census information reported only in 1930 and 1940. As seen in the data descriptions in Appendix Table 1, we used straight-line interpolations between the census years to fill in values for these variables in the intervening years. So the values in the prior section were basically trend values for those variables. Because the change in these variables would be the same in each year, we do not include them in the differencing specification. The variables that we do include in the ($X_{it} - X_{it-1}$) correlates vector either vary from year to year (share of tax returns, hospital beds per capita, measures of bovine tuberculosis, the general fertility rate (births/interpolated value for share of women aged 15-44)) or we could use changes in state measures to interpolate between various years throughout the period (retail sales per capita, auto registrations per capita, crop values per farm population, the new deal program measures.)

Table 4 shows the results of the difference analysis using the simplest form of the changes in average annual high temperatures and changes in annual inches of precipitation as well as the averages across each of the months of the year. The simple specifications of annual averages in specifications 1 and 2 suggest that weather fluctuations had little or no effect on infant mortality rates. The coefficients on both precipitation and average daily highs are small and statistically insignificant in specifications both with and without the extra correlates.

When the analysis moves to month by month weather information, some weather influences do appear when no correlates are included in specification 3. Changes in infant mortality rates are higher in areas where the average maximum temperature rose from the previous April and August, and where precipitation rose from the previous year in August and September. Infant mortality rates fell more in areas where there was more precipitation in February. After controlling for the correlates in specification four, there still was a rise in infant mortality when temperature rose from the previous August. Increased rainfall in July, August, and September was associated with a rise in infant mortality. Year-to-year increases in rainfall in January and February was associated with a statistically significant reduction in infant mortality.

The analysis in Table 4 also includes information on the coefficients of the other time-varying correlates in the analysis. A number of the relationships with infant mortality have been seen in other studies of death rates, in some cases including infant mortality rates. A number of studies show a positive relationship between death rates and the number of hospital beds in an area. There are several potential reasons for this effect. One is that the data on deaths report the location of the death not the residence of the deceased. Areas with more hospital beds tend to report more deaths because people with potentially fatal illnesses from areas without hospitals often came to areas with hospitals to receive treatment. A second possibility is that there was endogeneity bias because areas with higher death rates were more likely to add more hospital beds per capita. Since increased numbers of hospital beds involved capital expenditures, this effect may have been weakened to the extent that the addition of hospital beds lagged a rise in the death rate by a year or two. This still would not resolve the problem if there were serial correlation in the death rates.[2]

The measure of economic activity, retail sales per capita, displays a positive relationship with infant mortality rates during the 1930s. It has long been thought that improved incomes would reduce infant mortality rates. However, Fishback, Haines, and Kantor (2007) found a similar positive relationship between economic activity and several types of death rates in their fixed effects estimates using a panel of annual data for 114 cities between 1929 and 1940. Christopher Ruhm (2000) also found similar procyclical effects for various death rates in fixed effects analyses in the 1970s, 1980s, and 1990s.

There is some evidence that increased automobile ownership was associated with infant mortality, although the effect is imprecisely estimated. This could be another example of the procyclical effect because higher income people tended to own more automobiles. It may also have been an effect of the introduction of more pollutants in the air. {Paul discussion of gasolines as the time and the debates. This would be consistent with findings that increased particulates in the air contributed to greater infant mortality in cities in the modern era (Greenstone and Chay 2003).

Similarly, there is weak evidence that greater problems with bovine tuberculosis (BTB) was associated with greater infant mortality. Paul Rhode and Alan Olmstead (2008) have

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[2] In a separate unreported analysis that the positive relationship between hospital beds and infant mortality was essentially eliminated in the years after 1936 when the use of sulfa drugs had spread throughout the nation. Thomasson and 8(2007) found that the number of deaths of mothers during child birth had been slightly negatively related to the number of hospital beds for most of the period from 1920 through 1936. They found evidence that there was a greater likelihood of sepsis infections in hospitals than outside hospitals. Doctors could do little about the infections into the introduction of sulfa drugs throughout the country around 1937. However, once the drugs were available, there was a more negative correlation between access to hospitals and maternal mortality.

reported that large numbers of children and infants were killed by the transmission of the disease into the milk supply from diseased dairy cattle in the late 1800s and early 1900s. An extensive BTB eradication program between 1900 and 1930 had greatly diminished the problem but not fully eliminated it. BTB was much less widespread in the 1930s and may have been less virulent. The positive coefficient suggests still some effects, but the coefficient is not statistically significant.

Areas with higher general fertility rates were associated with lower infant mortality rates. We have also measures spending and loan activity from a series of major New Deal programs. None of the programs appear to have strong reductive effects on infant mortality. There is the potential of endogeneity bias that might have weakened the effectiveness of the programs. When Fishback, Haines, and Kantor (2007) controlled for endogeneity bias in their study of major cities in the 1930s, they found evidence that greater relief spending helped reduce infant mortality rates.

Climate, Weather, and Death Rates for the Rest of the Population

The relationships between climate/weather and mortality rates for the rest of the population above the age of one are similar to what we see for infant mortality rates. As in the case of infant mortality, greater literacy and more access to radios and magazines are associated with lower death rates. Further, when we add the information variables to specifications that include all correlates except the information variables the effects of climate/weather are reduced. A feature that is different from the infant mortality pattern, however, is that adding the information variables to a specification that includes only climate/weather variables does not change the relationship between infant mortality and climate.

Tables 5, 6, and 7 document these patterns. In Table 5 the climate/weather patterns are measured with the average high temperature for the year and the total inches of precipitation during the year. The simplest relationships in specification 1 shows that higher infant mortality is associated with lower average temperatures and more precipitation. The addition of the information variables to the simplest specification, moving from specification 1 to those in columns 2 and 3, have little impact on the relationship between climate/weather and non-infant mortality. When we add all of the correlates except the information variables in specification 4, the relationship between non-infant mortality and the average daily high temperature switches signs from negative to positive. Further, the positive relationship with precipitation is cut dramatically from a statistically significant 0.03 in column one to 0.006 in column 4. The addition of the information variables to specification 4 to create specification 5 causes the temperature coefficient to switch signs again to a negative and statistically significant -0.033. Meanwhile, the precipitation coefficient turns negative but at with an even smaller magnitude than in specification 4. The importance of information is highlighted by the statistically significant positive relationship of non-infant mortality with the percent illiterate and the negative coefficients on radio ownership and magazine circulation.

When climate/weather is measured with the share of days in each temperature band in the Table 6 regressions, the same pattern still arises. When no correlates aside from climate are included in the analysis in specification one in Table 6, non-infant mortality is higher with greater precipitation. The temperature comparisons are relative to the share of days when the high temperature is in the 50s. Non-infant mortality is statistically significantly higher when there were relatively more days with high temperatures exceeding 100 degrees, in the 70s, in the

30s, and below minus 10 degrees. It was lower when there were more days in between 0 and 10 degrees and between -10 and 0 degrees.

When we add all correlates except the information variables in specification 4, the precipitation coefficient is cut by three-fourths, while the only statistically significant temperature band coefficients are at the extremes. Temperatures over 100 degrees and under minus 10 are associated with higher death rates, while temperatures in the 0 to 10 ranges were associated with lower death rates. When the information correlates are added in specification 5 in Table 6, the coefficient of the over 100 temperature band is cut nearly in half and the coefficient at the other extreme is cut by about 15 percent.

As was the case with infant mortality, the temperatures and precipitation in some parts of the year are more important than in other parts of the year.   The simplest specification in column 1 Table 7 shows that non-infant mortality rises statistically significantly with higher average daily high temperatures in February, May and November, and lower average temperatures in April and October.   The key precipitation months associated with higher death rates are January, September and October, while greater February precipitation lowers death rates.   The addition of all correlates except the information variables in specification 4 of Table 7 shows the same pattern for monthly temperatures although somewhat muted. There are changes in the precipitation patterns, such that higher mortality is statistically significantly and positively associated with more precipitation in March, July, September, and October and negatively associated with more precipitation in February, April, May, June, and November.   Here again, addition of the information variables in specification 5 sharply mutes the some of the effects, cutting the effect of February high temperatures from 0.02 to 0.004 and the effect of November highs from 0.04 to 0.02.   The positive monthly precipitation effects are also muted by the inclusion of the variables, as the March coefficient is cut from 0.033 to 0.018, September is cut from 0.035 to 0.026 and October is cut from 0.039 to 0.020. The only precipitation coefficients that remain statistically significant are the negative ones for June and November and the positive ones for July and September.

In Table 8 we focus on weather fluctuations by using differencing to control for long run climate and other time-invariant factors. We also incorporate time fixed effects to control for nation-wide shocks. As was the case with infant mortality, fluctuations in the annual average high temperature and precipitation had small and statistically insignificant effects on changes in non-infant mortality with and without other time-varying covariates. Time of year makes a difference. Increases in temperature from the previous year in July, August, and November are associated with a rise in non-infant mortality, while increases in temperature from the previous year in March reduce non-infant mortality. Annual non-infant death rates fell in response to increased precipitation from the prior year in January and February and rose in response to increased precipitation in July, September, and October.

The examination of the remaining correlates in Table 8 shows that annual non-infant death rates also rose with increases in the number of hospital beds, the general fertility rate, a higher share of the population with enough income to pay federal income taxes, and in areas where the New Deal spent more per capita on relief programs and the farm programs, both loans and AAA grants. Death rates were lower in areas where more was spent on loans from the Disaster Loan Corporation.

Droughts, Excessive Wetness, and the Dust Bowl

The effects of differences in long-term climate and weather fluctuations on mortality seem to have been sharply muted by the influence of literacy and access to information. Current fears of global warming extend beyond just the day to day features of climates. There are also discussions that global warming might contribute to an increase in disastrous events, like long-term droughts, hurricanes, dust storms, and floods. The reverse Palmer Drought Severity Indexes mapped in Figures 3a through 3k show that various parts of the United States experienced major droughts during the 1930s and some experienced periods of extreme wetness. Meanwhile, the disasters associated with the Dust Bowl in Oklahoma, Kansas, and the West Texas Panhandle in the mid-1930s have been documented widely in numerous books, articles and both the book and film versions of *The Grapes of Wrath*. The dust in the air was so thick during some of the storms that someone in Topeka, Kansas reported seeing "prairie dogs…digging holes sixty feet up in the air (New York Times, February 7, 1933). Figures 4a through 4d show the areas that were hit hardest in specific years during the 1930s from information culled from work by Geoff Cunfer (2005) and by Zeynep Hansen and Gary Libecap (2003).

To capture the impact of these factors we have re-estimated the regressions while adding information on the Dust Bowl and the number of months of extreme wetness and extreme dryness based on the Palmer Drought Severity Index (PDSI). The PDSI measures wetness and dryness relative to long-term patterns in the same area over time. Table 9 shows the results for infant mortality rates and Table 10 shows the results for non-infant mortality rates.

Infant mortality rates show no sign of being raised by the Dust Bowl in any statistically significant way. The only two Dust Bowl coefficients that are positive are in the level specifications (3 and 4) with all correlates included. In specification 3 in Table 9 with annual information on climate, the coefficient implies that the presence of the Dust Bowl raised infant mortality by 1.9 deaths per thousand. However, when we allow the climate variables to vary from month to month in specification 4, the Dust Bowl effect falls to 0.38. Neither effect is statistically significant. When we move to the differencing specifications with year fixed effects, the Dust Bowl effect goes away. The results are actually consistent with some recent findings in a paper by David Cutler and Grant Miller (2007). They studied the long range effects of the Dust Bowl by seeing how people who were born in the years and location associated with the Dust Bowl fared as adults. They found few ill effects. The results here suggest that the reasons for the absence of the ill effects may have been due to an absence of an effect of the Dust Bowl on the health of infants during that period. If the dust blowing through did not linger in the air for much longer after the storm, then they may have led to no strong influences on the health of pregnant mothers and/or their children.

The pattern for adult mortality is similar in Table 10. Again, the only two Dust Bowl coefficients that are positive are in the level specifications (3 and 4) with all correlates. Neither is statistically significant. When we allow for monthly variations in climate variables, the Dust Bowl effects is cut nearly to zero.

We plan further work on the Dust Bowl issue because we are not satisfied with our measures of the Dust Bowl. Hansen and Libecap (2003) did not design their measures to capture year to year variation in the Dust Bowl, and Cunfer (2005) does not provide estimates for the period prior to 1935. So far we have used rough estimates of where we think the Dust Bowl hit in 1933 and 1934, but we are reading newspapers and other sources to see if we can pinpoint those locations more precisely. In our explorations of robustness tests for the Dust Bowl effect to date, we have tried different definitions, different time periods, and also limited the sample to states in the immediate area. In all cases we continue to find very small effects of the Dust Bowl so far.

The estimates in Table 9 for infant mortality also show no sign that periods of extreme drought were associated with higher infant mortality. In fact, the coefficients are negative with one exception. This may not be as surprising as one might think. Most mosquitoe-borne diseases are more common in wet conditions where there is standing water. Among those diseases, only St. Louis encephalitis, seems to gain from having a dry summer, although it requires a wet January and February. In fact, periods of extreme wetness appear to be associated with higher infant mortality. In the simplest regression with just months of extreme wetness and extreme dryness, specification 1 in Table 9, an additional month of extreme wetness increases the infant mortality rate by 3 deaths per thousand. This effect is cut sharply when the other correlates are added to the level regressions in specification 3. It reverses sign but is not statistically significant then we move to the difference specification 6. .

Allowing for monthly variation shows that the timing of drought or extreme wetness may be important. In both the levels and the difference regressions infant mortality is raised by extreme wetness in February, and lowered by extreme wetness in May. To some extent this fits patterns seen in studies of mosquito-born diseases. Excessive wetness in February may lead to more standing pools of water later in the year. Meanwhile, there is evidence that flooding associated with extreme wetness may lead to destruction of nests during the late spring.

In the levels regressions with all correlates infant mortality tends to be higher when there are drought conditions in August and November, and lower with droughts in April. The situation is quite different in the differenced regressions. Drought conditions in March and December are associated with a rise in infant deaths, while extreme droughts in April and July are associated with a reduction in infant deaths.

The influence of drought conditions on mortality are different for infants and non-infants. In specifications 1 and 3 in Table 10, the results for the level regressions show no statistically significant effects of either months of extreme wetness or months of extreme drought. The difference results in specification 5, however, shows strong positive effects of extreme wetness.

When we allow for more monthly variation in climate and weather, the level regressions with correlates in specification 4 suggest that extreme wetness in February raises non-infant deaths and extreme wetness in March lowers it. Extreme droughts during February lower non-infant deaths. In the difference analysis with correlates in specification 6, extreme wetness in February, April, and August raise non-infant mortality. Meanwhile, extreme droughts in February and July lower non-infant deaths, while extreme droughts in March and December raises the death rate.

Conclusions

Prior scholars note that the climate and health interact in a variety of complex ways that are strongly influenced by human decisions, locations, insect and animal populations, and a variety of different factors. Our goal here has been to examine various ways of measuring temperature and precipitation. We explore the raw correlations between climate and mortality during the Great Depression to see if we can discern any patterns, and then incorporate a wide range of demographic, economic, and geographic correlates to examine whether the raw correlations are still present.

The results show that variations across the country in climate were associated with differences in infant mortality and non-infant death rates. However, much of the influence of climate is muted once the other correlates are included.

The most interesting finding shows that information plays an important role in mediating the influence of climate on mortality. Public health scholars have long touted the health benefits of improved information flows during the campaigns to promote public health during the 1910s, 1920s, and 1930s. Certainly, we saw sharp declines in infant mortality during this period that cannot be fully explained by changes in income and sanitation. The results here provide support for this view. Both infant mortality and non-infant mortality rates were higher in areas where there was more illiteracy and lower in areas where people had more access to radios and the circulation of news magazines was greater. These effects are more than income effects because we control for urbanization and economic activity in the analysis. Of even more interest is how strongly the influence of climate on mortality changed when we add the information variables to the analysis. Many of the positive temperature coefficients that implied higher mortality with higher temperature were sharply cut in magnitude by the inclusion of the information coefficients. This is consistent with a view that access to better information reduced the impact of climate on mortality.

We also explored the impact of some of the extreme weather events during the 1930s that led many contemporaries to liken the period to the Trials of Job. The most infamous of these events was the Dust Bowl. In our analysis to date, we find that the Dust Bowl did not contribute to a rise in either infant or non-infant mortality. The result matches up with recent findings by Cutler and Miller (2007) that the Dust Bowl did not lead to long term negative health effects for the infants born in the Dust Bowl areas during the 1930s. The combination of the two studies suggests that neither long-term nor short-term effects on health. In the case here it may be that death rates are too crude a measure to get at health problems that lead to illness but not to death, and we hope to explore this issue further.

Finally, the results show that the climate and weather at some times of year have larger effects than at other times of year. We have only begun to explore this issue. Some of the findings seem consistent with prior analyses that show that mosquito-borne diseases benefit from wet and hot weather, particularly in the summer. However, these patterns can be complex and they vary for different diseases. As one example, St. Louis encephalitis (SLE) was the name given a disease that led to 1095 hospital cases and 201 deaths in St. Louis in the summer of 1933.[3] SLE is a mosquito-borne disease as well, but Thomas Monath (1980) found that later epidemics were typically associated with above-average temperatures and abnormally high precipitation in January and February, below normal temperature in April, above-average temperatures in May through August, and an abnormally dry July. In general the warm conditions help the virus multiply within the mosquito population and the other requirements (e.g. for April) are associated with specific life cycle events in the host populations. The conditions in St. Louis during the year of 1933 epidemic fit Monath's ideal conditions. The winter of 1932-33 was the second warmest on record, April was cool, and June through August were the driest months on record (Reiter 1988, 245-255). Other studies suggest that fluctuations in temperature throughout the day and throughout the month may influence the extent of the disease. More work therefore is needed to take the specific bio-science conditions into account when designing the weather variables used for further study.

[3]Scholars suggest that Paris, Illinois reported 38 cases and 14 deaths from the same disease in 1932 but somehow escaped having the disease named after the town (Chamberlain, 1980, 7).

Table 1
Coefficients and t-statistics from Regressions of Infant Deaths Per Thousand Live Births on Annual Average High Temperature, Annual Precipitation and Other Correlates

Variable	Spec. 1 Coeff. *t-stat.*	Spec. 2 Coeff. *t-stat.*	Spec. 3 Coeff. *t-stat.*	Spec. 4 Coeff. *t-stat.*	Spec. 5 Coeff. *t-stat.*
Avg. Daily High Temp. in Year	0.721772 *6.18*	0.094931 *1.04*	-0.0617 *-0.62*	0.426653 *1.92*	-0.18286 *-1.58*
Inches of Precipitation During Year	-0.12053 *-1.36*	-0.28847 *-3.48*	-0.27582 *-3.32*	-0.10758 *-1.91*	-0.1597 *-3.7*
% Illiterate		2.04932 *5.91*	1.866632 *5.17*		2.069251 *3.99*
% Owning Radio			-0.26055 *-6.13*		-0.41322 *-10.56*
Per Cap. Circulation of 15 Magazines, 1929			0.347631 *4.52*		-0.22017 *-2.96*
Remaining Correlates Included				*Included*	*Included*
N	*32598*	*32598*	*32584*	*32423*	*32421*

Notes. The regressions have White-corrected robust standard errors, which are clustered at the state level. Reported R-squareds range from 0.039 to 0.22. The Remaining Correlates are Retail Sales Per Capita, Auto Registrations Per Capita, Tax Returns Filed Per Capita, Crop Value, Percent Home Ownership, Public Works Admin. Grants Per Capita, Agric. Adj. Admin. Grants Per Capita, Relief Grants per Capita, Public Roads Admin. Grants Per Capita, Disaster Loan Corp. Loans Per Capita, Farm Loans Per Capita, Reconstruction Finance Corp. Loans Per Capita, US. Housing Authority Loans Per Capita, Civilian Conservation Corps Camps Estab. In Year t, Civilian Conservation Corps Camps Estab. In Year t-1, Civilian Conservation Corps Camps Estab. In Year t-2, Hospital Beds per Female Aged 15-44 potentially available for infants, Employment in Polluting Industries, 1930, Coal Tonnage, Results of Bovine TB Testing, Births per Woman Aged 15-44, Percent Women Aged 20-24 of Women Aged 15-44, Percent Women Aged 25-29 of Women Aged 15-44, Percent Women Aged 30-34 of Women Aged 15-44, Percent Women Aged 35-44 of Women Aged 15-44, Percent Urban, Percent Foreign Born, Percent African American, Population per Square Mile, Percent Families with Electricity, Mfg. Employment Per Capita, Retail Employment Per Capita, Number of Lakes, Number of Swamps, Maximum Elevation, Elevation Range, Percent Church Membership, Number of Rivers that Pass through 11-20 counties in County, Number of Rivers that Pass through 21-50 counties in County, Number of Rivers that Pass through over 50 counties in County, Number of Bays, Number of Beaches, On Atlantic Coast, On Pacific Coast, On Gulf Coast, On Great Lakes, Land Area in Square Miles, and a Constant Term

Table 2
Coefficients and t-statistics from Regressions of Infant Mortality Rate on Share of Days During Year in Temperature Bands, Annual Precipitation and Other Correlates

	Spec. 1 Coeff. *t-stat.*	Spec. 2 Coeff. *t-stat.*	Spec. 3 Coeff. *t-stat.*	Spec. 4 Coeff. *t-stat.*	Spec. 5 Coeff. *t-stat.*
Share of Days in Year that High Temperature					
High >= 100	2.380343	13.16617	23.96963	38.72325	23.87513
	0.06	0.44	0.81	1.17	0.99
100 >High >= 90	2.364965	-45.0031	-39.9283	-19.2749	-26.4441
	0.11	-2.53	-2.11	-0.78	-1.78
90 >High >= 80	24.53973	-11.216	-0.87754	9.67442	0.691595
	1.18	-0.72	-0.07	0.56	0.06
80 >High >= 70	61.1767	1.871154	-4.6874	18.36318	-1.65143
	2.62	0.12	-0.32	1.02	-0.15
70 >High >= 60	12.14191	-30.0658	-22.3198	7.311555	-2.31131
	0.5	-1.81	-1.61	0.47	-0.18
50 >High >= 40	1.205905	8.824388	18.79304	5.300141	27.59694
	0.05	0.5	1.26	0.34	2.3
40 >High >= 30	-60.9137	-48.9316	-31.4416	-40.9106	-16.8617
	-2.23	-2.33	-1.68	-2.19	-1.18
30 >High >= 20	-4.60398	-23.5237	-3.19632	-20.3925	-4.08446
	-0.15	-0.98	-0.14	-1.06	-0.25
20 >High >= 10	-89.4388	-97.9779	-64.2726	-47.6811	5.786096
	-2.26	-3.31	-2.63	-1.8	0.23
10 >High > 0	-57.8004	-56.9084	-33.339	-116.91	-8.86851
	-1.1	-1.42	-0.87	-2.13	-0.23
0 >High >= -10	131.1956	42.22832	32.50465	12.77905	45.6407
	1.72	0.61	0.48	0.21	0.63
-10 >High	184.8859	41.90796	49.84967	130.3593	135.5198
	1.39	0.42	0.62	1.29	1.3
Inches of Precipitation During Year	-0.20873	-0.30693	-0.28073	-0.14628	-0.1545
	-1.95	-3.39	-3.03	-2.36	-3.3
% Illiterate		2.146771	1.965136		2.065042
		6.24	5.51		3.92
% Owning Radio			-0.25244		-0.40782
			-6.55		-10.45
Per Cap. Circulation of 15 Magazines, 1929			0.309562		-0.22003
			3.72		-2.97
Remaining Correlates Included				Included	Included
N	32598	32598	32584	32423	32421

Table 3
Coefficients and t-statistics from Regressions of Infant Mortality Rate on Average High Temperature and Inches of Precipitation in Each Month and Other Correlates

	Spec. 1 Coeff. *t-stat.*	Spec. 2 Coeff. *t-stat.*	Spec. 3 Coeff. *t-stat.*	Spec. 4 Coeff. *t-stat.*	Spec. 5 Coeff. *t-stat.*
Daily Average Temperature in Month of					
January	0.108786	0.090583	0.016087	0.013646	-0.04253
	2.43	2.19	0.39	0.21	-0.82
February	0.304568	0.211011	0.071423	0.252703	-0.00883
	4.2	3.15	1.17	3.47	-0.17
March	0.1534	0.024638	0.114788	0.075736	0.054848
	1.64	0.35	1.44	0.82	0.76
April	0.077792	0.009054	-0.16375	-0.0835	-0.08659
	0.4	0.06	-0.86	-0.46	-0.58
May	0.063809	-0.2077	-0.06657	0.121471	0.119948
	0.42	-1.68	-0.59	1.15	1.32
June	0.317412	0.289583	0.303756	0.254584	0.268234
	1.75	1.93	2.31	1.84	2.21
July	-0.07287	0.01848	-0.18943	-0.09116	-0.25674
	-0.31	0.11	-1.05	-0.52	-1.73
August	-0.2415	-0.14336	0.008239	-0.29858	-0.06021
	-1.02	-0.81	0.05	-2.43	-0.56
September	-0.12424	0.000583	-0.08719	-0.05463	-0.10238
	-1.1	0.01	-1	-0.6	-1.34
October	-0.75383	-0.59269	-0.28728	-0.42961	-0.18157
	-7.26	-5.71	-2.75	-4.77	-1.98
November	0.532288	0.465401	0.281984	0.444142	0.126998
	4.42	5.69	3.43	6.06	1.99
December	-0.00966	-0.17431	-0.08831	-0.04288	-0.04415
	-0.1	-2.66	-1.11	-0.51	-0.68
Inches of Precipitation in Month of					
January	-0.14475	-0.25851	-0.20625	-0.13334	-0.1824
	-0.72	-1.53	-1.19	-0.87	-1.62
February	-0.80056	-1.03176	-0.93698	-0.80918	-0.62689
	-4.06	-6.35	-5.05	-4.46	-4.8
March	0.16573	0.134789	-0.05344	0.172934	0.051417
	0.76	0.64	-0.26	0.97	0.32
April	-0.48213	-0.58119	-0.5238	-0.41252	-0.23402
	-2.09	-3.16	-2.9	-2.95	-1.97
May	-0.77336	-0.72044	-0.61763	-0.43362	-0.32377
	-3.94	-4.19	-3.62	-3.26	-3.26
June	-0.6204	-0.50432	-0.30572	-0.32402	-0.03829

	-3.3	-3.26	-2.59	-3.45	-0.47
July	0.465731	-0.12708	-0.1583	-0.06122	-0.08111
	1.69	-0.63	-0.78	-0.41	-0.64
August	0.151809	-0.18692	-0.05229	-0.00919	-0.0091
	0.84	-1.35	-0.36	-0.08	-0.09
September	0.029784	0.148927	0.089881	0.277936	0.168465
	0.16	1.09	0.6	1.68	1.28
October	-0.23392	-0.16514	-0.13152	0.049914	-0.18066
	-1.27	-0.86	-0.72	0.34	-1.26
November	-0.25113	-0.29247	-0.27166	-0.13319	-0.11429
	-1.44	-1.83	-1.79	-1.28	-1.55
December	-0.4107	-0.50349	-0.63417	-0.29046	-0.39203
	-2.11	-2.69	-3.03	-1.93	-2.43
% Illiterate		1.967014	1.826289		2.005235
		5.87	4.98		3.89
% Owning Radio			-0.21726		-0.40118
			-4.09		-8.82
Per Cap. Circulation of 15			0.28556		-0.23112
Magazines, 1929			4.09		-3.15
Other Correlates Include				Included	Included
N	32598	32598	32584	32423	32421

Notes. Same as in Table 1. Reported R-squareds range from 0.083 to 0.223.

Table 4
Coefficients and t-statistics from Regressions of Change in Infant Mortality Rate on Change in Climate Variables and Change in Other Correlates

	Spec. 1 Coeff. *t-stat.*	Spec. 2 Coeff. *t-stat.*	Spec. 3 Coeff. *t-stat.*	Spec. 4 Coeff. *t-stat.*
Change from Previous Year				
Avg. Daily High Temp. in Year	0.000728	0.050148		
	0	0.27		
Inches of Precipitation During Year	0.007205	-0.00226		
	0.41	-0.13		
Change from Previous Year in Average High Temperature During Month of				
January			-0.01596	0.037248
			-0.42	0.73
February			-0.06941	-0.0159
			-0.91	-0.22
March			-0.02393	-0.07715
			-0.44	-1.03
April			0.193461	0.055407
			1.97	0.57
May			-0.06824	-0.10369
			-1.4	-1.76
June			-0.03066	-0.06747
			-0.33	-0.62
July			0.060144	0.044189
			0.7	0.47
August			0.240845	0.241991
			2.98	2.78
September			0.096631	0.042443
			0.96	0.39
October			-0.06748	0.010219
			-0.96	0.11
November			0.03836	0.057141
			0.67	0.67
December			0.040343	-0.02358
			0.53	-0.21
Change from Previous Year in Inches of Precipitation During Month of				
January			-0.13194	-0.14189
			-1.66	-1.64
February			-0.43403	-0.51335
			-3.63	-3.68
March			0.147974	0.122108
			1.52	1.61
April			-0.11392	-0.1891

		-1.37	-2.42
May		-0.14158	-0.14272
		-1.55	-1.7
June		0.053275	0.032679
		0.54	0.41
July		0.122233	0.158989
		1.46	2.14
August		0.22996	0.246484
		2.66	3.25
September		0.190187	0.172432
		2.38	2.36
October		0.062817	0.131104
		0.55	1.09
November		0.114326	0.102532
		1.61	1.32
December		-0.01153	0.019434
		-0.11	0.17
Results of Bovine TB Testing	0.525287		0.608191
	1.19		1.44
Hospital Beds per Female Aged 15-44 potentially available for infants	0.076763		0.077954
	1.98		2
Births per Woman Aged 15-44	-0.26054		-0.26224
	-7.51		-7.29
Retail Sales Per Capita	0.027464		0.030578
	2.84		2.7
% Owning Radio	-0.17102		-0.20374
	-2.28		-2.68
Auto Registrations Per Capita	13.96683		10.41737
	0.87		0.69
Crop Value	-0.00036		-0.00077
	-0.32		-0.73
Tax Returns Filed Per Capita	-3.417		17.59112
	-0.24		1.07
Public Works Admin. Grants Per Capita	-0.02426		-0.02193
	-1.01		-1.01
Agric. Adj. Admin. Grants Per Capita	0.028908		0.029695
	1.14		1.14
Relief Grants per Capita	0.020282		0.014682
	0.6		0.48
Public Roads Admin. Grants Per Capita	0.163097		0.101032
	0.72		0.45
Disaster Loan Corp. Loans Per Capita	-0.08598		-0.17058
	-0.18		-0.37
Farm Loans Per Capita	0.047844		0.054733
	0.93		0.99

Reconstruction Finance Corp. Loans Per Capita		-0.0943		-0.07681
		-1.67		-1.36
US. Housing Authority Loans Per Capita		-0.00659		-0.00282
		-0.12		-0.05
Civilian Conservation Corps Camps Estab. In Year t		0.015991		-0.0175
		0.08		-0.08
Year 1932	-0.81234	0.941307		2.122617
	-0.58	0.62		1.22
Year 1933	3.700018	2.51766		4.8392
	2.56	1.39		3.65
Year 1934	4.665262	3.818856		3.211256
	3.28	2.44		1.4
Year 1935	-0.7198	-2.8688		-1.97471
	-0.49	-1.81		-0.85
Year 1936	3.510212	2.64229		4.001284
	3.4	2.05		2.37
Year 1937	0.188231	-0.9743		-0.68209
	0.14	-0.64		-0.28
Year 1938	0.473626	1.338888		2.04797
	0.31	0.75		1.09
Year 1939	0.428169	-1.17692		1.080106
	0.31	-0.76		0.76
Year 1940	1.680108	2.67429		2.06064
	1.07	1.69		1.22
Constant	-2.86894	-1.82302	-1.39723	-2.42927
	-3.36	-1.73	-11.43	-2.32

Notes. The regressions have White-corrected robust standard errors, which are clustered at the state level. The Remaining Correlates are the Changes in Retail Sales Per Capita, Auto Registrations Per Capita, Tax Returns Filed Per Capita, Crop Value, Public Works Admin. Grants Per Capita, Agric. Adj. Admin. Grants Per Capita, Relief Grants per Capita, Public Roads Admin. Grants Per Capita, Disaster Loan Corp. Loans Per Capita, Farm Loans Per Capita, Reconstruction Finance Corp. Loans Per Capita, US. Housing Authority Loans Per Capita, Civilian Conservation Corps Camps Estab. In Year t, Hospital Beds per Female Aged 15-44 potentially available for infants, and a Constant Term

Table 5
Coefficients and t-statistics from Regressions of Non-Infant Deaths Per Thousand People on Annual Average High Temperature, Annual Precipitation and Other Correlates

	Spec. 1	Spec. 2	Spec. 3	Spec. 4	Spec. 5
	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.
	t-stat.	*t-stat.*	*t-stat.*	*t-stat.*	*t-stat.*
Avg. Daily High Temp. in	-0.051	-0.063	-0.032	0.022	-0.033
Year	*-2.12*	*-2.12*	*-1.61*	*1.62*	*-3.34*
Inches of Precipitation	0.031	0.028	0.043	0.006	-0.002
During Year	*2.63*	*2.4*	*4.94*	*1.39*	*-0.42*
% Illiterate		0.038	0.127		0.134
		0.96	*3.35*		*3.61*
% Owning Radio			-0.009		-0.053
			-1.73		*-10.1*
Per Cap. Circulation of 15			0.151		-0.021
Magazines, 1929			*9.58*		*-2.48*

Notes. The regressions have White-corrected robust standard errors, which are clustered at the state level. Reported R-squareds range from 0.039 to 0.22. The Remaining Correlates are Retail Sales Per Capita, Auto Registrations Per Capita, Tax Returns Filed Per Capita, Crop Value, Percent Home Ownership, Public Works Admin. Grants Per Capita, Agric. Adj. Admin. Grants Per Capita, Relief Grants per Capita, Public Roads Admin. Grants Per Capita, Disaster Loan Corp. Loans Per Capita, Farm Loans Per Capita, Reconstruction Finance Corp. Loans Per Capita, US. Housing Authority Loans Per Capita, Civilian Conservation Corps Camps Estab. In Year t, Civilian Conservation Corps Camps Estab. In Year t-1, Civilian Conservation Corps Camps Estab. In Year t-2, Hospital Beds per Female Aged 15-44 potentially available for infants, Employment in Polluting Industries, 1930, Coal Tonnage, Results of Bovine TB Testing, Births per Woman Aged 15-44, Percent of Population aged 5-9, 10-14, 15-19, 20-24, 25-29, 30-34, 35-44, 45-54, 55-64, 65-74, 75 and over, Percent Urban, Percent Foreign Born, Percent African American, Population per Square Mile, Percent Families with Electricity, Mfg. Employment Per Capita, Retail Employment Per Capita, Number of Lakes, Number of Swamps, Maximum Elevation, Elevation Range, Percent Church Membership, Number of Rivers that Pass through 11-20 counties in County, Number of Rivers that Pass through 21-50 counties in County, Number of Rivers that Pass through over 50 counties in County, Number of Bays, Number of Beaches, On Atlantic Coast, On Pacific Coast, On Gulf Coast, On Great Lakes, Land Area in Square Miles, and a Constant Term

Table 6
Coefficients and t-statistics from Regressions of Non-Infant Mortality Rate on Share of Days During Year in Temperature Bands, Annual Precipitation and Other Correlates

	Spec. 1 Coeff. *t-stat.*	Spec. 2 Coeff. *t-stat.*	Spec. 3 Coeff. *t-stat.*	Spec. 4 Coeff. *t-stat.*	Spec. 5 Coeff. *t-stat.*
Share of Days in Year that High Temperature					
High >= 100	5.9253199	6.245898	5.6537376	4.0611318	2.3489633
	1.74	1.89	1.7	2.04	1.48
100 >High >= 90	-4.427665	-5.8174	-5.11953	-2.09142	-3.10996
	-1.44	-1.9	-2.07	-1.33	-2.97
90 >High >= 80	3.0792415	2.030206	-0.01870	0.1518418	-1.1193712
	1.2	0.71	-0.01	0.12	-1.12
80 >High >= 70	6.4659766	4.723384	-1.21041	1.0813113	-0.8415495
	2.3	1.62	-0.51	0.78	-0.73
70 >High >= 60	3.6034486	2.368396	-0.76792	1.5105014	0.3858891
	1.48	0.93	-0.37	0.97	0.27
50 >High >= 40	5.2266821	5.455708	0.7692672	-0.34326	1.242737
	1.29	1.3	0.26	-0.25	1
40 >High >= 30	8.114672	8.473622	3.3481582	-2.72522	-0.6973798
	2.5	2.64	1.06	-1.66	-0.49
30 >High >= 20	-3.238951	-3.79263	-1.16735	-0.37342	0.76637834
	-0.86	-1.01	-0.34	-0.18	0.36
20 >High >= 10	6.430615	6.184703	3.7969074	-0.253966	3.4170776
	0.99	0.97	0.74	-0.09	1.29
10 >High > 0	-31.83301	-31.803	-21.71878	-12.8939	-3.1538209
	-2.74	-2.76	-2.17	-2.31	-0.67
0 >High >= -10	-26.27229	-28.8894	-26.97869	-3.27581	-0.9729119
	-2.16	-2.4	-2.43	-0.7	-0.29
-10 >High	28.442934	24.24312	18.496452	39.282855	33.403666
	1.6	1.37	1.23	5.39	4.88
Inches of Precipitation	0.025201	0.022298	0.0436157	0.0048751	0.00116884
During Year	2.08	1.93	4.45	1.04	0.26

Notes. See Notes to Table 5.

Table 7
Coefficients and t-statistics from Regressions of Non-Infant Mortality Rate on Average High Temperature and Inches of Precipitation in Each Month and Other Correlates

	Spec. 1 Coeff. *t-stat.*	Spec. 2 Coeff. *t-stat.*	Spec. 3 Coeff. *t-stat.*	Spec. 4 Coeff. *t-stat.*	Spec. 5 Coeff. *t-stat.*
Daily Average Temperature in Month of					
January	0.0058656	0.005635	-0.0094105	0.0012739	-0.0016264
	0.82	0.79	-1.47	0.23	-0.32
February	0.0337048	0.032532	0.0240289	0.0249387	0.00368783
	3.52	3.17	2.78	4.66	0.9
March	0.0040093	0.002403	0.0018975	0.0075567	0.00180388
	0.38	0.21	0.19	1.18	0.33
April	-0.153871	-0.154714	-0.1300094	-0.0423547	-0.0448842
	-5.74	-5.89	-6.1	-3.21	-4.23
May	0.0440343	0.040653	0.0477205	0.027133	0.02879122
	2.6	2.38	3.53	2.98	3.28
June	0.0033849	0.003037	0.0439681	0.027653	0.02636033
	0.17	0.15	2.52	2.4	2.48
July	-0.028148	-0.027009	-0.0134478	0.0015463	-0.0078617
	-1.34	-1.32	-0.68	0.1	-0.58
August	-0.016287	-0.015078	-0.0112642	-0.0106798	0.00450938
	-1.19	-1.09	-0.84	-0.76	0.36
September	-0.011086	-0.009541	0.0130288	-0.0159981	-0.0158004
	-0.64	-0.53	0.75	-1.43	-1.9
October	-0.043982	-0.041962	-0.0305559	-0.0528509	-0.0347276
	-2.63	-2.67	-2.06	-5.79	-4.57
November	0.1029848	0.102154	0.0891014	0.0443142	0.02100679
	7.77	7.61	7.66	7.16	4.07
December	-0.013448	-0.015505	-0.0317525	-0.0019098	-0.0052677
	-1.31	-1.35	-3.02	-0.24	-0.83
Inches of Precipitation in Month of					
January	0.0450558	0.04363	0.074505	0.0049496	-0.002886
	1.86	1.72	3.04	0.35	-0.26
February	-0.048383	-0.051277	-0.0239605	-0.0313984	-0.0226186
	-1.94	-2.05	-1.05	-1.91	-1.59
March	0.0343111	0.033919	0.0637621	0.0330535	0.0179759
	1.09	1.05	2.37	2.21	1.39
April	0.0003717	-0.000871	0.0330723	-0.0218876	-0.0130114
	0.02	-0.04	1.61	-2.06	-1.25
May	-0.015966	-0.015294	0.0392981	-0.0203594	-0.0120631
	-0.59	-0.56	1.86	-1.82	-1.04
June	-0.023382	-0.021925	0.0106621	-0.043395	-0.0262501

	-0.94	-0.86	0.54	-4.26	-3.02
July	-0.040179	-0.047594	-0.0038688	0.0218727	0.02372813
	-1.56	-2.09	-0.19	1.83	2.52
August	0.0288204	0.024576	0.0472458	0.0040929	0.0060815
	1.35	1.23	2.56	0.42	0.71
September	0.1448194	0.146303	0.122831	0.0346586	0.02557655
	5.36	5.47	4.5	3.01	2.55
October	0.0622156	0.063095	0.0719555	0.039188	0.01971979
	2.24	2.26	2.78	2.62	1.38
November	0.0168597	0.016336	0.0230394	-0.0164076	-0.0186286
	0.98	0.97	1.07	-1.97	-2.1
December	0.0008838	-0.000283	0.0019953	0.0115334	0.00360142
	0.04	-0.01	0.08	0.91	0.27

Notes. See Notes to Table 5.

Table 8
Coefficients and t-statistics from Regressions of Change in Non-Infant Mortality Rate on Change in Climate Variables and Change in Other Correlates

Change in Variable	Spec. 1 Coeff. *t-stat.*	Spec. 2 Coeff. *t-stat.*	Spec. 3 Coeff. *t-stat.*	Spec. 4 Coeff. *t-stat.*
Avg. Daily High Temp. in Year	0.005327	-0.000809		
	0.29	-0.04		
Inches of Precipitation During Year	-0.00247	-0.002756		
	-1.4	-1.58		
Change in Average High Temperature from Previous Year in Month of				
January			0.0040083	0.001851
			1.11	0.52
February			0.0054501	0.0013797
			1.05	0.29
March			-0.0114559	-0.0105093
			-2.47	-2.25
April			-0.0063635	-0.0035785
			-1.07	-0.68
May			-0.0036033	-0.0032322
			-0.99	-0.99
June			-0.0035703	-0.001904
			-0.67	-0.34
July			0.0129539	0.0088179
			2.35	1.6
August			0.0162626	0.0173219
			2.28	2.28
September			0.0060612	0.0068884
			0.83	0.92
October			-0.0065655	-0.0047072
			-1.22	-0.96
November			0.0073382	0.0075623
			1.64	1.69
December			0.0053671	0.0014479
			1.17	0.33
Change in Inches of Precipitation from Previous Year in Month of				
January			-0.021697	-0.0204343
			-3.12	-2.93
February			-0.0288382	-0.0316571
			-3.05	-3.24
March			-0.0073263	-0.0061024
			-1.02	-0.8
April			0.0069874	0.0073008

		1	1.03
May		-0.0066385	-0.0074249
		-1.1	-1.32
June		-0.0025086	-0.0016196
		-0.41	-0.28
July		0.0144112	0.0146001
		2.57	2.53
August		0.0055039	0.0073315
		0.78	0.96
September		0.0069091	0.0092286
		1.53	1.95
October		0.0172434	0.0194547
		1.9	2.41
November		-0.0021461	-0.0017781
		-0.83	-0.63
December		0.0160845	0.0150304
		1.57	1.54
Change in Variable			
Results of Bovine TB Testing	-0.032224		-0.0284734
	-1.14		-1.08
Hospital Beds per Female Aged 15-44 potentially available for infants	0.001901		0.0020062
	1.56		1.66
Births per Woman Aged 15-44	0.017812		0.0178864
	8.69		8.95
Retail Sales Per Capita	0.000577		0.0004396
	0.75		0.55
% Owning Radio	0.00199		-0.0003584
	0.24		-0.05
Auto Registrations Per Capita	0.575287		0.5860436
	0.62		0.69
Crop Value	-1.26E-05		-0.0000356
	-0.2		-0.47
Tax Returns Filed Per Capita	2.563225		3.8776343
	2.11		2.87
Public Works Admin. Grants Per Capita	0.001429		0.0015515
	1.31		1.5
Agric. Adj. Admin. Grants Per Capita	0.002521		0.002612
	1.87		1.97
Relief Grants per Capita	0.007605		0.0064385
	3.14		2.49
Public Roads Admin. Grants Per Capita	-0.005578		-0.0086202
	-0.57		-0.84

Disaster Loan Corp. Loans Per Capita		-0.090283		-0.0769627
		-2.4		-2.12
Farm Loans Per Capita		0.005835		0.0052145
		2.18		1.99
Reconstruction Finance Corp. Loans Per Capita		-0.001482		-0.0011868
		-0.48		-0.38
US. Housing Authority Loans Per Capita		-0.009628		-0.0067935
		-2.66		-1.58
Civilian Conservation Corps Camps Estab. In Year t		-0.00181		-0.0054468
		-0.12		-0.36
Year Dummy Variables				
Year 1932	0.3805766	0.362607	0.6600293	0.6140201
	4.31	3.93	5.65	5.51
Year 1933	0.2272961	0.260647	0.4945392	0.5110103
	2.47	2.28	4.56	4.14
Year 1934	0.7279776	0.45278	0.9453229	0.6393224
	7.35	3.57	7.6	4.04
Year 1935	0.293538	0.193798	0.5108047	0.427425
	2.93	1.79	3.53	2.96
Year 1936	0.8627741	0.871175	1.0151332	0.969644
	9.19	6.68	7.82	6.04
Year 1937	-0.071786	-0.165447	0.0881738	0.0076684
	-0.76	-1.56	0.69	0.06
Year 1938	-0.192304	-0.260349	0.072578	-0.0164095
	-1.87	-1.96	0.7	-0.12
Year 1939	0.293669	0.193027	0.4973046	0.4036894
	5.13	2.66	5.62	4.09
Year 1940	0.4558439	0.406009	0.646538	0.4996656
	6.07	3.17	5.78	3.36
Constant	-0.3656	-0.308842	-0.5524689	-0.471521
	-6.26	-3.06	-6.93	-4.15

Notes. The regressions have White-corrected robust standard errors, which are clustered at the state level. The Remaining Correlates are the Changes in Retail Sales Per Capita, Auto Registrations Per Capita, Tax Returns Filed Per Capita, Crop Value, Public Works Admin. Grants Per Capita, Agric. Adj. Admin. Grants Per Capita, Relief Grants per Capita, Public Roads Admin. Grants Per Capita, Disaster Loan Corp. Loans Per Capita, Farm Loans Per Capita, Reconstruction Finance Corp. Loans Per Capita, US. Housing Authority Loans Per Capita, Civilian Conservation Corps Camps Estab. In Year t, Hospital Beds per Female Aged 15-44 potentially available for infants, and a Constant Term

Table 9
Coefficients and t-statistics from Regressions of Change in Non-Infant Mortality Rate on Change in Climate Variables and Change in Other Correlates

	Level Specifications 1 Through 4					Differenced
	Spec. 1 Coeff. *t-stat.*	Spec. 2 Coeff. *t-stat.*	Spec. 3 Coeff. *t-stat.*	Spec. 4 Coeff. *t-stat.*	Spec. 5 Coeff. *t-stat.*	Spec. 6 Coeff. *t-stat.*
Dust Bowl Occurred	-2.358122	-2.842517	1.902818	0.381235	-1.29307	-0.94452
	-0.65	-0.81	0.97	0.2	-0.69	-0.47
Months of Extreme	3.7111151		1.319326		-0.71096	
Drought During Year	3.55		3.45		-1.73	
Months of Extreme	-0.304439		-0.053802		-0.02298	
Wetness During Year	-0.84		-0.27		-0.26	
Extreme Wetness During the Month of						
January		-2.905564		0.696620		1.276922
		-1.62		0.53		1.07
February		7.28299		5.28676		3.51901
						2.57
		4.05		4.23		
March		-5.993795		-3.548317		-2.71925
		-1.92		-2.2		-1.3
April		4.807521		1.6323034		0.509121
		2.83		1.22		0.4
May		-4.476682		-1.558695		-2.98594
		-2.06		-0.98		-1.79
June		-0.079916		-0.615881		1.706485
		-0.04		-0.47		1.31
July		-1.404841		-1.775113		-1.14827
		-1.08		-1.39		-1.15
August		-1.723613		-0.375181		-0.8806
		-1.29		-0.36		-1.23
September		1.633564		1.087002		-0.06191
		0.78		0.81		-0.05
October		-0.44354		-1.885324		0.233771
		-0.22		-1.17		0.16
November		3.187567		0.425069		0.114842
		1.49		0.31		0.08
December		-3.299335		-0.046598		-0.01193
		-2.1		-0.06		-0.01
Extreme Drought in						

Month of January		4.448552		-0.063182		-0.94903
		1.1		-0.04		-0.35
February		7.359488		3.264967		-2.9615
		1.49		0.98		
						-0.79
March		2.453775		4.341471		5.54612
		0.65		1.54		1.67
April		4.610415		-7.071391		-9.8448
		0.86		-1.81		-2.12
May		4.9983		3.4133053		-5.19527
		0.88		0.89		-1.48
June		-4.508627		-0.612366		5.594336
		-0.77		-0.15		1.6
July		5.767051		-0.315727		-10.5283
		1.16		-0.08		-2.94
August		8.811895		-0.288514		-0.79426
		2.34		-0.09		-0.18
September		-4.54968		-3.174473		-0.76844
		-1.03		-1.11		-0.46
October		0.550668		1.618951		-3.8152
		0.09		0.46		-1.18
November		12.95248		7.115035		6.371248
		1.85		1.98		1.49
December		-2.73661		1.665288		4.19153
		-0.73		0.93		2.02
Other Correlates Included	No	No	Included	Included	No	No
Change in Other Correlates Included	No	No	No	No	No	Included

Notes. All Estimations have White-corrected robust standard errors clustered at the State level. The Level Regressions Include the List of Other Correlates listed in the Notes to Table 1. The Difference Regressions include the List of Changes in Other correlates listed in the Notes to Table 4. In specification 1 and 3 annual average high temperature and average inches of precipitation are included. In specification 2 and 4 the monthly averages for high temperature and monthly totals for precipitation are included. In specification 5 the change in the annual annual average high temperature and average inches of precipitation are included. In specification 6 year-to-year change in the monthly averages for high temperature and monthly totals for precipitation are included.

Table 10
Coefficients and t-statistics from Regressions of Change in Non-Infant Mortality Rate on Change in Climate Variables and Change in Other Correlates

	Level Specifications				Differenced Specifications	
	Spec. 1 Coeff. *t-stat.*	Spec. 2 Coeff. *t-stat.*	Spec. 3 Coeff. *t-stat.*	Spec. 4 Coeff. *t-stat.*	Spec. 5 Coeff. *t-stat.*	Spec. 6 Coeff. *t-stat.*
Dust Bowl Occurred	-2.5502	-2.75637	0.178788	0.018042	-0.0931	-0.0892
	-5.37	-6.05	1.4	0.13	-0.85	-0.68
Months of Extreme Drought	0.08506		0.027731		-0.0107	
During Year	0.88		0.94		-0.23	
Months of Extreme Wetness	-0.0187		0.011895		0.02266	
During Year	-0.51		0.71		3.37	
Extreme Wetness Occurred in Month of						
January		-0.32526		0.189820		-0.0018
		-1.22		1.67		-0.02
February		0.416199		0.3111686		0.20275
		1.63		2.44		2.37
March		-0.48949		-0.283820		-0.1153
		-1.74		-2.28		-1.1
April		1.25602		0.1730532		0.15124
		4.75		1.58		1.61
May		-0.49259		-0.1876053		-0.1298
		-1.8		-1.38		-1.54
June		-0.13485		-0.1557868		0.07234
		-0.67		-1.52		0.92
July		0.052528		-0.0128654		-0.0840
		0.2		-0.11		-1.35
August		0.304274		0.0210936		0.09908
		1.09		0.21		1.78
September		-0.26779		0.1254545		-0.0348
		-0.81		0.8		-0.37
October		-1.02827		-0.0843084		0.04308
		-4.01		-0.6		0.44
November		0.12910		-0.0724021		-0.1207
		0.62		-0.47		-1.22
December		0.60105		0.0587401		-0.0206
		2.34		0.56		-0.21

Extreme Drought Occurred in Month of						
January		0.560929		0.3429885		0.13988
		1.46		1.11		1.25
February		0.062774		-0.9055725		-1.2479
		0.12		-2.58		-3.02
March		-0.42120		0.2692035		0.2738
		-0.61		0.9		1.71
April		1.51902		0.0067814		0.68468
		1.72		0.01		0.94
May		1.06681		-0.1281276		-0.3595
		2.18		-0.57		-1
June		-0.23195		-0.1944016		0.37818
		-0.34		-0.47		1.5
July		-0.43846		0.1989931		-0.5596
		-0.69		0.57		-2.15
August		-0.51054		0.1131384		-0.176
		-1.14		0.45		-0.75
September		1.14997		-0.3573454		0.07527
		2.23		-1.4		0.81
October		0.16167		0.0294912		-0.1036
		0.22		0.11		-0.49
November		0.25633		0.4187767		0.29033
		0.46		1.32		1.27
December		-1.54471		-0.2244775		0.19237
		-7.01		-1.35		2.04
Other Correlates Included	No	No	Included	Included	No	No
Change in Other Correlates Included	No	No	No	No	Included	Included

Notes. All Estimations have White-corrected robust standard errors clustered at the State level. The Level Regressions in specifications 3 and 4 include the list of other correlates listed in the Notes to Table 5. The Difference Regression in specification 6 includes the List of Changes in Other correlates listed in the Notes to Table 8. In specification 1 and 3 annual average high temperature and average inches of precipitation are included. In specification 2 and 4 the monthly averages for high temperature and monthly totals for precipitation are included. In specification 5 the change in the annual annual average high temperature and average inches of precipitation are included. In specification 6 year-to-year change in the monthly averages for high temperature and monthly totals for precipitation are included.

Figure 1

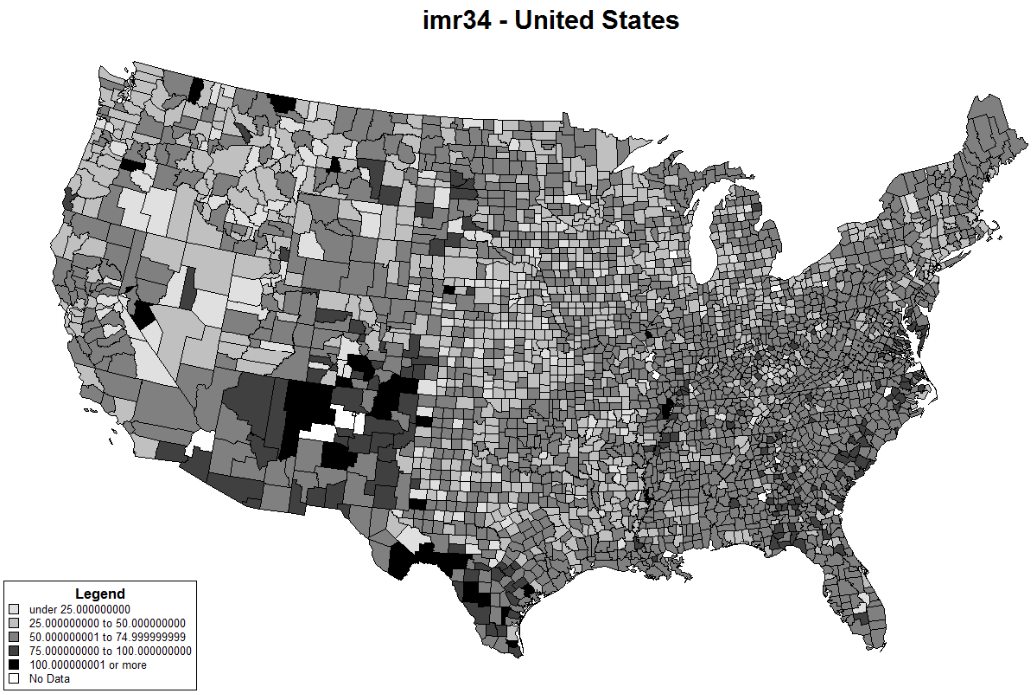
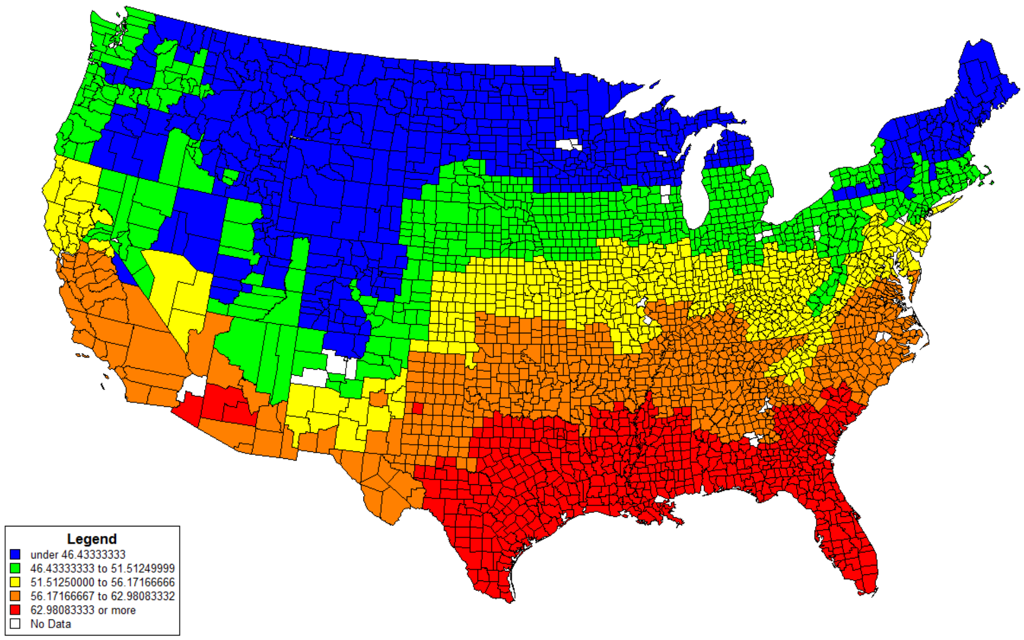
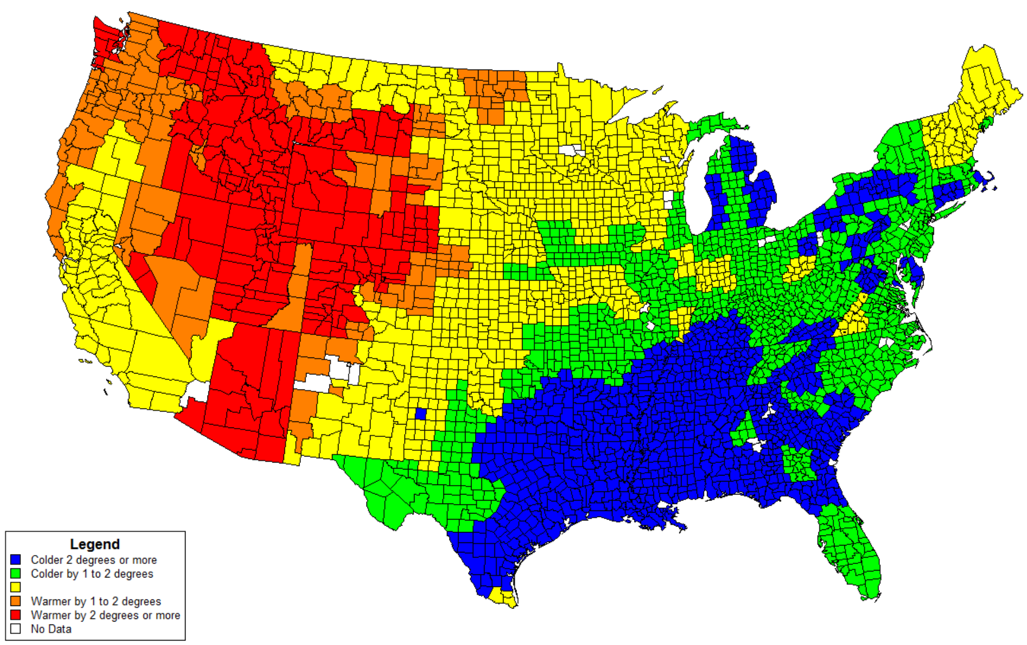

imr34 - United States
Legend
under 25.000000000
25.000000000 to 50.000000000
50.000000001 to 74.999999999
75.000000000 to 100.000000000
100.000000001 or more
No Data

Figure 2 and 2a

Average Monthly Temperature, 1930-1939, Adjusted for Time-of-Day

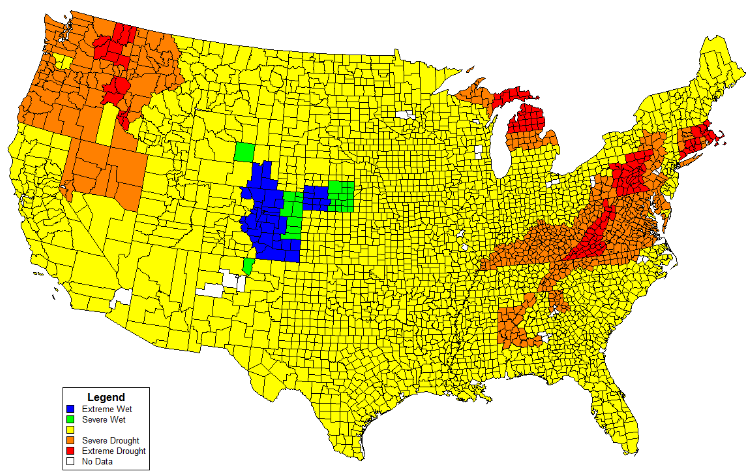


Monthly Average Temperature Difference, 1940 Minus 1920s Average, Adjusted for Time-of-Day

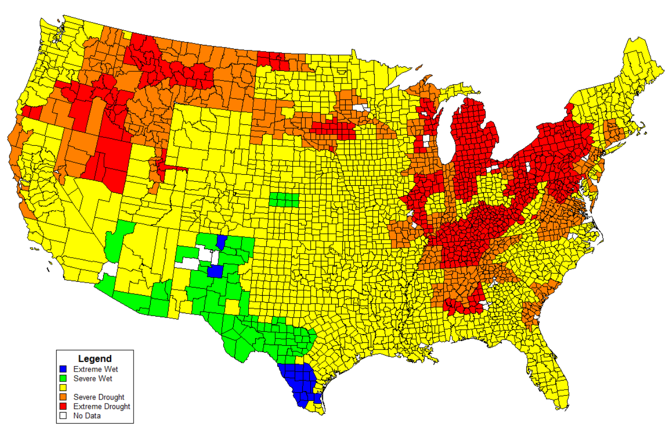


Figures 3a -3k

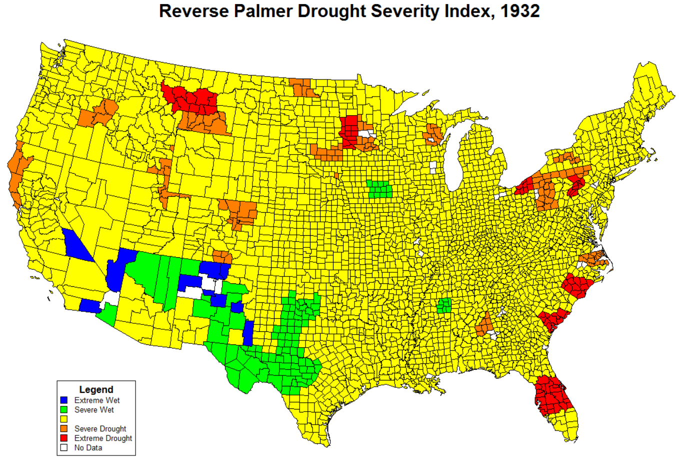
Reverse Palmer Drought Severity Index, 1930



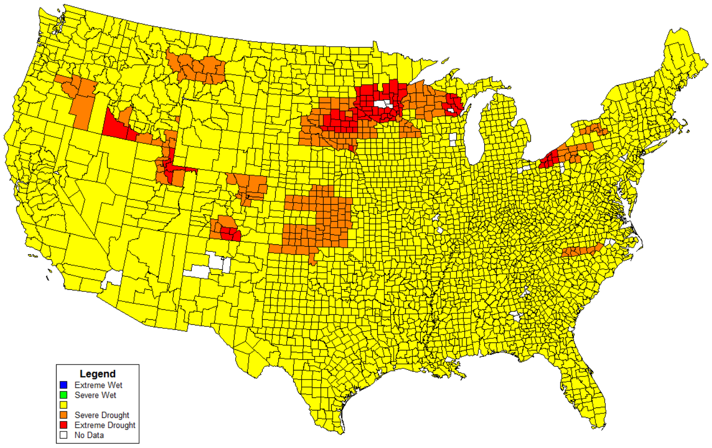
Reverse Palmer Drought Severity Index, 1931



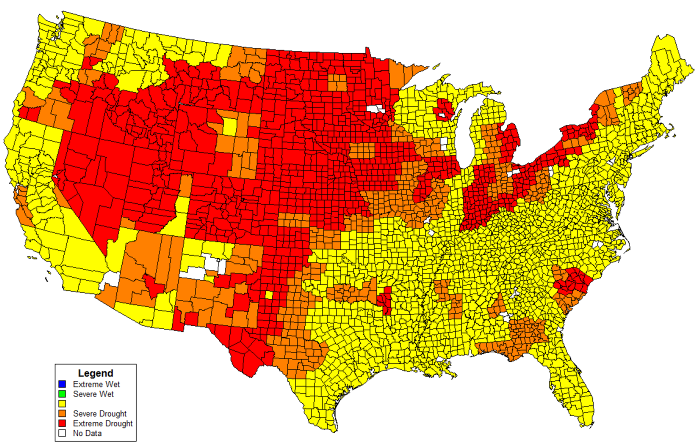
Reverse Palmer Drought Severity Index, 1932



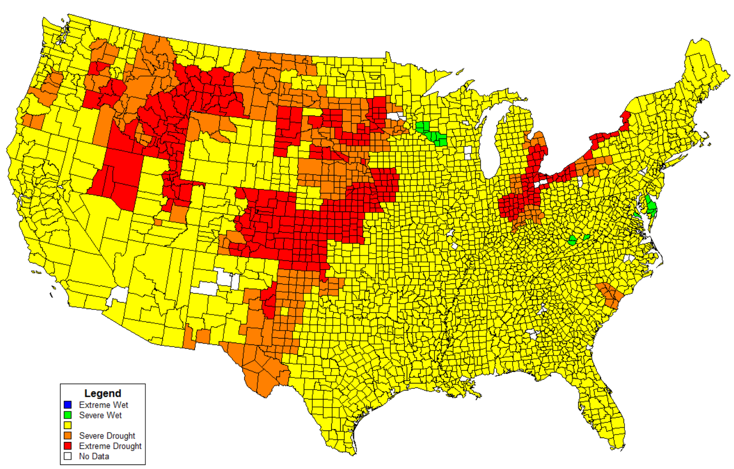
Reverse Palmer Drought Severity Index, 1933



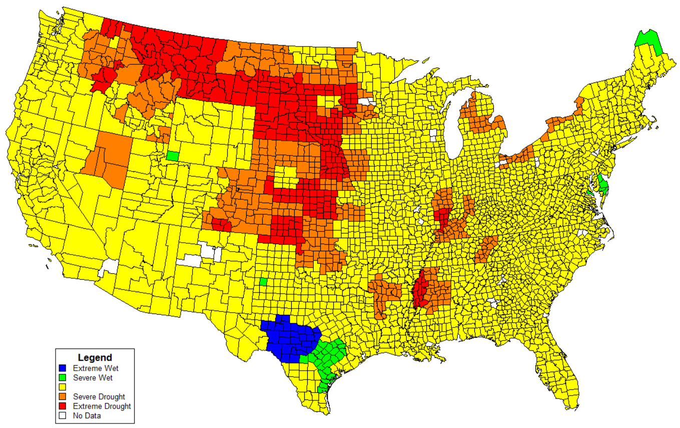
Reverse Palmer Drought Severity Index, 1934



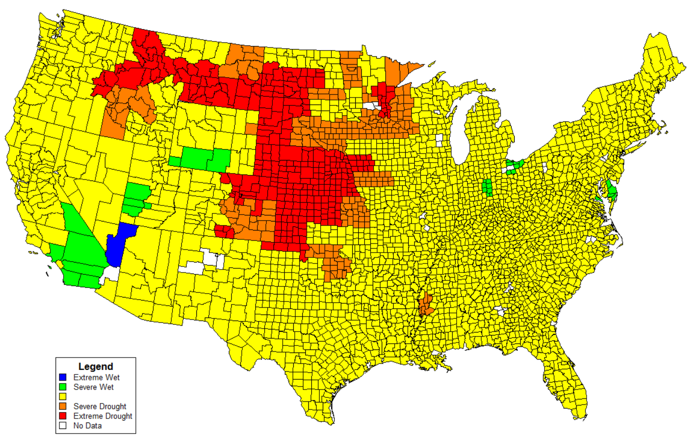
Reverse Palmer Drought Severity Index, 1935



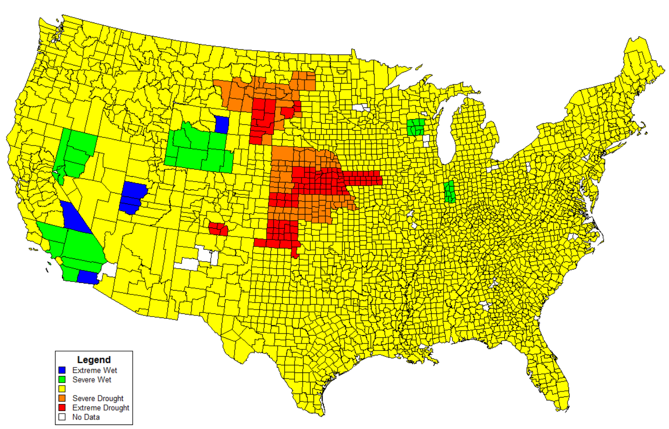
Reverse Palmer Drought Severity Index, 1936



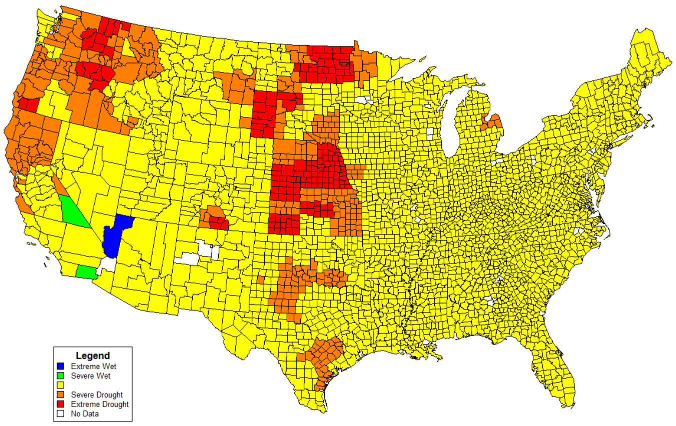
Reverse Palmer Drought Severity Index, 1937



Reverse Palmer Drought Severity Index, 1938



Reverse Palmer Drought Severity Index, 1939



Reverse Palmer Drought Severity Index, 1939

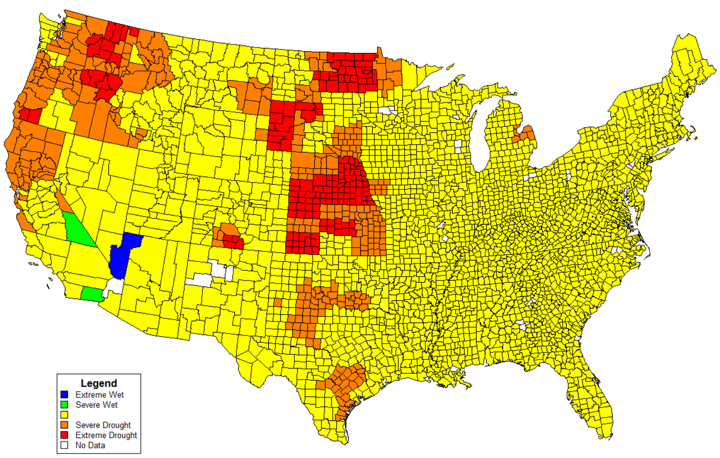
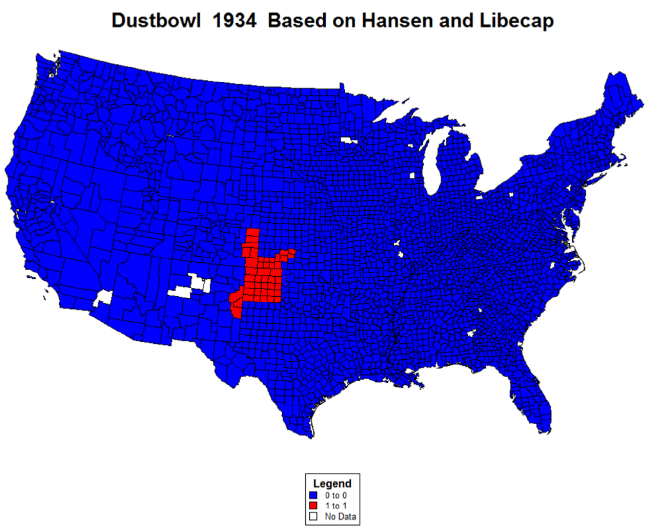
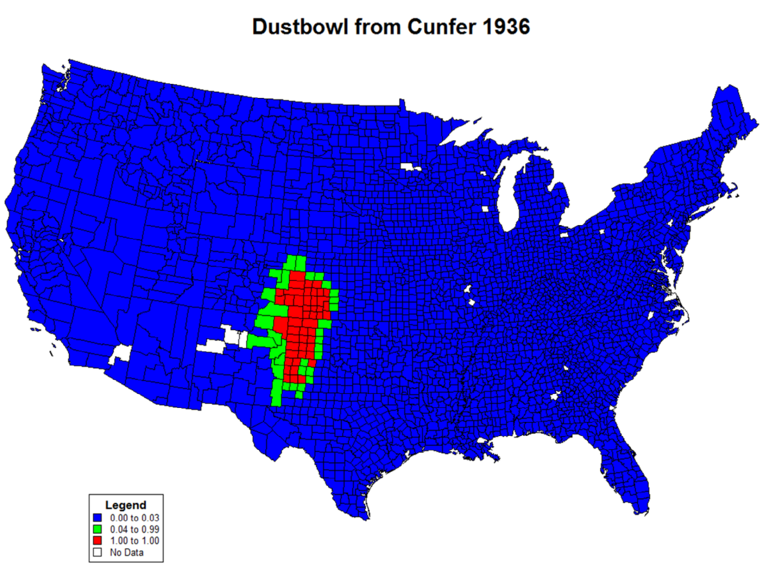


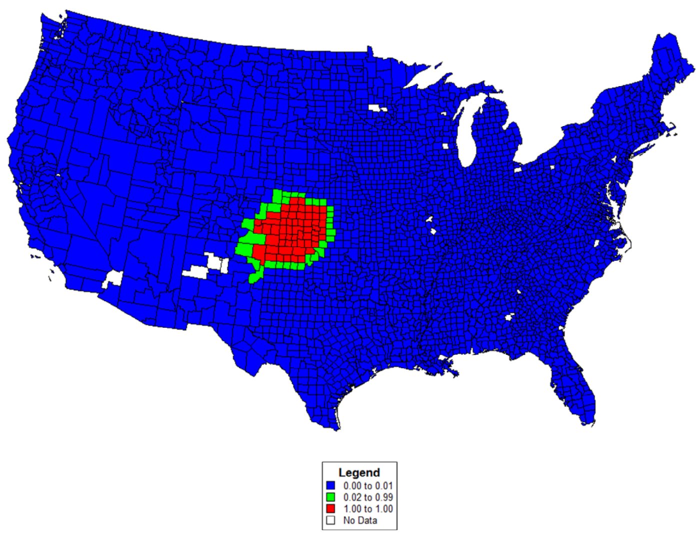
Figure 4 a-d

Dust Bowl Figures

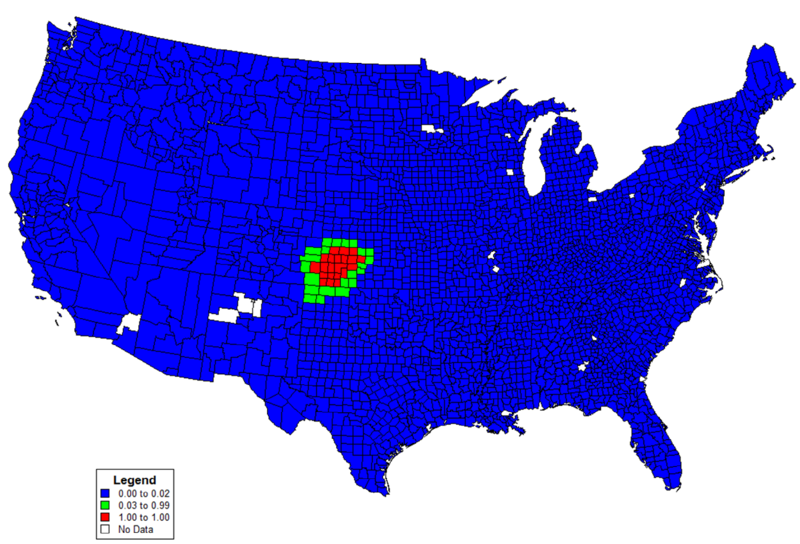




Dust Bowl 1938 Based on Cunfer



Dust Bowl 1940 - Cunfer



Appendix Table 1

Variables Used in the Models

Variable Name	Description	All years or interpolation procedure
imr	Infant mortality rate, number of infant deaths per thousand live births	All years
drat	Non-infant mortality rate, number of deaths of people over age one per thousand population	Deaths all years, population is 1930, 1940 and straight-line interpolation in between
pctill	Percent illiterate	1930, 1940, straight-line interpolation in between
pradiot	Percent families with radios	1930, 1940, straight-line interpolation in between
pcmg1529	Circulation of 15 national magazines as of January 1 1929 per person in 1930	1929, same value throughout
rtsapcsy	Retail sales per capita	1929, 1933, 1935, 1939, interpolated using state personal income in between
autorpop	Auto registrations per capita	1930, 1931, 1936, interpolated using state information in between
taxrtpop	Tax returns per capita	all years
crpvalis	Crop values	1929, 1939, interpolated using state information on crop value in between
phomeown	Percent homeowners	1930, 1940, straight-line interpolation in between
fcgpwapc	Public Works Admin. Federal and Nonfederal grants per capita	county total for June 1933 through June 1939 distributed using state information
fcgaaapc	Agricultural Adjustment Administration grants per capita	county total for June 1933 through June 1939 distributed using state information
fcgrelpc	Relief spending per capita by WPA, FERA, CWA, SSA, and FSA grants	county total for June 1933 through June 1939 distributed using state information
fcgprapc	Public Roads Administration grants per capita	county total for June 1933 through June 1939 distributed using state information
fcldlcpc	Disaster Loan Corporation loans per capita	county total for June 1933 through June 1939 distributed using state information
fclfarpc	Farm loans per capita	county total for June 1933 through June 1939 distributed using state information
fclrfcpc	Reconstruction Finance Corporation Loans per Capita	county total for June 1933 through June 1939 distributed using state information

fclushapc	U.S. Housing Authority Loans per capita	county total for June 1933 through June 1939 distributed using state information
cccfy	Number Civilian Conservation Corps camps started in fiscal year t	all years
cccfyl	Number Civilian Conservation Corps camps started in fiscal year t-1	all years
cccfyl2	Number Civilian Conservation Corps camps started in fiscal year t-2	all years
tbedinffem	Hospital beds per 1000 women aged 15-44, hospitals that might help infants	all years
odirty30	Number of people employed in polluting industries of chemicals, cigars and cigarettes, glass, bread, meat packing, autos, iron and steel, nonmetals, planing mills, lumber mills, boots and shoes, printing, apper, cotton textiles, and rubber	1930, same value throughout
coaltone	County coal tonnage in year t	Coal tonnage based on tonnage/employment ratio in 1930 and then interpolated using state estimates of coal tonnage
tbbovine	Results of Bovine Tuberculosis Status tests	Annual based on tests in May through July for 1930 through 1937, October in 1938 and 1939, and January 1941 for 1940
gfr	General Fertility Rate, Births per 1000 women aged 15-44	Annual birth information divided by trend number of women aged 15 to 44 interpolated between 1930 and 1940 Census
pp0509	Percent of Population aged 5-9	1930, 1940, straight-line interpolation in between
pp1014	Percent of Population aged 10-14	1930, 1940, straight-line interpolation in between
pp1519	Percent of Population aged 15-19	1930, 1940, straight-line interpolation in between
pp2024	Percent of Population aged 20-24	1930, 1940, straight-line interpolation in between
pp2529	Percent of Population aged 25-29	1930, 1940, straight-line interpolation in between
pp3034	Percent of Population aged 30-34	1930, 1940, straight-line interpolation in between
pp3544	Percent of Population aged 35-44	1930, 1940, straight-line interpolation in between
pp4554	Percent of Population aged 45-54	1930, 1940, straight-line interpolation in between
pp5564	Percent of Population aged 55-64	1930, 1940, straight-line interpolation in between

pp6574	Percent of Population aged 65-74	1930, 1940, straight-line interpolation in between
pp75up	Percent of Population aged 75-up	1930, 1940, straight-line interpolation in between
pcturb	Percent Urban	1930, 1940, straight-line interpolation in between
pforb	Percent Foreign-born	1930, 1940, straight-line interpolation in between
pctneg	Percent Negro	1930, 1940, straight-line interpolation in between
popdens	Population density	1930, 1940, straight-line interpolation in between
pelec	Percent of families with Electricity	1930, 1940, straight-line interpolation in between
memppop	Manufacturing Employment as a percentage of the population	manufacturing employment in 1930, 1940 interpolated between years using census of manufacturing county evidence for 1929, 1931, 1933, 1935, 1937, and 1939 and state information on manufacturing employment in between, population is 1930 and 1940 with straight-line interpolation in between
rtemppop	Retail employment as a percentage of the population	1930, 1940, straight-line interpolation in between
lake	Average number of lakes in county .	same value throughout
swamp	Average number of swamps in county .	same value throughout
elevmax	Average max elevation in county .	same value throughout
elevrang	Average elevation range in counties	same value throughout
rptotc26	Percent church members 1926/pop1930	same value throughout
riv1120	Average number of rivers that pass through 11-20 counties in county, population weight	same value throughout
riv2150	Average number of rivers that pass through 21-50 counties in county, population weight	same value throughout
riv51up	Average number of rivers that pass through 51 and over counties in county, population weight	same value throughout
bay	Average number of bays in county .	same value throughout
beach	Average number of beaches in county .	same value throughout
coastat	County on Atlantic Ocean	same value throughout
coastpc	County on Pacific Ocean	same value throughout
coastgu	County on Gulf of Mexico	same value throughout

coastgl	County on Great Lakes	same value throughout
area30	1930 area in square miles	1930, same value throughout
Notes	For infant mortality rate the percentages of population of all ages were replaced by the percentages of women aged 15 to 44 in age groups 20-24, 25-29, 30-34, 35-44.	
	In the difference regressions, the change in the following time-varying variables were included: rtsapcsy, autorpop, taxrtpop, crpvalis, fcgpwapc, fcgaaapc, fcgrelpc,fcgprapc, fcldlcpc,fclfarpc,fclrfcpc,fclushapc, cccfy, tbedinffem, tbbovine, gfr	

Data Appendix
To Be Completed.

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