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Rainfall Risk and Religious Membership in the Late Nineteenth-Century United States

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Abstract

Building on the idea that religious communities provide mutual insurance against some idiosyncratic risks, we argue that religious membership is more valuable in societies exposed to greater common risk. In our empirical analysis we exploit rainfall risk as a source of common economic risk in the nineteenth-century United States and show that religious communities were larger in counties where they faced greater rainfall risk. The link between rainfall risk and the size of religious communities is stronger in counties that were more agricultural, that had lower population densities, or that were exposed to greater rainfall risk during the growing season.

Keywords: Religious community size, agricultural risk, informal insurance

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1 Introduction

Most of today's major religious communities provide social assistance and access to social support networks, and religious communities throughout history have often been the main source of social support beyond the family (McBride, 1962; Bremner, 1994; Parker, 1998; Pullan, 1998, 2005; Gruber and Hungerman, 2007; Belcher and Tice, 2011). The social support provided by religious communities appears to be a type of informal mutual insurance that may have been especially valuable in early agricultural societies exposed to much economic risk and without formal insurance mechanisms (McCleary and Barro, 2006a). The great economic risk faced by early agricultural societies could therefore have contributed to the historical spread of today's major religious communities, and their beliefs in the spiritual rewards of mutual aid and charity, but empirical evidence is lacking.

Historical census data for the United States provide a rare opportunity to examine the link between exposure to economic risk and the size of religious communities in a society with little formal insurance. In 1890, the US Census collected data on religious membership and the seating capacity of churches in all counties. Data on the seating capacity of churches are also available for 1850, 1860, and 1870. Agriculture was the dominant sector in more than four of five counties until 1890 (Haines, 2010). As almost all of agriculture was rainfed, output was subject to rainfall risk (USDA, 1923, 1925). The rainfall data needed to obtain proxies for rainfall risk at the county level are available starting in 1895 (PRISM, 2011). Hence, we can examine the link between exposure to economic risk and the size of religious communities by analyzing whether late nineteenth-century religious communities in the United States were larger in counties where they faced greater rainfall risk.[1]

Our theoretical analysis of the link between economic risk and the size of religious communities across late nineteenth-century US counties builds on the idea that religious communities insure their members against some risks and considers religious membership to be a social activity that reduces the time available for other activities (Berman, 2000; McCleary and Barro, 2006a,b; Dehejia, DeLeire, and Luttmer, 2007; Glaeser and Sacerdote, 2008; Chen, 2010). We think of late nineteenth-century farmers in a county as being subject to two different types of production risks; uninsurable county-level rainfall risk and idiosyncratic risk that is (partly) insurable within local religious communities. We then show that the value of the insurance provided within local religious communities is greater in counties exposed to greater rainfall risk if the degree of relative risk aversion is in the empirically relevant range. As a result, religious communities end up being larger in counties where they face greater rainfall risk.

In the United States, religious communities are widely regarded as having been the main

[1] As we can only measure rainfall risk since 1895, our empirical analysis presumes that nineteenth-century differences in rainfall risk across counties persisted into the twentieth century. Our rainfall data for 1895-2000 indicate that county-level rainfall risk is very persistent over time.

source of social assistance – especially in agricultural regions – until the rise of government social spending at the beginning of the twentieth century (McBride, 1962; Lindert, 2004; Gruber and Hungerman, 2007).[2] Data on nineteenth-century church spending indicate substantial expenditures on local relief and charity (Nemeth and Luidens, 1994). There is also extensive historical evidence that local religious community members supported each other in case of need (see e.g., Trattner, 1974; Bodnar, 1985; Gjerde, 1985; Overacker, 1998; Szasz, 2004; Bovee, 2010). Even today about half of those who attend religious services at least once a year believe that their local church would help "a great deal" in response to illness or some other difficult situation (Glaeser and Sacerdote, 2008; Smith et al., 2013).

Our empirical analysis indicates a positive link between rainfall risk and the size of religious communities across US counties in 1890 and also in 1870 and 1860. In 1890, a year for which we have data on church membership and seating capacity for more than 2500 counties, we find that an increase of one standard deviation in rainfall risk is associated with a nearly 10-percent increase in the size of religious communities. If rainfall risk affects membership in religious communities through agricultural production risk, then there should be a link between rainfall risk and the size of religious communities among agricultural counties. We therefore undertake a separate analysis of the link between rainfall risk and religious community size among counties whose population densities are below and above the median and also split counties into those above and below the median of value added in agriculture relative to manufacturing. We find a statistically significant link between rainfall risk and the size of religious communities among counties with below-median population densities and also among counties with above-median agricultural value added. On the other hand, the link between rainfall risk and the size of religious communities among more densely populated counties and among counties with lower agricultural value added is usually statistically insignificant. For 1850, we do not find a statistically significant link between rainfall risk and the size of religious communities. We argue that the difference with our findings for 1860, 1870, and 1890 arises because of sample size and sample selection, as the number of counties with the necessary data declines as we go further back in time and we lose mostly agricultural counties.

The US Census for 1910, 1920, and 1930 collected county-level data on the value of crops produced. These data, when combined with historical rainfall levels, provide an opportunity to examine the relationship between rainfall and agricultural productivity that underlies our analysis for a period close to the late nineteenth century. The data can also be used to

[2] At the end of the nineteenth century, fraternal groups and labor unions started gaining in importance. But religious communities were the associations with by far the widest geographic spread – more than 97 percent of US counties had at least one church in 1890 – and the largest membership (Putnam, 2000). Religious communities are still the associations with the largest membership in the United States. More than 37 percent of respondents in the General Social Survey self-identify as a member of some church group, and 38 percent of respondents indicate that they participated more than twice in a church activity during the preceding year (Smith et al., 2013). These figures more than triple their counterparts for trade unions, fraternal groups, hobby clubs, or neighbor associations.

assess the importance for agricultural productivity of rainfall during the growing season and the nongrowing season – which in the US at the beginning of the twentieth century were March to November and December to February, respectively (Covert, 1912). Our results indicate that rainfall during the growing season has a stronger effect on the value of crops produced per acre than nongrowing-season rainfall. Hence, if rainfall risk affects membership in religious communities through agricultural production risk, then the link between the size of religious communities and rainfall risk should be stronger for growing-season rainfall risk than nongrowing-season rainfall risk. When we relate the size of religious communities to growing-season rainfall risk, nongrowing-season rainfall risk, and a cross-season covariance term, we find that the statistically significant link is mostly with growing-season rainfall risk.

The US Census also collected county-level data on the 1890 population's foreign birthplaces and on the foreign birthplaces of the 1880 population's parents. When we use these data to control for effects of national cultures on the size of religious communities in 1890, we find that the link between rainfall risk and the size of religious communities remains largely unaffected. This link is unaffected also when we use US census data on the size of different religious denominations to control for differences in religious cultures.

The rest of this paper is structured as follows. Section 2 discusses the related literature. Section 3 presents a theoretical analysis of the value of partial insurance against idiosyncratic risk and the size of religious communities when there is common agricultural output risk. Section 4 details our estimation framework. Section 5 presents our data and empirical findings. Section 6 concludes.

2 Related Literature

Our work is related to various strands of literature. Within the literature on the economic determinants of religious activity, Chen (2010) is the most closely related. Using Indonesian micro panel data, he shows that rapid inflation during the 1997-1998 financial crisis lowered the real incomes of government employees but increased the real incomes of wetland farmers. Chen finds that, during the first half of 1998, these changes led to increased attendance at communal Koran study groups by government employees and to decreased attendance by wetland farmers. He argues that such behavior can be explained as a form of ex-post insurance. Chen also finds that religious institutions facilitate consumption smoothing within local communities. This result is consistent with Dehejia, DeLeire, and Luttmer (2007), who find that US households that contribute to a religious organization are better able to insure their consumption against income shocks and that individuals who attend religious services are better able to insure their happiness. Chen's and Dehejia, DeLeire, and Luttmer's studies provide evidence that religious communities partially insure those who participate in their activities. We take partial insurance within religious communities as given and examine whether religious communities are larger when the value of such insurance is greater. Also, whereas Chen studies individual responses of religious activity to specific economic shocks in an ex-post insurance framework, we examine the link between the exposure to economic risk and aggregate membership in religious communities in an ex-ante insurance setting.

Our analysis is also related to the literature documenting that religious communities respond to the demand for social assistance. Hungerman (2005) finds that the 1996 US welfare reform, which decreased services to noncitizens, was followed by increased member donations and community spending of Presbyterian congregations. Gruber and Hungerman (2007) show that the New Deal social programs crowded out charitable spending of six Christian denominations. Hungerman (2009) finds that a US Supreme Court-mandated expansion of Social Security insurance in 1991 crowded out charitable spending of United Methodist churches.

Given that religious communities provide social support, it is natural to wonder whether the decline in religious membership in many developed economies is related to rising government welfare expenditures.[3] Gill and Lundsgaarde (2004) find that welfare expenditures have a negative effect on church attendance across countries. Franck and Iannaccone (2014) find some (weaker) support for a negative effect of welfare spending on church attendance using retrospective panel data for 8 European countries, Canada, and the United States. Scheve and Stasavage (2006) point out that church attendance and government welfare expenditures could be related also because religiosity changes preferences for social insurance – possibly because of the psychological benefits of religiosity when individuals are dealing with adverse events (Pargament, 1997). In their empirical work, Scheve and Stasavage show that religiosity has a negative effect on preferences for social insurance at the individual level and that this finding can account for the negative effect of religiosity on welfare expenditures across countries.[4]

Bentzen (2013) observes that if religiosity helps people deal with adverse events, then it may spread more easily in areas where natural disasters are more frequent. Using regional data on earthquakes, volcano eruptions, and tropical storms for a large number of countries, she finds a robust effect of natural disasters on a range of religious beliefs while controlling for individual and country characteristics. On the other hand, Bentzen finds no robust effect of natural disasters on church attendance.[5] She finds the same pattern of results

[3] A main question in the literature on the determinants of religious membership is whether membership depends on income, see McCleary and Barro (2006a,b), Becker and Woessmann (2013), and Franck and Iannaccone (2014) for example.

[4] There is also a literature on the consequences of religious participation for economic outcomes at the individual and country level, see Barro and McCleary (2003) and Gruber (2005) for example.

[5] This result is consistent with recent findings on the psychological benefits of religiosity. In their long-term panel study of depression risk, Miller et al. (2012, 2014) find that religiosity and spirituality – but not church attendance – are associated with greater cortical thickness and lower risk of depression.

when investigating religiosity and church attendance among second-generation immigrants from regions that had suffered natural disasters.

Much of the theoretical economics literature views religious communities as clubs that sustain the provision of local public goods, including social insurance, with the help of social sanctions and prohibitions, see Iannaccone (1992, 1998). Berman (2000) and Abramitzky (2008) expand this framework and discuss how mutual insurance is sustained among ultra-Orthodox Jews and *kibbutzniks*, respectively. We build on this literature and take it as given that religious communities can insure their members against at least some risks. We also borrow from the literature that considers religious membership to be a social activity (e.g., Azzi and Ehrenberg, 1975; Glaeser and Sacerdote, 2008).

Our work is also related to the literature on informal insurance in economies with little insurance supplied by governments or markets. The literature points to a wide range of informal insurance mechanisms, from the scattering of agricultural plots to reciprocal gift exchange, see Alderman and Paxson (1994), Townsend (1995), Dercon (2004), and Banerjee and Duflo (2011). This literature also discusses informal insurance mechanisms in response to (growing-season) rainfall risk, see Rosenzweig (1988a,b) and Rosenzweig and Stark (1989) on informal insurance and family structure and Durante (2010) on informal insurance and interpersonal trust.

3 A Model of Common Rainfall Risk, Idiosyncratic Risk, and Religious Membership

In our model, agriculture is subject to two different types of production risks. The first, county-level rainfall risk, is common to all farmers in the same county and therefore not insurable within counties. The second production risk faced by farmers is idiosyncratic. We take (some of) the idiosyncratic risk faced by farmers to be insurable within local religious communities but assume that religious membership takes time that could be used for alternative social activities. Our model predicts that for an empirically plausible degree of relative risk aversion, the value of the insurance provided within local religious communities is greater in counties with greater rainfall risk. As a result, more farmers join religious communities in counties with greater rainfall risk and religious communities are larger where they face greater rainfall risk (holding expected agricultural income constant).

Agricultural production Consider a nation made up of many counties. Each county is inhabited by a continuum of ex-ante identical farmers of measure 1. Agricultural output Y_{fc} produced by farmer f in county c by the end of a year depends on fixed county characteristics

Z_c, county-level rainfall R_c, and the farmer's labor input s_f,

$$Y_{fc} = s_f R_c^{\beta} Z_c \tag{1}$$

where R_c is a weighted average of monthly rainfall levels R_{mc} during the year,

$$R_c = \prod_{m=1}^{12} R_{mc}^{\alpha_m} \tag{2}$$

with $\sum_{m=1}^{12} \alpha_m = 1$. The parameter β captures the percentage increase in agricultural output in response to a 1-percent increase in rainfall every month.[6] The parameters α_m capture that rainfall may be more important in some months than in others and allow us to accommodate the empirical evidence that rainfall matters more during growing-season months.

Monthly rainfall levels at the county level $R_{mc} \geq 0$ are taken to be random and follow a joint log-normal distribution with county specific distribution parameters.[7] The amount of labor each farmer is able to put into production $s_f \geq 0$ is taken to be subject to idiosyncratic shocks – health shocks or accidents for example – and log-normally distributed with a mean and variance that does not depend on the farmer. We take idiosyncratic labor input risk to be independent of county-level rainfall risk (it would be straightforward to allow for some correlation).

Consumption and religious membership We think of religious community membership as a social activity that provides insurance against idiosyncratic labor input shocks. Farmers must decide whether to join a religious community before the realization of rainfall and labor input shocks. The utility function of farmers is

$$V_{fc} = \frac{C_{fc}^{1-\rho} - 1}{1-\rho} - q_c p_f M_{fc}. \tag{3}$$

The first term captures the utility of consumption $U(C_{fc})$ using a constant relative risk aversion utility function with relative risk aversion $\rho > 0$. The second term captures the disutility from the social activities required for religious membership. The indicator variable M_{fc} is equal to 1 if the farmer is a member of a religious community and 0 otherwise. The parameter $p_f \geq 0$ captures individual heterogeneity in the disutility incurred by the social activities required for religious membership, while $q_c > 0$ captures county-specific factors.

[6] Our empirical analysis using data on the value of crops produced from the 1910, 1920, and 1930 US census indicates that the log-linear relationship between output and rainfall in equation (1) describes the data quite well, see Section 5.2 and Figure A.2.

[7] Assuming a log-normal distribution implies that the natural logarithm (ln) of monthly rainfall is normally distributed. Figure A.1 plots the standardized distributions of ln rainfall at the county level for the 1895-2000 period for each month of the year.

Farmers with $p_f = 0$ value social activities required for religious membership as highly as the social activities they would engage in if they did not join a religious community; hence, their utility from social activities does not change with religious membership. In contrast, farmers with $p_f > 0$ experience reduced utility from social activities when they join a religious community; the reason is that they value the social activities required for religious membership less than their preferred alternative activities.

The value of insurance against idiosyncratic risk Farmers consume their agricultural output Y_{fc} so consumption is subject to both rainfall risk and labor input risk. We assume that religious communities are able to sustain perfect mutual insurance against idiosyncratic labor input risk.[8] The increase in the expected utility of consumption $\Delta EU(C_{fc})$ that comes with religious community membership is straightforward to calculate as our assumptions imply that the utility of consumption is log-normally distributed,

$$\ln \Delta EU(C_{fc}) = \mu + (1-\rho) \ln EY_c + \frac{\rho(\rho-1)\beta^2}{2} RVar_c \tag{4}$$

where EY_c is expected output in the county, $RVar_c = Var(\ln R_c)$ captures county-level rainfall risk, and μ depends on preference and technology parameters as well as on the amount of idiosyncratic risk. Hence, holding expected output constant, the consumption utility gain of religious membership is increasing in the amount of rainfall risk $RVar_c$ farmers face if and only if their degree of relative risk aversion is strictly greater than unity, $\rho > 1$. Intuitively, this is because $\rho > 1$ implies that idiosyncratic risk and rainfall risk aggravate each other in the sense that a negative realization of one risk for the utility of consumption is worse the lower the realization of the other risk (Franke, Schlesinger, and Stapleton, 2006). Formally, $\rho > 1$ implies $\partial \left[\partial U(C[R,s])/\partial R\right]/\partial s < 0$ where $U(C)$ is the utility of consumption and $C[R,s]$ captures that output, and therefore consumption, depends on both rainfall and labor. When the degree of relative risk aversion is smaller than unity, $\rho < 1$, idiosyncratic risk and rainfall risk actually ameliorate each other $\partial \left[\partial U(C)/\partial R\right]/\partial s > 0$ because the complementarity between rainfall and labor in agricultural production in (1) implies that a negative idiosyncratic shock has a lower output cost when rainfall is low. Most estimates of the coefficient of relative risk aversion in the literature exceed unity, see for example Attanasio and Weber (1989), Vissing-Jorgensen and Attanasio (2003), and Chiappori and Paiella (2011).[9]

[8]We could also assume that religious communities are able to insure only part of the idiosyncratic risk but this would not add insights as far as we can see but complicate the notation. In our model, perfect insurance of the idiosyncratic risk within religious communities is possible as long as the community has a positive measure of members. A model with a discrete number of members could capture two opposing effects absent from our analysis. On the one hand, larger religious communities can spread idiosyncratic risk better. On the other hand, larger communities may have more difficulties in avoiding free riding (Iannaccone, 1992).

[9]While these estimates rely on post-World War II data, risk aversion in the late nineteenth-century United States, when incomes were closer to subsistence levels and less government insurance was available,

Rainfall risk and the size of religious communities Farmers with $p_f = 0$ always join religious communities; after all, they enjoy the social activities required for religious membership no less than alternative social activities, and religious communities provide insurance against idiosyncratic shocks. Farmers with $p_f > 0$ face a trade-off because religious membership decreases their utility from social activities but provides insurance against idiosyncratic shocks. Combining (3) and (4) yields that farmers join a religious community if and only if the insurance gain exceeds the cost of religious membership

$$\mu + (1-\rho)\ln EY_c + \frac{\rho(\rho-1)\beta^2}{2} RVar_c \geq \ln q_c + \ln p_f. \tag{5}$$

County-specific variables affecting the disutility of religious membership can be accounted for by allowing $\ln q_c$ to depend on such variables as county income or county size X_c,

$$\ln q_c = \theta \ln EY_c + \nu \ln X_c. \tag{6}$$

We assume that the individual-specific element of the disutility of religious membership $\ln p_f$ is distributed according to some cumulative distribution function $H(x)$. Combined with (5) and (6), this implies that the size of the religious community in county c, $M_c = \int_f M_{fc}$, is

$$M_c = H\left(\mu - (\theta + \rho - 1)\ln EY_c - \nu \ln X_c + \frac{\rho(\rho-1)\beta^2}{2} RVar_c\right). \tag{7}$$

Hence, religious communities are larger in counties with greater rainfall risk if $\rho > 1$.

Rainfall risk during the growing and nongrowing season The agricultural production function in (1) and (2) allows for heterogenous effects of monthly rainfall. According to the literature on the effect of weather on crop yields, rainfall matters more in growing-season months than in nongrowing-season months (Schlenker and Roberts, 2009). We now examine what this implies for the importance of nongrowing-season versus growing-season rainfall risk for the size of religious communities in our theoretical model.

The US nongrowing season varies by crop and state – see Covert (1912) and USDA (2007) for, respectively, historical and modern data – but it typically includes the months of November, December, and January.[10] Define $N = \{\text{December, January, February}\}$ and $G = \{\text{March}, \ldots, \text{November}\}$ and express the sum of the monthly rainfall effects in (2) over the growing season and the nongrowing season as

$$a_N = \sum_{m \in N} \alpha_m \quad \text{and} \quad a_G = \sum_{m \in G} \alpha_m. \tag{8}$$

is usually thought to have been at least as high (Kimball, 1988).

[10]Covert (1912) records the growing season for corn, wheat, and cotton as running from March through November.

Using this notation, rainfall risk $RVar_c = Var(\ln R_c)$ can be written in terms of rainfall risk during the growing season, rainfall risk during the nongrowing season, and a covariance term,

$$RVar_c = a_G^2 RVar_c^G + a_N^2 RVar_c^N + a_G a_N RCov_c \tag{9}$$

where $RVar_c^G$ and $RVar_c^N$ capture growing-season and nongrowing-season rainfall risk

$$RVar_c^G = Var\left(\sum_{m\in G} \alpha_{Gm} \ln R_{mc}\right) \tag{10}$$

$$RVar_c^N = Var\left(\sum_{m\in N} \alpha_{Nm} \ln R_{mc}\right), \tag{11}$$

with $\alpha_{Gm} = \alpha_m/a_G$ and $\alpha_{Nm} = \alpha_m/a_N$. $RCov_c$ is twice the covariance between growing and nongrowing-season rainfall

$$RCov_c = 2Cov\left(\sum_{m\in G} \alpha_{Gm} \ln R_{mc}, \sum_{m\in N} \alpha_{Nm} \ln R_{mc}\right). \tag{12}$$

From (7) and (9) we know that relative to the importance of growing-season rainfall risk for the size of religious communities, the importance of nongrowing-season rainfall risk is $(a_N/a_G)^2$. As a_N/a_G is equal to the agricultural output effect of nongrowing-season rainfall relative to growing-season rainfall, $a_N/a_G = \beta_N/\beta_G$ see (1), (2), and (8), it follows that we can assess the importance of nongrowing-season versus growing-season rainfall risk for the size of religious communities by estimating β_N and β_G.

4 Estimating the Effect of Rainfall Risk on the Size of Religious Communities

Our empirical investigation of the link between rainfall risk and the size of religious communities across US counties in the late nineteenth century begins with a log-linearized version of (7)

$$\ln \textit{Religious community size}_c = \varphi + \lambda RVar_c + \gamma \ln EY_c + \phi \ln X_c \tag{13}$$

where $RVar_c$ is rainfall risk, EY_c expected agricultural output, and X_c other variables that affect the size of religious communities. The parameter of interest is λ, the link between rainfall risk and the size of religious communities. To estimate (13) we need proxies for rainfall risk and expected agricultural output, which in turn requires county-level rainfall data for a sufficiently long period of time as well as values for the parameters β and α_m in the agricultural production function in (1) and (2). Our main analysis is for the case where monthly rainfall enters the agricultural production function symmetrically. However, we also examine the case where the effect of rainfall on output is smaller in the nongrowing season than in the growing season.

Symmetric effects of monthly rainfall When monthly rainfall enters the agricultural production function in (1) and (2) symmetrically, $\alpha_m = \alpha$, the rainfall risk measure becomes

$$RVar_c = Var\left(\frac{1}{12}\sum_{m=1}^{12} \ln R_{mc}\right) \tag{14}$$

and expected agricultural output can be written as

$$\ln EY_c = \ln \delta Z_c + \ln E\left(\prod_{m=1}^{12} R_{mc}^{\frac{\beta}{12}}\right) = \ln \delta Z_c + \ln RY_c \tag{15}$$

where $RY_c = E\left(\prod_m R_{mc}^{\beta/12}\right)$ captures the effect of rainfall on average output. We estimate β, the average effect of rainfall on agricultural productivity in the late nineteenth-century United States, using county-level data on the value of crops from the US Census in 1910, 1920, and 1930. The availability of multiple observations for each county allows us to take a within-county approach. Our estimating equation is based on (1)

$$\ln Y_{ct} = \text{county FE \& time effects} + \beta\left(\frac{1}{12}\sum_{m=1}^{12} \ln R_{mct}\right), \tag{16}$$

where Y_{ct} is the value of crops per unit of farmland. The county fixed effects (FE) capture all fixed county characteristics. The time effects capture changes over time and are allowed to vary by state. We also control for the amount of farmland and estimate specifications with controls for contemporaneous temperature and lagged rainfall and temperature.

Substituting (15) into (13) yields our estimating equation for the link between rainfall risk and the size of religious communities

$$\ln \textit{Religious community size}_c = \lambda RVar_c + \gamma \ln RY_c + \phi \ln X_c + \varphi \ln Z_c \tag{17}$$

where $RY_c = E\left(\prod_m R_{mc}^{\beta/12}\right)$ with β estimated using (16), $RVar_c$ is defined in (14), and X_c, Z_c stand for other county characteristics that may influence agricultural output or the size of religious communities. The rainfall data we use is for the 1895-2000 period (the county rainfall data is only available since 1895).[11]

[11] Our empirical analysis therefore presumes that county-level rainfall risk during the nineteenth century was similar to rainfall risk over the 1895-2000 period. Or to put it differently, that county-level rainfall risk is persistent over time. Our data suggest this to be the case as the correlation coefficient between county-level rainfall risk over the 1895-1947 period and over the 1948-2000 period is 0.94.

Rainfall during the growing and nongrowing season To get a sense for the link between the size of religious communities and rainfall risk during the growing and the nongrowing season, we reestimate (17) after replacing the term for rainfall risk by

$$\lambda_G RVar_c^G + \lambda_N RVar_c^N + \delta RCov_c. \tag{18}$$

The variances and the covariance are defined in (10)-(12) and calculated as the corresponding moments over the 1895-2000 period, assuming symmetric effects of monthly rainfall within each season.

Our theoretical model implies that the importance for the size of religious communities of nongrowing-season rainfall risk relative to growing-season rainfall risk is $(a_N/a_G)^2$, where $a_N/a_G = \beta_N/\beta_G$ is the effect of nongrowing-season relative to growing-season rainfall on agricultural productivity. We can therefore assess the importance of nongrowing-season versus growing-season rainfall risk for the size of religious communities by reestimating the agricultural production function in (16) after splitting the rainfall effect into a growing-season effect and a nongrowing-season effect

$$\text{Rainfall effect} = \beta_G \left(\frac{1}{9} \sum_{m \in G} \ln R_{mct} \right) + \beta_N \left(\frac{1}{3} \sum_{m \in N} \ln R_{mct} \right). \tag{19}$$

5 Data and Empirical Results

5.1 Data

Size of religious communities 1850-1890 The decennial census of the United States during the period 1850-1890 collected information on churches at the county level. There are two measures of the size of religious communities, the seating capacity of churches in 1850, 1860, 1870, and 1890 (the 1880 data were never published) and the number of church members in 1890. Our data refer to all religious denominations listed in the US Census. These data are retrieved from ICPSR file 2896 (Haines, 2010). For summary statistics see the Appendix tables.

Climate data Our rainfall data come from PRISM (2011), which provides monthly rainfall data on a 4 times 4 km grid from 1895 onward. PRISM was developed for the National Oceanic and Atmospheric Administration and is also used by the US Department of Agriculture, NASA, and several professional weather channels.[12] We map the data into counties to obtain monthly rainfall at the county level. We also use PRISM data on monthly average temperature, which we process analogously to the rainfall data.

[12]See Deschenes and Greenstone (2007) who also use the PRISM data.

Soil and elevation data We control for 53 soil types using the US Department of Agriculture's SSURGO database.[13] We use these data to calculate the fraction of each county's land area that falls into the different soil categories. The source of our elevation data is the Environmental System Research Institute.[14] We calculate the fraction of each county's land area falling into the following 11 elevation bins: below 200 meters, 200 to 400 meters; 400 to 600 meters and so on up to 2000 meters; and above 2000 meters.

Other data The data on land area, population, value added in agriculture and in manufacturing, total farmland, value of crops produced, and the birthplace of foreign-born individuals come from the US Census and are retrieved from ICPSR file 2896 and IPUMS (Haines, 2010; Ruggles et al., 2010). Value added in manufacturing is calculated as manufacturing output minus the cost of materials. Value added in agriculture is calculated as output minus the cost of fertilizers in 1890; in 1860 and 1870, value added in agriculture is obtained as output in agriculture since there is no information on fertilizer purchases.

5.2 Empirical Results

Agricultural production and rainfall Table 1 reports our results on the effect of rainfall on the value of crops produced per unit of farmland from the US Census in 1910, 1920, and 1930 using the within-county estimation approach in (16). Our method of estimation is weighted least squares. We weight counties by their average farmland over the period as within-county changes in the value of crops per unit of farmland should be more closely related to county-level average rainfall when more land is under cultivation.[15] The value of crops reported in the US Census corresponds to the year preceding the census year so that t in (16) refers to 1909, 1919, and 1929. The "rainfall year t" data used in column (1) goes from December $t-1$ to November t. That is, the rainfall year t encompasses the growing and

[13] http://soils.usda.gov/surveys/geography/ssurgo/.

[14] www.esri.com.

[15] Deschenes and Greenstone (2007) use the same weights in a similar context. One reason for weighting is that idiosyncratic shocks to the output of different units of farmland are more likely to average out when more land is under cultivation. Another reason is that our measure of average rainfall refers to the average in a county as a whole, not the average on cultivated land. The discrepancy between these two averages should tend to be smaller in counties with more farmland when holding the share of land under cultivation constant. Moreover, the discrepancy should also tend to be smaller in counties with a larger share of land under cultivation and counties with more farmland tend to have a larger share of land under cultivation in our data. To see these last two points in a concrete example, let F be the acres of farmland in a county and $\phi \in (0,1)$ the share of land under cultivation. Take rainfall on acre i to be $R_i = R + \varepsilon_i$ with ε_i identically and independently distributed with mean zero and variance σ^2. Then the variance of the difference between rainfall per acre in the whole county and rainfall per acre on cultivated land is $\sigma^2(1-\phi)/F$. This means that average rainfall in the county is a better proxy for average rainfall on cultivated land in those counties with more farmland and/or with a greater share of land under cultivation. In any case, the unweighted least-squares results are similar to those in Table 1 in that all effects other than rainfall at t are statistically insignificant. The effect of rainfall at t is statistically significant at the 1-percent level but smaller than in Table 1, 0.27 as compared to 0.52 in the specification in column (3). Using the value of 0.27 in equation (17) does not affect any of our findings on the link between rainfall risk and religious membership (the point estimates change by only a small amount).

nongrowing season ending in year t.[16] Column (2) adds a control for the rainfall year $t-1$ which is defined analogously to rainfall year t and goes from December $t-2$ to November $t-1$. The results in columns (1) and (2) indicate a statistically significant effect of rainfall in year t while the effect of rainfall in year $t-1$ is statistically insignificant. The effect of rainfall in year t implies that a 1-percent increase in average monthly rainfall in year t raised the value of crops by around 0.5 percent at the beginning of the twentieth century.[17] In column (3) we add controls for average temperature in year t and $t-1$ (December $t-1$ to November t and December $t-2$ to November $t-1$, respectively). The average temperature effects are statistically insignificant, which probably simply reflects that the average monthly temperature data available is not a good basis to capture the effect of temperature on agricultural productivity (Deschenes and Greenstone, 2007; Schlenker and Roberts, 2009).

Rainfall risk and the size of religious communities Tables 2-5 present our results on the link between rainfall risk and the size of religious communities. The estimating equation is (17), and the estimation method is least squares. The variable on the left-hand side is either the natural logarithm (ln) of church membership (for 1890) or of church seating capacity (for 1890, 1870, and 1860). The right-hand-side control capturing the effect of rainfall on average agricultural output, $RY_c = E\left(\prod_m R_{mc}^{\beta/12}\right)$, is calculated using a value for β of 0.52 based on the results in Table 1. Other controls used are ln population and ln land area; the share of land of a given soil type using a 53-category soil classification system; the share of land at a given elevation using 11 elevation bins; average elevation; average temperature over the period 1895-2000; and state fixed effects.

Table 2, column (1) shows that the link between rainfall risk and church membership in 1890 is statistically significant at the 1-percent level. The point estimate implies that an increase of one standard deviation in rainfall risk is associated with an increase in church membership of about 11 percent (the cross-county standard deviation of rainfall risk is 0.054). Columns (2) and (3) split the full 1890 sample into counties with population densities below and above the median. Counties with lower population densities tend to be more agricultural. So, if rainfall risk affects church membership through economic risk in the agricultural sector, then we should expect a link between rainfall risk and church membership among these counties. Column (2) shows that the link between rainfall risk and church membership is in fact statistically significant at the 1-percent level among counties with population densities below the median. The point estimate implies that a 1-standard-

[16] Put differently, the "rainfall year t" encompasses the growing season of year t and the nongrowing season that lies partly in year t and partly in year $t-1$. Having rainfall years subsume both a growing and a nongrowing season facilitates comparisons when we allow for separate effects of rainfall during the two types of seasons.

[17] The log-linear relationship between agricultural output and rainfall appears to describe the data quite well, see Figure A.2.

deviation increase in rainfall risk is associated with an increase in church membership of about 15 percent. On the other hand, the link between rainfall risk and church membership among counties with relatively high population densities – a group that includes all urban US counties in 1890 – in column (3) is estimated imprecisely and is statistically insignificant.[18]

Table 2, columns (4) and (5) show the results when the full 1890 sample is split into counties with value added in agriculture relative to manufacturing above and below the median. The median share of agriculture over agriculture plus manufacturing is 0.87 and the average share of agriculture in counties above the median is 0.95. Counties with agricultural value added above the median are therefore almost entirely agricultural and quite uniformly so, as the difference between the share of agriculture in the most and the least agricultural county in this group is only 12 percentage points. Hence, if rainfall risk affects church membership through economic risk, then there should be a positive link between rainfall risk and church membership among these counties. The result in column (4) shows that the link is in fact positive and statistically significant at the 1-percent level. The point estimate implies that a 1-standard-deviation increase in rainfall risk is associated with an increase in church membership of about 19 percent. On the other hand, there is no statistically significant link between rainfall risk and church membership among the counties with agricultural value added below the median in column (5). It is worth noting that the agricultural sector is smaller than the manufacturing sector on average in this group of counties and that the group is also very heterogenous in terms of the share of agriculture.

Table 3 reestimates the specifications in Table 2 using church seating capacity in 1890 as a measure of the size of religious communities. The pattern of results is similar to the results obtained with church membership. The link between rainfall risk and church seating capacity in the full sample in column (1) is statistically significant at the 1-percent level. The point estimate implies that a 1-standard-deviation increase in rainfall risk is associated with an increase in church seating capacity of about 9 percent. When we split the sample by population density in columns (2) and (3) we find that the link between rainfall risk and church seating capacity among counties with population densities below the median in column (2) is statistically significant with a p-value of 0.051. The point estimate in column (2) implies that a 1-standard-deviation increase in rainfall risk is associated with an increase in church seating capacity of about 12 percent. Among the counties with relatively high population densities in column (3), the link between rainfall risk and church seating capacity is imprecisely estimated and statistically insignificant. Columns (4) and (5) split the sample by agricultural value added. Among the counties with agricultural value added above the median in column (4), the link between rainfall risk and church seating capacity is statistically significant at the 1-percent level. The point estimate implies that a 1-standard-

[18]Our findings on the link between rainfall risk and religious membership, as presented in Tables 2–5, are not affected when we also control for the variance in annual average temperature over the 1895–2000 period. The temperature variance is always statistically insignificant.

deviation increase in rainfall risk is associated with an increase in church seating capacity of about 30 percent. Among the counties with agricultural value added below the median in column (5), there is no statistically significant link between rainfall risk and church seating capacity.

Table 4 summarizes our results on the link between rainfall risk and church seating capacity in 1870. This sample is around 20 percent smaller than the 1890 sample. Even so, the results are similar to those for 1890 church seating capacity. The link between rainfall risk and church seating capacity in the full sample in column (1) is statistically significant at the 5-percent level. The point estimate implies that a 1-standard-deviation increase in rainfall risk is associated with an increase in church seating capacity of about 12 percent. In columns (2) and (3) we consider the sample split by population density. The link between rainfall risk and 1870 church seating capacity is statistically significant at the 1-percent level in counties with population densities below the median in column (2). The point estimate implies that a 1-standard-deviation increase in rainfall risk is associated with an increase in church seating capacity of about 19 percent among these counties. On the other hand, the link between rainfall risk and church seating capacity among counties with higher population densities in column (3) is imprecisely estimated and statistically insignificant. Columns (4) and (5) consider the sample split according to agricultural value added below and above the median. The median agricultural share in 1870 is 0.89 and counties with agricultural value added above the median are therefore, again, almost entirely agricultural and homogenous in terms of the share of agriculture. The link between rainfall risk and church seating capacity among the more agricultural counties in column (4) is statistically significant at the 5-percent level. The point estimate implies that a 1-standard-deviation increase in rainfall risk is associated with an increase in church seating capacity of about 40 percent. Rainfall risk shows a weaker, but still statistically significant, link with church seating capacity among less agricultural counties in column (5).

Table 5 reports our results on the link between rainfall risk and church seating capacity in 1860. The sample is nearly 30 percent smaller than the 1890 sample and about 10 percent smaller than the 1870 sample. Still, results are similar to those we obtained for 1870 and 1890 seating capacity. The link between rainfall risk and church seating capacity in the full sample in column (1) is statistically significant with a p-value of 0.054. The point estimate implies that a 1-standard-deviation increase in rainfall risk is associated with an increase in church seating capacity of about 11 percent. Columns (2) and (3) present the results when we split the sample by population density below and above the median. The link between rainfall risk and 1860 church seating capacity is statistically significant at the 5-percent level in counties with population densities below the median in column (2). The point estimate implies that a 1-standard-deviation increase in rainfall risk is associated with an increase in church seating capacity of about 12 percent. On the other hand, the link between rainfall risk and church seating capacity among counties with relatively high population densities in column (3) is imprecisely estimated and statistically insignificant. Columns (4) and (5) report the results of the sample split according to agricultural value added below and above the median. In 1860, the median share of agriculture was 0.91, and the difference between the most and least agricultural county in the group with above-median agricultural shares was 8 percentage points. Hence, counties with agricultural value added above the median were homogeneously almost entirely agricultural. The link between rainfall risk and church membership among the more agricultural counties in column (4) is statistically significant at the 10-percent level (the p-value is 0.072). The point estimate implies that a 1-standard-deviation increase in rainfall risk is associated with an increase in church seating capacity of almost 50 percent. On the other hand, rainfall risk does not show a statistically significant link with church membership among counties with agricultural value added below the median in column (5).

For the year 1850, we do not find a statistically significant link between rainfall risk and church seating capacity. We attribute this to the smaller number of counties and sample selection. The necessary data are available for approximately 1450 counties in 1850 compared to about 1820 counties in 1860; approximately 2070 counties in 1870; and 2650 counties in 1890. Moreover, most of the counties lost in 1850 compared to 1860, 1870, or 1890 are counties with low population density and high agricultural value added. The consequence of the drop in sample size and of sample selection between 1860 and 1850 can be illustrated by reestimating the link between rainfall risk and church seating capacity in the 1860 subsample of counties for which there are data in 1850. This always yields statistically insignificant estimates, whereas in the full 1860 sample results were similar to those for 1870 and 1890.

Agricultural production and seasonal rainfall Table 6 examines how the effect of rainfall on the value of crops per unit of farmland in Table 1 changes when we distinguish between rainfall during the growing and nongrowing season (March through November and December through February, respectively). Column (1) reproduces the specification of Table 1 that controls for rainfall in year t and $t-1$. In column (2) we split rainfall in year t and $t-1$ into growing-season rainfall and nongrowing-season rainfall as in (19). The estimates can be interpreted as the effects on agricultural productivity of a 1-percent increase in monthly rainfall during the growing-season and nongrowing-season in year t and $t-1$. We find that the effects of both growing-season and nongrowing-season rainfall in year t are positive and statistically significant. A 1-percent increase in monthly rainfall during the growing season raises agricultural productivity by 0.33 percent and a 1-percent increase in nongrowing-season rainfall raises productivity by 0.15 percent. For year $t-1$, only growing-season rainfall is statistically significant and enters positively. A 1-percent increase in monthly rainfall during the growing season in year $t-1$ increases agricultural productivity in year t

by 0.28 percent. The result in column (4) shows that the effects of rainfall on agricultural productivity change little when we control for average growing-season and non-growing season temperatures in year t and $t-1$.[19]

Seasonal rainfall risk and the size of religious communities Table 7 summarizes our results on the link between the size of religious communities and rainfall risk during the growing and nongrowing season. The estimating equation is (17) with the rainfall risk term replaced by (18). The control variables are the same as in Tables 2-5. Because we found rainfall during the growing season to be a significant determinant of agricultural productivity, our theory predicts a positive link between growing-season rainfall risk and the size of religious communities. Nongrowing-season rainfall mattered less for agricultural productivity than growing-season rainfall and we therefore expect nongrowing-season rainfall risk to matter less for the size of religious communities than growing-season rainfall risk. To get an idea of how much less important nongrowing-season rainfall risk should be, recall that equations (7)-(9) and (19) imply that the importance of nongrowing-season rainfall risk relative to growing-season rainfall risk for the size of religious communities is $(\beta_N/\beta_G)^2$ where β_G and β_N are the (contemporaneous) effects of growing-season and nongrowing-season rainfall on agricultural productivity. The formula changes somewhat when agricultural productivity also depends on lagged rainfall; in this case, the lagged effect of rainfall and the correlation between rainfall in different years plays a role too. In our data, the correlation between rainfall in different years is approximately zero. The appropriate formula for the relative importance of nongrowing-season versus growing-season rainfall risk for the size of religious communities is therefore $\left(\beta_{N,t}^2+\beta_{N,t-1}^2\right)/\left(\beta_{G,t}^2+\beta_{G,t-1}^2\right)$ with subscripts t and $t-1$ denoting the year t and $t-1$ effect of rainfall on agricultural productivity. Substituting the statistically significant rainfall effects in column (4) of Table 6 into this formula yields a value of 0.11.[20] Hence, the effect of nongrowing-season rainfall risk on the size of religious communities should be approximately one tenth of the effect of growing-season rainfall risk.

Table 7, column (1) reports our results on the link between rainfall risk during the growing and nongrowing season and church membership in 1890. The link between growing-season rainfall risk and church membership is positive and statistically significant at the

[19] It is worth noting that the effect of year $t-1$ growing-season average temperature is positive and statistically significant. However, the effect is small in the sense that it implies a small effect of growing-season temperature risk on the size of religious communities relative to the effect of growing-season rainfall risk. We elaborate on this point in the next footnote.

[20] The same approach can be used to calibrate the importance of growing-season temperature risk (the variance over time of average growing-season temperature) for religious membership relative to the importance of growing-season rainfall risk. In this case the appropriate formula is $(\omega_{G,t}^2+\omega_{G,t-1}^2)/(\beta_{G,t}^2+\beta_{G,t-1}^2)$ where $\omega_{G,t}$ is the effect of year t growing-season temperature on agricultural output. Substituting the statistically significant estimates in column (4) of Table 6 yields 0.056, which indicates that temperature risk should be substantially less important for religious membership than rainfall risk. When we add the growing-season temperature variance over the 1895-2000 period as a right-hand-side variable in our regressions, it is always statistically insignificant. Our other findings are unaffected by this change.

1-percent level. The link between nongrowing-season rainfall risk and church membership is positive and statistically significant at the 5-percent level. The point estimate on nongrowing-season rainfall risk is approximately one quarter of the point estimate on growing-season rainfall risk. Column (2) examines the link between rainfall risk during the growing and nongrowing season and church seating capacity in 1890. We find a positive and statistically significant link between growing-season rainfall risk and church seating capacity, whereas the link between nongrowing-season rainfall risk and church seating capacity is statistically insignificant. The results for 1870 and 1860 church seating capacity in columns (3) and (4) are similar to those for 1890. The link between growing-season rainfall risk and church seating capacity is statistically significant, whereas the link between nongrowing-season rainfall risk and church seating capacity is statistically insignificant. The covariance term is statistically insignificant in all cases except for 1870 church seating capacity.

Accounting for differences in national and religious cultures The US Census collected county-level data on the foreign birthplaces of the population in 1890 and the foreign birthplaces of the population's parents in 1880 (the data on birthplaces of foreign-born parents is not available in 1890). These data allow us to account for possible effects of national cultures on the size of religious communities in 1890. To do so, we first calculate for each US county the share of the 1890 population born in 33 different foreign places and the share of the 1880 population's parents born in those places.[21] We then include these shares as additional right-hand-side control variables in our church membership and seating capacity regressions.

Table 8 presents the results when we measure the size of religious communities using church membership. The main finding is that the link between rainfall risk and church membership changes little when we control for possible effects of national cultures, see Table 2 for comparison. The link between rainfall risk and church membership in the full sample in column (1) remains positive and statistically significant at the 1-percent level. When we split the sample by population density in columns (2) and (3), we again find a positive and statistically significant link between rainfall risk and church membership among counties with population densities below the median but a statistically insignificant link among counties with population densities above the median. Columns (4) and (5) split the sample into counties with agricultural value added above and below the median. We find a positive and statistically significant link between rainfall risk and church membership among more agricultural counties but a statistically insignificant link among less agricultural counties. Finally, in column (6) we consider the link between rainfall risk during the growing and

[21] The European foreign birthplaces listed in the census are Austria, Belgium, Bohemia, Canada, Denmark, France, Germany, Greece, Holland, Hungary, Ireland, Italy, Luxemburg, Norway, Poland, Portugal, Russia, Spain, Sweden, Switzerland, Turkey, United Kingdom, and "other European countries." For the Americas, the options are Atlantic Islands, Central America, Cuba, Mexico, and South America. The remaining categories are Africa, Asia, Australia, India, and Pacific Islands.

nongrowing season and church membership. We continue to find a stronger link between church membership and growing-season rainfall risk than between church membership and nongrowing-season rainfall risk. Table 9 reports the results when we measure the size of religious communities using church seating capacity. Controlling for national cultures actually strengthens our results on the link between rainfall risk and church seating capacity, see Table 3 for comparison.

As there are county-level data on religious membership by denomination, we can also control for the relative size of different religious denominations and thereby account for denominational differences in religious culture. To do so, we first calculate the share of church members in each county belonging to 12 different denominations and proceed analogously with church seating capacity.[22] We then include these shares as additional right-hand-side control variables when we regress the size of religious communities on rainfall risk. Table 10 reports the results when we measure the size of religious communities and the relative size of denominations using church membership. The main finding is that the link between rainfall risk and church membership changes little, see Table 2 and 8 for comparison. There is a positive and statistically significant link between rainfall risk and church membership in the full sample. When we split the full sample, the link is only statistically significant (and positive) among counties with population densities below the median and agricultural value added above the median. When we consider the link between growing-season and nongrowing-season rainfall risk on the one hand and church membership on the other, the link continues to be stronger for growing-season rainfall risk. Table 11 presents the results when we measure religious community size and the relative size of denominations using church seating capacity. Again, the link between rainfall risk and church membership changes little, see Table 3 and 9 for comparison.

6 Conclusion

We have built on the idea that religious communities insure their members against some idiosyncratic risks to argue that religious membership is more valuable in societies exposed to greater common economic risk. In our empirical analysis we used late nineteenth-century census data on church membership and seating capacity in the United States to see whether religious communities were larger in counties with greater rainfall risk. Our analysis focused on rainfall risk as a driver of common economic risk because most counties were agricultural at the time and rainfall was a significant determinant of agricultural output.

We found that religious communities were significantly larger in US counties with greater rainfall risk. The link between rainfall risk and the size of religious communities was stronger

[22]The denominations are taken from Gutmann's (2007) classification of nineteenth-century religious denominations into Baptists, Congregationalists, Conservatives, Disciples of Christ, Episcopal, Jewish, Lutherans, Methodists, Mormons, Presbyterians, Reformed, and Roman Catholics.

among more agricultural counties and among counties with lower population densities. The link was also stronger for rainfall risk during the growing season. A 1-standard-deviation increase in rainfall risk was associated with an increase in the size of religious communities around 10 percent across all counties. Among counties with agricultural value added above the median, a 1-standard-deviation increase in rainfall risk was associated with an increase in the size of religious communities between 20 percent (in 1890) and 50 percent (in 1860).

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Tables

Table 1: Rainfall and Value of Crops Produced in 1909, 1919, and 1929

	(1)	(2)	(3)
Rainfall t	0.515***	0.511***	0.516***
	(0.183)	(0.178)	(0.181)
Rainfall t-1		0.177	0.178
		(0.144)	(0.144)
Temperature t			0.0246
			(0.0377)
Temperature t-1			0.0212
			(0.0438)
County FE	Yes	Yes	Yes
Time effects	Yes	Yes	Yes
Farmland	Yes	Yes	Yes
R2	0.633	0.634	0.634
Number of counties	8,787	8,787	8,787

Notes: The left-hand-side variable is the natural logarithm (ln) of the value of crops produced per acre at the county level in 1909, 1919, and 1929. The results in column (1) are for the estimating equation in (16); see Section 4 and 5.2. (pages 12-13) for more details on the specification. Columns (2)-(3) add controls for lagged rainfall and for contemporaneous and lagged temperature. Temperature refers to average temperature. The method of estimation is weighted least squares with weights equal to the farmland of counties. All specifications control for ln farmland, time effects, and county fixed effects; time effects are allowed to vary by state. Standard errors (in parentheses) account for arbitrary heteroskedasticity and are clustered at the county level. ***, **, and * denote significance at the 1%, 5%, and 10% level respectively.

Table 2: Rainfall Risk and Church Membership in 1890

		Sample split: Population density		Sample split: Agriculture/manufacturing value added	
	Baseline	Below median	Above median	Above median	Below median
	(1)	(2)	(3)	(4)	(5)
Rainfall risk	2.122***	2.865***	0.771	3.606***	-1.426
	(0.631)	(0.933)	(2.385)	(1.160)	(1.045)
ln RY	0.175	0.109	0.569*	0.328	-0.207
	(0.185)	(0.167)	(0.331)	(0.324)	(0.184)
Soil shares	Yes	Yes	Yes	Yes	Yes
Elevation shares	Yes	Yes	Yes	Yes	Yes
Average elevation	Yes	Yes	Yes	Yes	Yes
Average temperature	Yes	Yes	Yes	Yes	Yes
Size	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes
R2	0.914	0.876	0.882	0.903	0.921
Number of counties	2,693	1,346	1,347	1,341	1,341

Notes: The left-hand-side variable is the natural logarithm (ln) of church membership at the county level in 1890. The estimating equation employed is (17). Rainfall risk is defined in equation (14) and calculated using 1895-2000 rainfall data. The RY variable is defined just after equation (17) and is calculated using the same rainfall data and a value $\beta = 0.52$. See Section 4 for more details on the specification and Section 5.1 for data sources. Other right-hand-side controls are ln population and ln land area of the county (size), the share of land of a given soil type using a 53-category soil classification system, the share of land at a given elevation using 11 elevation bins, average elevation, average temperature over the period 1895-2000, and state fixed effects. The method of estimation is least squares. Standard errors (in parentheses) account for arbitrary heteroskedasticity and are clustered at the state level. ***, **, and * denote significance at the 1%, 5%, and 10% level respectively.

Table 3: Rainfall Risk and Church Seating Capacity in 1890

		Sample split: Population density		Sample split: Agriculture/manufacturing value added	
	Baseline	Below median	Above median	Above median	Below median
	(1)	(2)	(3)	(4)	(5)
Rainfall risk	1.742***	2.253*	2.776	5.587***	-1.633
	(0.633)	(1.119)	(2.067)	(1.885)	(1.280)
ln RY	0.896**	0.709*	0.574	1.546***	0.355*
	(0.343)	(0.358)	(0.357)	(0.541)	(0.195)
Soil shares	Yes	Yes	Yes	Yes	Yes
Elevation shares	Yes	Yes	Yes	Yes	Yes
Average elevation	Yes	Yes	Yes	Yes	Yes
Average temperature	Yes	Yes	Yes	Yes	Yes
Size	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes
R2	0.902	0.870	0.832	0.895	0.916
Number of counties	2,651	1,325	1,326	1,322	1,323

Notes: The left-hand-side variable is the natural logarithm (ln) of church seating at the county level in 1890. The estimating equation employed is (17). Rainfall risk is defined in equation (14) and calculated using 1895-2000 rainfall data. The RY variable is defined just after equation (17) and is calculated using the same rainfall data and a value $\beta = 0.52$. See Section 4 for more details on the specification and Section 5.1 for data sources. Other right-hand-side controls are ln population and ln land area of the county (size), the share of land of a given soil type using a 53-category soil classification system, the share of land at a given elevation using 11 elevation bins, average elevation, average temperature over the period 1895-2000, and state fixed effects. The method of estimation is least squares. Standard errors (in parentheses) account for arbitrary heteroskedasticity and are clustered at the state level. ***, **, and * denote significance at the 1%, 5%, and 10% level respectively.

Table 4: Rainfall Risk and Church Seating Capacity in 1870

		Sample split: Population density		Sample split: Agriculture/manufacturing value added	
	Baseline	Below median	Above median	Above median	Below median
	(1)	(2)	(3)	(4)	(5)
Rainfall risk	2.268**	3.531***	0.897	7.220**	1.733*
	(1.074)	(0.957)	(4.379)	(3.388)	(0.916)
ln RY	0.449*	0.392*	0.724	1.426*	0.294
	(0.246)	(0.218)	(0.495)	(0.558)	(0.318)
Soil shares	Yes	Yes	Yes	Yes	Yes
Elevation shares	Yes	Yes	Yes	Yes	Yes
Average elevation	Yes	Yes	Yes	Yes	Yes
Average temperature	Yes	Yes	Yes	Yes	Yes
Size	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes
R2	0.825	0.678	0.799	0.721	0.898
Number of counties	2,068	1,034	1,034	1,033	1,034

Notes: The left-hand-side variable is the natural logarithm (ln) of church seating at the county level in 1870. The estimating equation employed is (17). Rainfall risk is defined in equation (14) and calculated using 1895-2000 rainfall data. The RY variable is defined just after equation (17) and is calculated using the same rainfall data and a value $\beta = 0.52$. See Section 4 for more details on the specification and Section 5.1 for data sources. Other right-hand-side controls are ln population and ln land area of the county (size), the share of land of a given soil type using a 53-category soil classification system, the share of land at a given elevation using 11 elevation bins, average elevation, average temperature over the period 1895-2000, and state fixed effects. The method of estimation is least squares. Standard errors (in parentheses) account for arbitrary heteroskedasticity and are clustered at the state level. ***, **, and * denote significance at the 1%, 5%, and 10% level respectively.

Table 5: Rainfall Risk and Church Seating Capacity in 1860

		Sample split: Population density		Sample split: Agriculture/manufacturing value added	
	Baseline	Below median	Above median	Above median	Below median
	(1)	(2)	(3)	(4)	(5)
Rainfall risk	2.079*	2.282**	4.417	8.999*	-0.444
	(1.047)	(0.989)	(3.033)	(5.006)	(0.989)
ln RY	0.0640	-0.292	1.100*	1.543*	-0.275
	(0.456)	(0.494)	(0.571)	(0.784)	(0.255)
Soil shares	Yes	Yes	Yes	Yes	Yes
Elevation shares	Yes	Yes	Yes	Yes	Yes
Average elevation	Yes	Yes	Yes	Yes	Yes
Average temperature	Yes	Yes	Yes	Yes	Yes
Size	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes
R2	0.805	0.665	0.807	0.726	0.873
Number of counties	1,822	911	911	909	909

Notes: The left-hand-side variable is the natural logarithm (ln) of church seating at the county level in 1860. The estimating equation employed is (17). Rainfall risk is defined in equation (14) and calculated using 1895-2000 rainfall data. The RY variable is defined just after equation (17) and is calculated using the same rainfall data and a value $\beta = 0.52$. See Section 4 for more details on the specification and Section 5.1 for data sources. Other right-hand-side controls are ln population and ln land area of the county (size), the share of land of a given soil type using a 53-category soil classification system, the share of land at a given elevation using 11 elevation bins, average elevation, average temperature over the period 1895-2000, and state fixed effects. The method of estimation is least squares. Standard errors (in parentheses) account for arbitrary heteroskedasticity and are clustered at the state level. ***, **, and * denote significance at the 1%, 5%, and 10% level respectively.

Table 6: Seasonal Rainfall and Value of Crops Produced in 1909, 1919, and 1929

	(1)	(2)	(3)	(4)
Rainfall t	0.511***		0.516***	
	(0.178)		(0.181)	
-- Rainfall t, Growing season		0.326*		0.325*
		(0.186)		(0.194)
-- Rainfall t, Nongrowing season		0.148***		0.147***
		(0.0363)		(0.0382)
Rainfall t-1	0.177		0.178	
	(0.144)		(0.144)	
-- Rainfall t-1, Growing season		0.279***		0.314***
		(0.0837)		(0.0837)
-- Rainfall t-1, Nongrowing season		-0.0482		-0.0497
		(0.0666)		(0.0644)
Temperature t			0.0246	
			(0.0377)	
-- Temperature t, Growing season				-0.0203
				(0.0459)
-- Temperature t, Nongrowing season				-0.00891
				(0.0214)
Temperature t-1			0.0212	
			(0.0438)	
-- Temperature t-1, Growing season				0.107**
				(0.0453)
-- Temperature t-1, Nongrowing season				-0.0208
				(0.017)
County FE	Yes	Yes	Yes	Yes
Time effects	Yes	Yes	Yes	Yes
Farmland	Yes	Yes	Yes	Yes
R2	0.634	0.638	0.634	0.639
Number of counties	8,787	8,787	8,787	8,787

Notes: The left-hand-side variable is the natural logarithm (ln) of the value of crops produced per acre at the county level in 1909, 1919, and 1929. The estimating equation is (16) with the rainfall term split into rainfall over the growing season and nongrowing season as in equation (19), see Section 4 and Section 5.2 (pages 12-13 and 17-18) for more details on the specification. Temperature refers to average temperature. The growing season is March-November, and the nongrowing season is December-February following Covert (1912), see page 8. The data sources are in Section 5.1. Columns (1) and (3) are reproduced from Table 1. The method of estimation is weighted least squares with weights equal to the farmland of counties. All specifications control for ln farmland, time effects, and county fixed effects. The time effects are allowed to vary by state. Standard errors (in parentheses) account for arbitrary heteroskedasticity and are clustered at the county level. ***, **, and * denote significance at the 1%, 5%, and 10% level respectively.

Table 7: Seasonal Rainfall Risk and Size of Religious Communities

	Church membership	Church seating capacity		
	1890	1890	1870	1860
	(1)	(2)	(3)	(4)
Growing-season rainfall risk	0.949***	1.281**	1.351***	1.631***
	(0.291)	(0.515)	(0.465)	(0.577)
Nongrowing-season rainfall risk	0.268**	0.108	-0.175	-0.524
	(0.122)	(0.153)	(0.349)	(0.454)
RCov(Growing-season, Nongrowing-season rainfall)	0.327	-0.784	2.462*	0.753
	(0.407)	(0.563)	(1.394)	(1.861)
ln RY control	Yes	Yes	Yes	Yes
Soil shares	Yes	Yes	Yes	Yes
Elevation shares	Yes	Yes	Yes	Yes
Average elevation	Yes	Yes	Yes	Yes
Average temperature	Yes	Yes	Yes	Yes
Size	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes
R2	0.914	0.903	0.825	0.805
Number of counties	2,693	2,651	2,068	1,822

Notes: The left-hand-side variable is the natural logarithm (ln) of church membership or ln church seating at the county level from the US Census in 1890, 1870, or 1860. The estimating equation employed is (17) with the rainfall risk term replaced by equation (18) and calculated using 1895-2000 rainfall data. The RY variable is defined just after equation (17) and is calculated using the same rainfall data and a value $\beta = 0.52$. The growing season is March-November and the nongrowing season is December-February following Covert (1912), see page 8. See Section 5.1 data sources and Sections 4 and 5.2 for more details on the specification. Other right-hand-side controls are ln population and ln land area of the county (size), the share of land of a given soil type using a 53-category soil classification system, the share of land at a given elevation using 11 elevation bins, average elevation, average temperature over the period 1895-2000, and state fixed effects. The method of estimation is least squares. Standard errors (in parentheses) account for arbitrary heteroskedasticity and are clustered at the state level. ***, **, and * denote significance at the 1%, 5%, and 10% level respectively.

Table 8: Rainfall Risk, National Cultures, and Church Membership in 1890

		Sample split: Population density		Sample split: Agriculture/manufacturing value added		
	Baseline	Below median	Above median	Above median	Below median	Growing and Non-growing Season
	(1)	(2)	(3)	(4)	(5)	(6)
Rainfall risk	2.085***	3.248***	2.087	3.137**	-0.568	
	(0.723)	(0.834)	(1.963)	(1.375)	(0.617)	
Growing-season rainfall risk						0.862**
						(0.425)
Nongrowing-season rainfall risk						0.294*
						(0.160)
RCov(Growing-season, Nongrowing-season rainfall)						0.689
						(1.282)
ln RY control	Yes	Yes	Yes	Yes	Yes	Yes
FG national cultures	Yes	Yes	Yes	Yes	Yes	Yes
SG national cultures	Yes	Yes	Yes	Yes	Yes	Yes
Soil shares	Yes	Yes	Yes	Yes	Yes	Yes
Elevation shares	Yes	Yes	Yes	Yes	Yes	Yes
Average elevation	Yes	Yes	Yes	Yes	Yes	Yes
Average temperature	Yes	Yes	Yes	Yes	Yes	Yes
Size	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes
R2	0.919	0.899	0.896	0.912	0.930	0.920
Number of counties	2,520	1,260	1,260	1,257	1,258	2520

Notes: The left-hand-side variable is the natural logarithm (ln) of church membership at the county level in 1890. The estimating equation employed is (17); in column (6) the rainfall risk term is replaced by equation (18). Rainfall risk is calculated using 1895-2000 rainfall data. The RY variable is defined just after equation (17) and is calculated using the same rainfall data and a value β = 0.52. The growing season is March-November and the nongrowing season is December-February following Covert (1912), see page 8. See Section 4 for more details on the specification and Section 5.1 for data sources. First-generation (FG) national cultures refer to the shares of foreign-born county residents in 1890 by foreign birthplace. Second-generation (SG) national cultures refer to the shares of foreign-born parents of county residents in 1880 by foreign birthplace. The data identifies 33 different foreign birthplaces listed in footnote 21. Other right-hand-side controls are ln population and ln land area of the county (size), the share of land of a given soil type using a 53-category soil classification system, the share of land at a given elevation using 11 elevation bins, average elevation, average temperature over the period 1895-2000, and state fixed effects. The method of estimation is least squares. Standard errors (in parentheses) account for arbitrary heteroskedasticity and are clustered at the state level. ***, **, and * denote significance at the 1%, 5%, and 10% level respectively.

Table 9: Rainfall Risk, National Cultures, and Church Seating in 1890

		Sample split: Population density		Sample split: Agriculture/manufacturing value added		
	Baseline	Below median	Above median	Above median	Below median	Growing and Non-growing Season
	(1)	(2)	(3)	(4)	(5)	(6)
Rainfall risk	2.382***	3.355***	1.981	5.748***	0.125	
	(0.723)	(0.834)	(1.963)	(1.375)	(0.617)	
Growing-season rainfall risk						1.685***
						(0.512)
Nongrowing-season rainfall risk						-0.0604
						(0.112)
RCov(Growing-season, Nongrowing-season rainfall)						1.395
						(1.116)
ln RY control	Yes	Yes	Yes	Yes	Yes	Yes
FG national cultures	Yes	Yes	Yes	Yes	Yes	Yes
SG national cultures	Yes	Yes	Yes	Yes	Yes	Yes
Soil shares	Yes	Yes	Yes	Yes	Yes	Yes
Elevation shares	Yes	Yes	Yes	Yes	Yes	Yes
Average elevation	Yes	Yes	Yes	Yes	Yes	Yes
Average temperature	Yes	Yes	Yes	Yes	Yes	Yes
Size	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes
R2	0.905	0.883	0.855	0.895	0.928	0.905
Number of counties	2,502	1,251	1,251	1,249	1,250	2,502

Notes: The left-hand-side variable is the natural logarithm (ln) of church seating at the county level in 1890. The estimating equation employed is (17); in column (6) the rainfall risk term is replaced by equation (18). Rainfall risk is calculated using 1895-2000 rainfall data. The RY variable is defined just after equation (17) and is calculated using the same rainfall data and a value $\beta = 0.52$. The growing season is March-November and the nongrowing season is December-February following Covert (1912), see page 8. See Section 4 for more details on the specification and Section 5.1 for data sources. See the notes to Table 8 for a description of the first-generation (FG) and second-generation (SG) national cultures variables as well as the other right-hand-side controls. The method of estimation is least squares. Standard errors (in parentheses) account for arbitrary heteroskedasticity and are clustered at the state level. ***, **, and * denote significance at the 1%, 5%, and 10% level respectively.

Table 10: Rainfall Risk, National Cultures, Religious Cultures, and Church Membership in 1890

		Sample split: Population density		Sample split: Agriculture/manufacturing value added		
	Baseline	Below median	Above median	Above median	Below median	Growing and Non-growing Season
	(1)	(2)	(3)	(4)	(5)	(6)
Rainfall risk	2.073***	2.789***	2.399	2.887**	-0.0127	
	(0.618)	(0.691)	(1.739)	(1.266)	(0.710)	
Growing-season rainfall risk						0.905**
						(0.439)
Nongrowing-season rainfall risk						0.289*
						(0.169)
RCov(Growing-season, Nongrowing-season rainfall)						0.368
						(1.248)
ln RY control	Yes	Yes	Yes	Yes	Yes	Yes
FG national cultures	Yes	Yes	Yes	Yes	Yes	Yes
SG national cultures	Yes	Yes	Yes	Yes	Yes	Yes
Denomination shares	Yes	Yes	Yes	Yes	Yes	Yes
Other RHS controls	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes
R2	0.928	0.915	0.901	0.921	0.935	0.928
Number of counties	2,520	1,260	1,260	1,257	1,258	2520

Notes: The left-hand-side variable is the natural logarithm (ln) of church membership at the county level in 1890. The estimating equation employed is (17); in column (18) the rainfall risk term is replaced by equation (18). Rainfall risk is calculated using 1895-2000 rainfall data. The RY variable is defined just after equation (17) and is calculated using the same rainfall data and a value $\beta = 0.52$. The growing season is March-November and the nongrowing season is December-February following Covert (1912), see page 8. See Section 4 for more details on the specification and Section 5.1 for data sources. Denomination shares refer to the members of 12 different denominations divided by the total number of church members; the denominations are listed in footnote 22. See the notes to Table 8 for a description of the first-generation (FG) and second-generation (SG) national cultures variables as well as the other right-hand-side controls. The method of estimation is least squares. Standard errors (in parentheses) account for arbitrary heteroskedasticity and are clustered at the state level. ***, **, and * denote significance at the 1%, 5%, and 10% level respectively.

Table 11: Rainfall Risk, National Cultures, Religious Cultures, and Church Seating in 1890

		Sample split: Population density		Sample split: Agriculture/manufacturing value added		
	Baseline	Below median	Above median	Above median	Below median	Growing and Non-growing Season
	(1)	(2)	(3)	(4)	(5)	(6)
Rainfall risk	2.437***	3.226***	1.905	5.557***	0.188	
	(0.654)	(0.800)	(2.645)	(1.371)	(0.622)	
Growing-season rainfall risk						1.615***
						(0.489)
Nongrowing-season rainfall risk						-0.0106
						(0.117)
RCov(Growing season, Nongrowing-season rainfall)						1.535
						(0.970)
ln RY control	Yes	Yes	Yes	Yes	Yes	Yes
FG national cultures	Yes	Yes	Yes	Yes	Yes	Yes
SG national cultures	Yes	Yes	Yes	Yes	Yes	Yes
Denomination shares	Yes	Yes	Yes	Yes	Yes	Yes
Other RHS controls	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes
R2	0.909	0.889	0.864	0.900	0.931	0.909
Number of counties	2,502	1,251	1,251	1,249	1,250	2,502

Notes: The left-hand-side variable is the natural logarithm (ln) of church seating at the county level in 1890. The estimating equation employed is (17); in column (6) the rainfall risk term is replaced by equation (18). Rainfall risk is calculated using 1895-2000 rainfall data. The RY variable is defined just after equation (17) and is calculated using the same rainfall data and a value $\beta = 0.52$. The growing season is March-November and the nongrowing season is December-February following Covert (1912), see page 8. See Section 4 for more details on the specification and Section 5.1 for data sources. Denomination shares refer to the church seating capacity of 12 different denominations divided by the total number of church seatings; the denominations are listed in footnote 22. See the notes to Table 8 for a description of the first-generation (FG) and second-generation (SG) national cultures variables as well as the other right-hand-side controls. The method of estimation is least squares. Standard errors (in parenthesis) account for arbitrary heteroskedasticity and are clustered at the state level. ***, **, and * denote significance at the 1%, 5%, and 10% level respectively.

Appendix Table 1: Summary Statistics

Panel A: Full sample

	1890			1870			1860			1850		
Variable	Obs	Mean	StdDev	Obs	Mean	StdDev	Obs	Mean	StdDev	Obs	Mean	StdDev
ln Church membership	2,693	8.14	1.37	-	-	-	-	-	-	-	-	-
ln Church seating	2,651	9.07	1.32	2,068	8.53	1.30	1,822	8.59	1.25	1,448	8.48	1.31
Rainfall risk	2,693	0.06	0.05	2,068	0.05	0.04	1,822	0.04	0.04	1,448	0.04	0.03
Growing-season rainfall risk	2,693	0.07	0.07	2,068	0.06	0.07	1,822	0.06	0.06	1,448	0.05	0.05
Nongrowing-season rainfall risk	2,693	0.22	0.24	2,068	0.15	0.12	1,822	0.14	0.10	1,448	0.12	0.06
Cov (Growing-season, Nongrowing-season rainfall)	2,693	0.01	0.02	2,068	0.01	0.02	1,822	0.01	0.01	1,448	0.01	0.01
Average temperature	2,693	12.29	4.47	2,068	12.78	4.10	1,822	13.01	3.94	1,448	13.13	3.71
ln Population	2,693	9.47	1.06	2,068	9.32	0.97	1,822	9.28	0.94	1,448	9.23	0.90
ln Area	2,693	6.49	0.76	2,068	6.37	0.71	1,822	6.31	0.65	1,448	6.26	0.58
Population per square mile	2,693	73.1	669.65	2,068	74.5	1128	1,822	67.2	1010	1,448	58.45	729.4
Agricultural value added relative to agriculture plus manufacturing	2,682	0.76	0.26	2,067	0.81	0.21	1,818	0.84	0.21	1,446	0.78	0.23

Panel B.1: Counties with population density above the median

Variable	1890 Obs	1890 Mean	1890 StdDev	1870 Obs	1870 Mean	1870 StdDev	1860 Obs	1860 Mean	1860 StdDev
ln Church membership	1,347	8.94	0.81	-	-	-	-	-	-
ln Church seating	1,326	9.89	0.69	1,034	9.38	0.82	911	9.37	0.83
Rainfall risk	1,347	0.04	0.03	1,034	0.03	0.02	911	0.03	0.01
Average temperature	1,347	12.27	3.38	1,034	11.90	3.19	911	12.06	3.23
ln Population	1,347	10.10	0.73	1,034	9.94	0.71	911	9.86	0.68
ln Area	1,347	6.12	0.53	1,034	6.09	0.54	911	6.07	0.56
Population per square mile	1,347	133.7	943.10	1,034	138	1593	911	122.9	1426
Agricultural value added relative to agriculture plus manufacturing	1,347	0.70	0.27	1,034	0.78	0.22	911	0.81	0.21

Panel B.2: Counties with population density below the median

Variable	1890 Obs	1890 Mean	1890 StdDev	1870 Obs	1870 Mean	1870 StdDev	1860 Obs	1860 Mean	1860 StdDev
ln Church membership	1,346	7.34	1.35	-	-	-	-	-	-
ln Church seating	1,325	8.26	1.30	1,034	7.67	1.11	911	7.82	1.12
Rainfall risk	1,346	0.08	0.06	1,034	0.06	0.06	911	0.06	0.05
Average temperature	1,346	12.31	5.35	1,034	13.65	4.69	911	13.97	4.34
ln Population	1,346	8.84	0.97	1,034	8.69	0.77	911	8.70	0.78
ln Area	1,346	6.85	0.79	1,034	6.65	0.75	911	6.56	0.63
Population per square mile	1,346	12.46	9.09	1,034	11.24	7.12	911	11.63	6.81
Agricultural value added relative to agriculture plus manufacturing	1,335	0.82	0.23	1,033	0.85	0.20	907	0.87	0.20

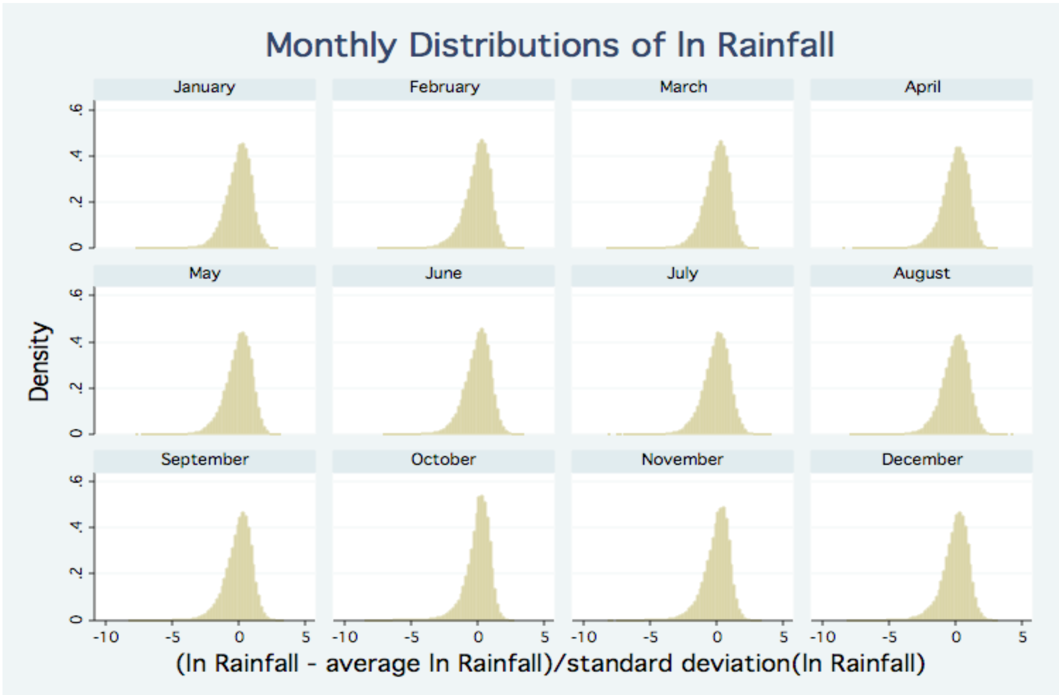
Panel C.1: Counties with agricultural share above the median

	1890			1870			1860		
Variable	Obs	Mean	StdDev	Obs	Mean	StdDev	Obs	Mean	StdDev
ln Church membership	1,341	7.71	1.29	-	-	-	-	-	-
ln Church seating	1,322	8.68	1.31	1,033	8.23	1.10	909	8.30	1.10
Rainfall risk	1,341	0.07	0.05	1,033	0.05	0.03	909	0.04	0.03
Average temperature	1,341	13.12	4.52	1,033	14.34	3.63	909	14.54	3.56
ln Population	1,341	9.10	0.95	1,033	9.05	0.75	909	9.03	0.75
ln Area	1,341	6.52	0.76	1,033	6.33	0.58	909	6.30	0.54
Population per square mile	1,341	22.34	15.47	1,033	20.90	14.12	909	20.62	13.49
Agricultural value added relative to agriculture plus manufacturing	1,341	0.95	0.04	1,033	0.95	0.03	909	0.96	0.03

Panel C.2: Counties with agricultural share below the median

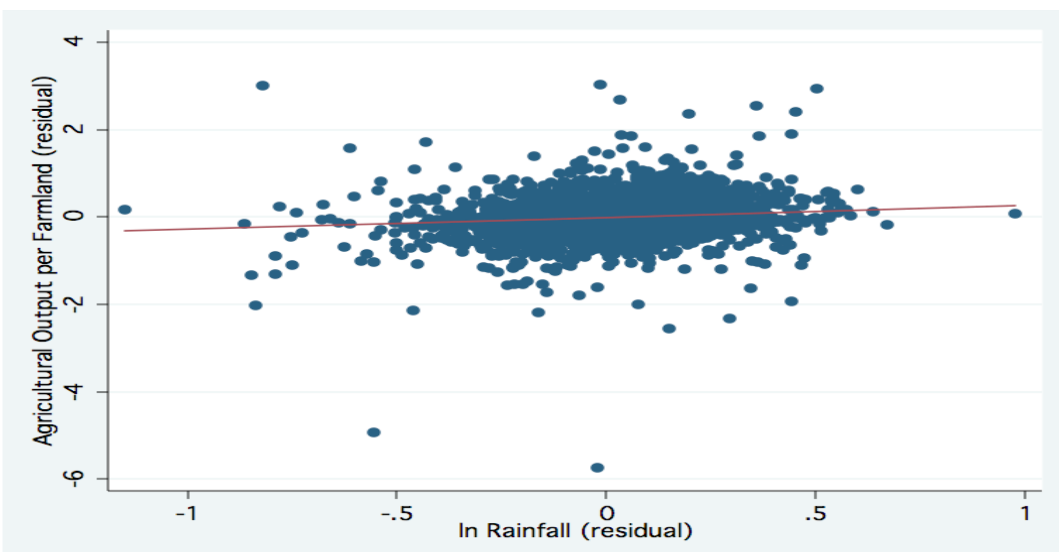
	1890			1870			1860		
Variable	Obs	Mean	StdDev	Obs	Mean	StdDev	Obs	Mean	StdDev
ln Church membership	1,341	8.60	1.27	-	-	-	-	-	-
ln Church seating	1,323	9.48	1.18	1,034	8.83	1.40	909	8.90	1.32
Rainfall risk	1,341	0.05	0.05	1,034	0.05	0.05	909	0.04	0.05
Average temperature	1,341	11.45	4.24	1,034	11.21	3.95	909	11.48	3.68
ln Population	1,341	9.87	0.99	1,034	9.59	1.07	909	9.54	1.03
ln Area	1,341	6.45	0.77	1,034	6.41	0.82	909	6.33	0.74
Population per square mile	1,341	124.4	946.25	1,034	128	1594	909	114.1	1428
Agricultural value added relative to agriculture plus manufacturing	1,341	0.43	0.25	1,034	0.67	0.22	909	0.71	0.23

Appendix Figure A.1



Notes: This graph plots the standardized distributions of the natural logarithm (ln) of rainfall 1895-2000 at the county level by month.

Appendix Figure A.2



Notes: This graph plots the residuals from regressing the county-level natural logarithm (ln) of the value of crops produced per acre (horizontal axis) and of rainfall (vertical axis) in 1909, 1919, and 1929 on county fixed effects, time effects that vary by state, and ln farmland. See Section 5.1 for the data sources; and Section 4 as well as Section 5.2. (pages 12-13) for more details on the specification.