AGRICULTURAL RISK AND THE SPREAD OF RELIGIOUS COMMUNITIES

Philipp Ager
University of Southern Denmark

Antonio Ciccone
Mannheim University, ICREA, UPF, and Barcelona GSE

Abstract
Building on the idea that members of religious communities insure each other against some idiosyncratic risks, we argue that religious communities should be more widespread where populations face greater common risk. Our theoretical argument builds on idiosyncratic and common risks aggravating each other. When this is the case, individuals have a greater incentive to mutually insure against idiosyncratic risk when greater common risk makes the worst case scenario of bad realizations of common and idiosyncratic risks more likely. Our empirical analysis exploits common rainfall risk as a source of common county-level agricultural risk in the 19th-century United States. We find that a greater share of the population was organized in religious communities in counties with greater common agricultural risk, holding expected agricultural output constant. The link between rainfall risk and membership in religious communities is stronger among more agricultural counties and counties exposed to greater rainfall risk during the growing season. We also find that among the historically more agricultural counties, more than 1/3 of 19th-century differences in religious membership associated with rainfall risk persist to the turn of the 21st century. (JEL: Z12, O13, N31)

1. Introduction

Most of today's major religious communities provide social assistance and access to support networks, and historically religious communities have often been the only source of support beyond the family (Bremner 1994; Parker 1998; Pullan 1998, 2005;

The editor in charge of this paper was Claudio Michelacci.

Acknowledgments: We would like to thank three anonymous referees, Sandeep Baliga, Robert Barro, Sascha Becker, Jeanet Bentzen, Alessandra Bonfiglioli, Davide Cantoni, Dan Hungerman, Claudio Michelacci, Marco Ottaviani, Christian Stoltenberg, Joachim Voth, and David Yanagizawa-Drott for helpful comments. We also thank Richard Hornbeck for his assistance with the soil data in the project's early stages as well as Hayk Yeritsian for professional GIS assistance. Ciccone gratefully acknowledges financial support from CREI and Spanish research grants ECO2011-25272, ECO2011-30323-C03-02, and SEV-2011-0075 (Severo Ochoa Program for Centers of R&D Excellence). The paper was previously entitled "Rainfall risk and religious membership in the 19th-century United States".

E-mail: phag@sam.sdu.dk (Ager); antonio.ciccone@gmail.com (Ciccone)

Journal of the European Economic Association 2018 16(4):1021–1068 DOI: 10.1093/jeea/jvx029

Cnaan et al. 2002; Gruber and Hungerman 2007; Harris and Bridgen 2007; Belcher and Tice 2011). The social support provided by religious communities appears to be a type of informal mutual insurance especially valuable in historical agricultural societies exposed to much economic risk and without formal insurance mechanisms (McCleary and Barro 2006a). Economic risk could therefore have contributed to the spread of today's major religious communities and 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 economic risk and the spread of religious communities in a society with little formal insurance. In 1890, the US Census collected data on church members and seating capacity in around 2700 counties. Data on the seating capacity of churches are also available for 1870, 1860, and 1850. 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 investigate whether a greater part of the population organized into religious communities when they faced greater economic risk by examining whether in the 19th-century United States churches in counties with higher rainfall risk had more total members or a greater total seating capacity relative to population.[1]

Our theoretical analysis of the link between economic risk and the spread of religious communities builds on two preexisting ideas: Religious communities can sustain mutual insurance against at least some risks, and religious membership is a social activity that reduces time for other activities (Berman 2000; McCleary and Barro 2006a,b; Dehejia, DeLeire, and Luttmer 2007; Glaeser and Sacerdote 2008; Chen 2010). These ideas are integrated into a model where the agricultural output of farmers in an area (a county) is subject to idiosyncratic risk and to common (county-level) rainfall risk. Idiosyncratic risk is partially insurable within a county's religious communities, whereas common agricultural risk due to common rainfall risk is not. We then show that when relative risk aversion is in the empirically relevant range, the value of mutual insurance against idiosyncratic risk through membership in religious communities increases with common agricultural risk.[2] Intuitively, this is because for risk aversion in the empirically relevant range, the effects of idiosyncratic risk and common rainfall risk aggravate each other in the sense that a bad realization of one risk reduces consumption utility more, the worse the realization of the other risk. As a

1. As we can only measure rainfall risk since 1895, our empirical analysis presumes that 19th-century differences in rainfall risk across counties persisted into the 20th century. Our rainfall data for 1895–2000 indicate that cross-county differences in rainfall risk are very persistent over time.

2. It is well understood that risk aversion alone is not sufficient for insurance demand to increase with uninsurable background risk (Gollier 2004; Franke, Schlesinger, and Stapleton 2006). In fact, an important baseline result in the literature is that the demand for insurance may be unaffected by uninsurable background risk in standard settings with constant relative risk aversion. Our theoretical analysis differs from the literature on insurance demand with uninsurable background risk as in our setting, insurance involves a social activity that (also) takes time.

result, individuals have more to gain from mutual insurance against idiosyncratic risk when greater common risk makes the worst case scenario of bad realizations of both idiosyncratic and common risks more probable. Individuals facing greater common risk are therefore more likely to opt into the mutual insurance sustained within religious communities rather than spending time on alternative social activities. Hence, holding expected agricultural output constant, a larger part of the population will be members of a religious community in counties with greater common agricultural risk. This result does not hold for all values of relative risk aversion in our model, as idiosyncratic risk and common risk can ameliorate each other even with risk averse agents. When this is the case, our theoretical model implies that greater common agricultural risk actually decreases membership in religious communities. However, for idiosyncratic risk and common risk to ameliorate each other in our model, the strength of relative risk aversion needs to be below unity and such values are outside of the empirical range.

In the United States, religious communities are widely regarded as having been the main source of social assistance, especially in agricultural regions, until the rise of government social spending at the beginning of the 20th century (McBride 1962; Cnaan et al. 2002; Lindert 2004; Gruber and Hungerman 2007; Harris and Bridgen 2007).[3] The available financial accounts of 19th-century churches 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, almost 85% of those who attend religious services at least once a year believe that their congregation would help them in case of illness or some other difficult situation, according to the US General Social Survey (Glaeser and Sacerdote 2008; Smith et al. 2013).

Our theoretical model implies that a greater part of the population should organize into religious communities in agricultural economies with greater common agricultural risk when holding agricultural output constant. We evaluate this hypothesis by examining whether in the 19th-century United States, churches in counties with greater rainfall risk had more total members or a greater total seating capacity relative to population. To control for expected agricultural output, we include a range of geographic variables as well as the effect of rainfall on expected agricultural output in our empirical analysis. Our empirical results indicate a statistically and quantitatively significant link between membership in religious communities and rainfall risk in 1890, 1870, and 1860. A one-standard-deviation increase in rainfall risk is associated

3. At the end of the 19th 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% of US counties had at least one church in 1890—and the largest membership (Putnam 2000). Even today, religious communities are the associations with the largest membership in the United States. More than 37% of respondents in the General Social Survey self-identify as a member of some church group, and 38% 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.

with about a 10% increase in total church members and seating capacity relative to population.[4]

If rainfall risk affects the value of church membership through agricultural production risk, there should be a positive link between the share of the population organizing into religious communities and rainfall risk in predominately agricultural counties. Moreover, the link between membership in religious communities and rainfall risk should be stronger in more agricultural counties than less agricultural counties. We therefore undertake a separate analysis of the link between membership in religious communities and rainfall risk among counties with value added in agriculture relative to manufacturing above and below the median. Among more agricultural counties, we find a strong positive and statistically significant link between rainfall risk and total church members and seating capacity relative to population. The link among less agricultural counties is significantly weaker than among more agricultural counties and usually statistically insignificant.

The 1910, 1920, and 1930 US Census collected county-level data on the value of crops produced. Combined with historical rainfall levels, these data provide a unique opportunity to examine the relationship between rainfall and agricultural output that underlies our analysis of the link between religious membership and rainfall risk in the 19th-century United States. The data can also be used to assess the importance of rainfall during the growing season and the nongrowing season for agricultural output. Our results indicate that growing-season rainfall has a stronger effect on agricultural output than nongrowing-season rainfall. Hence, if rainfall risk affects the value of church membership through agricultural production risk, the link between membership in religious communities and rainfall risk should be stronger for growing-season rainfall risk than nongrowing-season rainfall risk. When we relate membership in 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. We use these data to control for potential effects of different national cultures on membership in religious communities. The controls for different national cultures turn out to be jointly statistically significant determinants of religious membership. The link between rainfall risk and membership in religious communities changes little however (it actually becomes somewhat stronger). We also control for the relative sizes of different religious denominations present in a county to account for potential effects of different religious cultures on membership in religious communities. The controls for different religious cultures also turn out to be jointly statistically significant determinants of

4. For 1850, we do not find a statistically significant link between rainfall risk and membership in religious communities. We argue below 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.

religious membership. But the link between membership in religious communities and rainfall risk changes little (it again becomes somewhat stronger). Following Altonji, Elder, and Taber (2005), the finding that the link between rainfall risk and membership in religious communities becomes somewhat stronger when we control for first- and second-generation immigrants' countries of origin and for the religious denominations present in a county, suggests that the link between rainfall risk and membership in religious communities is unlikely to reflect selection on unobservables (e.g., selection of groups of people with greater attachment to their religious communities into counties with greater rainfall risk).

An alternative explanation of our finding of a positive link between rainfall risk and membership in religious communities could be the so-called coping theory of religiosity, which points to psychological benefits of religiosity when individuals are dealing with adverse events (Pargament 1997). This theory of religiosity is usually applied in the context of adverse events that also are unpredictable (e.g., Bentzen 2015). Our measure of county-level rainfall variability (risk) is persistent over time. For example, the correlation coefficient between our 100-year measure of county-level rainfall variability and the same measure of county-level rainfall variability obtained for five 20-year periods is around 0.9 on average and never below 0.85; and the correlation coefficient between adjacent 20-year periods of rainfall variability is never below 0.78. As a result, individuals living in a county with greater rainfall variability are likely to have experienced periods of greater rainfall variability repeatedly during their lifetime and also likely to have had their parents and grandparents experience periods of greater rainfall variability repeatedly during their lifetimes. Individuals in counties with greater rainfall variability should therefore not be taken by surprise by rainfall variability in the same way individuals in counties with, for example, greater earthquake risk might be taken by surprise by an earthquake. Moreover, the coping theory of religiosity appears to be mostly related to religious beliefs and spirituality not to church attendance and membership (e.g., Miller et al. 2012, 2014). In fact, Bentzen (2015) finds a robust positive effect of earthquakes on religious beliefs but not on church attendance.

An interesting further question is whether the effects of agricultural production risk on 19th-century religious membership persist to modern times. We examine this question using county-level data on US religious membership around the turn of the 21st century. Our empirical results indicate that among historically more agricultural counties—the group of counties where we found an effect of rainfall risk on historical religious membership—more than 1/3 of 19th-century differences in religious membership associated with rainfall risk persist to the turn of the 21st century. The tendency to participate in religious communities therefore appears to be transmitted intergenerationally by families or local communities, maybe in the same way as families or broader communities transmit other cultural traits (e.g., Bao et al. 1999; Bisin and Verdier 2000; Bengtson et al. 2009; Alesina and Giuliano 2010; Fernández 2011; Giavazzi, Petkov, and Schiantarelli 2014).

2. Related Literature

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. Dehejia et al. (2007) find that income shocks have a smaller effect on the consumption level of US households who contribute to a religious organization and a smaller effect on the self-reported happiness of households who attend religious services. Chen (2010) observes that social insurance provided by religious communities is not limited to those who participate ex ante (the insurance we focus on in our theoretical analysis) but also extends to those who start participating following adverse shocks. To show that individuals are more likely to start attending church following adverse shocks, Chen examines the evolution of individual income and religious intensity following the 1997–1998 Indonesian financial crisis. He finds that the crises decreased the income of government employees relative to wetland farmers and that religious intensity during the first half of 1998 moved inversely with income. Chen also finds that the presence of religious institutions in a local community is associated with more consumption smoothing. Further evidence on how religious communities are affected by adverse shocks is provided by Ager, Hansen, and Lønstrup (2016), who document a surge in church membership in counties affected by the Mississippi flood of 1927.

Our hypothesis is that partial insurance within religious communities implies a greater incentive to organize into religious communities where populations are exposed to higher levels of common risk. We therefore examine how membership in religious communities depends on the amount of common risk faced by a population, rather than specific realizations of shocks. Accordingly, individuals in our theoretical analysis decide on church membership before shocks realize, as a function of the risks they face. To capture the cost of church membership, we borrow from the literature that considers religious membership to be a social activity that reduces time for other activities (e.g., Azzi and Ehrenberg 1975; Glaeser and Sacerdote 2008).

Our analysis is also related to the literature documenting that religious communities respond to the demand for social assistance. Hungerman (2005) finds that a 1996 US welfare reform decreasing 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 an expansion of social security mandated by the US Supreme Court 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.[5] 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 eight European countries, Canada, and the United States. Scheve and Stasavage (2006) point out that alternatively church attendance and government welfare expenditure could be related because religiosity changes the preferences for social insurance, possibly due to 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.[6]

Bentzen (2015) observes that if religiosity helps people to deal with adverse events, it may spread more easily in areas where natural disasters are more frequent. Using regional data, Bentzen finds a robust positive association between earthquakes and a range of religious beliefs when controlling for individual and country characteristics. On the other hand, Bentzen finds no robust association between earthquakes and church attendance. When she examines religious beliefs and church attendance among second-generation immigrants from regions that have suffered earthquakes, she again finds robust effects of earthquakes on religious beliefs but not on church attendance. Bentzen's findings are 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.

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 range of 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; Durante (2010) on informal insurance and interpersonal trust; and Davis (2014) on informal insurance and individual versus collective responsibility.

5. 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.

6. 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.

3. Production Risks and Membership in Religious Communities in a Rainfed Agricultural Economy

Our theoretical analysis considers the agricultural output produced by farmers in a certain location (a county) as being subject to two types of risks. The first is uninsurable common rainfall risk. The second is idiosyncratic risk. Members of local religious communities insure each other against some idiosyncratic risks, but religious membership takes time away from alternative social activities. We show that when relative risk aversion is in the empirically relevant range, the value of mutual insurance within local religious communities is greater in counties with greater rainfall risk. As a result, a larger share of farmers organize into religious communities in counties with greater rainfall risk, holding expected agricultural output constant.[7]

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. The output, Y_{fc}, produced by farmer f in county c by the end of a year depends on fixed county characteristics determining the output of agriculture, Z_c; county-level rainfall, R_c; and a farmer-specific input subject to idiosyncratic shocks, 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% increase in rainfall every month. 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. Our empirical analysis using data on the value of crops produced from the 1910, 1920, and 1930 US Census indicates that the relationship between output and rainfall in equation (1) describes the data quite well; see Section 5.2 and the (binned) scatter plots in Appendix Figure A.1. Monthly rainfall levels at the county level, $R_{mc} \geq 0$, are taken to be random and follow a joint lognormal distribution with county-specific distribution parameters. Appendix Figure A.2 plots the standardized ln rainfall distributions at the county level for the 1895–2000 period for each month of the year.

7. See Gollier (2004) for the theory of decision making with multiple risks. As already mentioned, an important baseline result in the literature on decision making with multiple risks is that the demand for insurance may be unaffected by uninsurable background risk in standard settings with constant relative risk aversion. Our theory features constant relative risk aversion for consumption but differs from standard settings in the literature in that insurance involves a social activity that takes time. Put differently, insurance in our setting does not solely involve consumption in some states of the world in exchange for consumption in other states of the world.

For concreteness, we think of $s_f \geq 0$ as the farmer's labor input and of idiosyncratic shocks to s_f as health shocks or accidents. We take s_f to be lognormally distributed with constant mean and variance and 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, s_f.[8] There is a single religious community in each county.[9] Farmers in a county must decide whether to join the local religious community before the realization of county-level rainfall shocks 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, whereas $q_c > 0$ captures county-specific factors. Farmers with $p_f = 0$ value the 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. On the other hand, 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}, and their consumption levels are therefore generally subject to both rainfall and labor input risk. We assume that the religious community of county

8. For simplicity, all idiosyncratic risk can be insured within religious communities in the model. It would be straightforward to add uninsurable idiosycratic risk to capture partial insurance of idiosyncratic risk within religious communities.

9. As we focus on the choice of joining or not joining a religious community, it is sufficient for there to be one religious community per county. A drawback of this simplification is that our model can be read to have implications for the size of single religious communities in a county—rather than total religious membership—which we think is unwarranted. To have a model that makes well-founded predictions about the size of single religious communities, one would have to take into account that sustaining informal insurance requires suppressing free riding and that this is more difficult in larger religious communities (Iannaccone 1992). This could be incorporated in our model in a simple way by assuming that mutual insurance can only be sustained in a religious community as long as it does not exceed a certain critical size. In this case, counties where a larger share of the population organizes into religious communities would generally have more rather than larger religious communities.

c is able to sustain perfect mutual insurance against idiosyncratic labor input risk among local members.[10] As a result, (1) implies that the output and consumption level of a farmer in county c who is a member of the local religious community is $E(s)R_c^{\beta}Z_c$, where $E(s)$ is the expected labor input level. The increase in the expected utility of consumption, $\Delta EU(C_{fc})$, that comes with religious community membership is straightforward to calculate, as $C_{fc}^{1-\rho}$ in (3) is lognormally distributed whether farmers are members of a religious community or not,[11]

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

where EY_c is expected agricultural output in the county, $R\mathrm{Var}_c = \mathrm{Var}(\ln R_c)$ captures county-level rainfall risk, and μ depends on preference and technology parameters as well as on the amount of idiosyncratic risk. Hence, if we hold expected agricultural output $\ln EY_c$ constant, the consumption utility gain of religious membership is increasing in the amount of rainfall risk, $R\mathrm{Var}_c$, 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 reduces consumption utility more, the lower the realization of the other risk (Franke et al. 2006). Formally, $\rho > 1$ implies $\partial[\partial U(C[R, s])/\partial R]/\partial s < 0$, where $U(C)$ is the utility of consumption and $C[R, s]$ captures that output and, hence, consumption depends on rainfall and labor input. When the degree of relative risk aversion is smaller than unity, $\rho < 1$, idiosyncratic risk and rainfall risk actually ameliorate each other, $\partial[\partial U(C)/\partial R]/\partial s > 0$, because the complementarity between rainfall and labor in agricultural production in (1) implies that a negative realization of one risk reduces output less, the lower the realization of the other risk is. Most estimates of the coefficient of relative risk aversion in the literature exceed unity: see Attanasio and Weber (1989), Vissing-Jorgensen and Attanasio (2003), and Chiappori and Paiella (2011).[12]

10. 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).

11. When $X \sim \ln N(\mu, \sigma^2)$, $EX = \exp(\mu + \sigma^2/2)$. Hence, the lognormality of output implies $E\ln Y_c = \ln EY_c - \mathrm{Var}(\ln Y_c)/2$. Defining $\sigma_{Rc}^2 = \mathrm{Var}(\ln R_c)$ and $\sigma_s^2 = \mathrm{Var}(\ln s)$ and making use of $C_{fc} = Y_{fc}$ and (1), this in turn implies $C_{fc}^{1-\rho} \sim \ln N((1-\rho)(\ln EY_c - \beta^2\sigma_{Rc}^2/2), (1-\rho)^2\beta^2\sigma_{Rc}^2)$ when the farmer is a member of a religious community and $C_{fc}^{1-\rho} \sim \ln N((1-\rho)(\ln EY_c - \beta^2\sigma_{Rc}^2/2 - \sigma_s^2), (1-\rho)^2(\beta^2\sigma_{Rc}^2 + \sigma_s^2))$ when the farmer is not a religious community member. The result in (4) can now be obtained by applying $EX = \exp(\mu + \sigma^2/2)$ when $X \sim \ln N(\mu, \sigma^2)$ to calculate the difference between $EC_{fc}^{1-\rho}$ when the farmer is a member of a religious community and $EC_{fc}^{1-\rho}$ when the farmer is not.

12. Although these estimates rely on post-World War II data, risk aversion in the late 19th-century United States, when incomes were closer to subsistence levels and less government insurance was available, is usually thought to have been at least as high (Kimball 1988).

Rainfall Risk and Membership in Religious Communities. Farmers with $p_f = 0$ always join religious communities. After all, they enjoy the social activities required for religious membership as much as the preferred alternatives, and religious communities provide insurance against idiosyncratic shocks. Farmers with $p_f > 0$ face a trade-off because religious membership decreases their utility from other 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,

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

County-specific determinants of the disutility of religious membership can be accounted for by allowing $\ln q_c$ to depend on such variables as expected income, for example,

$$\ln q_c = \theta \ln EY_c.^{13} \tag{6}$$

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 membership in religious communities in county c, $M_c = \int_f M_{fc}$, is

$$M_c = H\left(\mu - (\theta + \rho - 1)\ln EY_c + \frac{\rho(\rho-1)\beta^2}{2} R\mathrm{Var}_c\right). \tag{7}$$

Hence, if we hold expected agricultural output EY_c constant, membership in religious communities is larger in counties with greater rainfall risk if $\rho > 1$.

Rainfall Risk During the Growing and Nongrowing Seasons. 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 how such heterogeneity affects the link between membership in religious communities and rainfall risk.

The US nongrowing season varies by crop and state; see Covert (1912) and USDA (2007) for historical and modern data, respectively, but it typically includes the months of November, December, and January.[14] Define $N = \{\text{December, January, February}\}$ and $G = \{\text{March}, \ldots, \text{November}\}$ and express the sum of the monthly rainfall effects

13. For example, churches in richer counties may be easier to get to or equipped more comfortably.

14. Covert (1912) records the growing season for corn, wheat, and cotton as March through November.

in (2) over the growing season and the nongrowing season as

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

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

$$R\text{Var}_c = a_G^2 R\text{Var}_c^G + a_N^2 R\text{Var}_c^N + a_G a_N R\text{Cov}_c \tag{9}$$

where $R\text{Var}_c^G$ and $R\text{Var}_c^N$ capture growing-season and nongrowing-season rainfall risk,

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

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

with $\alpha_{Gm} = \alpha_m / a_G$ and $\alpha_{Nm} = \alpha_m / a_N$. $R\text{Cov}_c$ in (9) is twice the covariance between growing-season and nongrowing-season rainfall,

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

From (7) and (9) it follows that the strength of the effect of nongrowing-season rainfall risk on membership in religious communities relative to the effect of growing-season rainfall risk is $(a_N/a_G)^2$. From (1) and (8) it follows that the effects of nongrowing-season and growing-season rainfall on agricultural output are $\beta_N = \beta a_N$ and $\beta_G = \beta a_G$, respectively. Hence, our theoretical model implies that the strength of the effect of nongrowing-season rainfall risk on membership in religious communities relative to the effect of growing-season rainfall risk is determined by the effect of nongrowing-season rainfall on agricultural output relative to the effect of growing-season rainfall, $(a_N/a_G)^2 = (\beta_N/\beta_G)^2$.

4. Estimating the Effect of Rainfall Risk on Membership in Religious Communities

Our empirical investigation of the link between membership in religious communities and rainfall risk across US counties in the late 19th century begins with a log-linearized version of (7),

$$\ln\left(\frac{Church\ members\ or\ seatings_c}{Population_c}\right) = \varphi + \lambda R\mathrm{Var}_c + \gamma \ln EY_c, \tag{13}$$

where $R\mathrm{Var}_c$ is rainfall risk and EY_c is expected agricultural output as defined in our theoretical model, and we measure the share of the population organizing into religious communities as total church members or total church seating capacity relative to population.[15] The parameter of interest is the link between membership in religious communities and rainfall risk, λ, holding expected output constant.

An important issue when estimating (13) is that the distribution of rainfall in a county affects not only rainfall risk but also expected agricultural output. We therefore need to account for the effect of the rainfall distribution on expected agricultural output and this requires estimates of the parameters β and α_m in the agricultural production function in (1) and (2). The parameters α_m are also necessary to calculate rainfall risk in a county. The parameter β will be estimated using county-level data on rainfall and agricultural output at the beginning of the 20th century. For the parameters α_m we consider two different cases. The main case is where monthly rainfall enters the agricultural production function symmetrically over the whole year. The second case is where monthly rainfall enters the agricultural production function symmetrically during the growing and nongrowing season but rainfall may matter more for agricultural output during the growing season.

Symmetric Effects of Monthly Rainfall. When monthly rainfall enters the agricultural production function in (1) and (2) symmetrically, $\alpha_m = 1/12$, the rainfall risk measure becomes

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

and (1) implies that expected agricultural output can be written as

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

where $EY_c^R = E\left(\prod_m R_{mc}^{\beta/12}\right)$ captures the effect of rainfall on expected output and $\delta = \ln E(s)$. We can estimate β, the average effect of rainfall on agricultural output in the late 19th-century United States, using county-level data on the value of crops

15. The log-formulation has the usual advantages (e.g., Wooldridge 2012), as the variable (*Church members or seatings*$_c$)/*Population*$_c$ takes positive values only, is very positively skewed, and has some large values that probably reflect measurement error. The formulation in (13) implies that the dependent variable takes positive and negative values, that the distribution is unskewed, and that extreme observations are curtailed.

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. The estimating equation based on (1) and $\alpha_m = \alpha$ is

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

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 membership in religious communities and rainfall risk

$$\ln\left(\frac{\textit{Church members or seatings}_c}{\textit{Population}_c}\right) = \varphi + \lambda R\text{Var}_c + \gamma \ln E Y_c^R + \sum_{i=1}^{I}\varphi_i X_{ic}, \tag{17}$$

where $R\text{Var}_c$ is defined in (14), $EY_c^R = E\left(\prod_m R_{mc}^{\beta/12}\right)$ with β estimated using (16), and X_{ic} stands for fixed county characteristics like soil quality or ruggedness of the terrain that may affect agricultural output. The rainfall data we use are for the 1895–2000 period (the county rainfall data are only available from 1895 onward).[16] It turns out to be important to control for rainfall-driven differences in expected agricultural output EY_c^R in our empirical setting, as there is a strong negative cross-county correlation between the mean and the variance of $\ln R_c$ in the data. Moreover, even if the mean and the variance of $\ln R_c$ were uncorrelated, one would still have to control for rainfall-driven expected agricultural output EY_c^R, as our theoretical model implies that a county's rainfall distribution affects rainfall-driven expected agricultural output holding the mean of $\ln R_c$ constant.

Rainfall During the Growing and Nongrowing Seasons. To assess the link between membership in religious communities and rainfall risk during the growing and nongrowing seasons, we reestimate (17) after replacing the term for rainfall risk by

$$\lambda_G R\text{Var}_c^G + \lambda_N R\text{Var}_c^N + \tau R\text{Cov}_c. \tag{18}$$

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

16. Our empirical analysis therefore presumes that county-level rainfall risk during the 19th 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.

As shown above, our theoretical model implies that λ_N/λ_G, the effect of nongrowing-season rainfall risk on membership in religious communities relative to the effect of growing-season rainfall risk, should be equal to $(\beta_N/\beta_G)^2$, where β_N/β_G is the effect of nongrowing-season rainfall on agricultural output relative to the effect of growing-season rainfall. We can therefore assess the importance of nongrowing-season rainfall risk relative to growing-season rainfall risk for membership in 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

Membership in Religious Communities 1850–1890. The decennial censuses of the United States during the period 1850–1890 collected information on churches at the county level. The data allow us to obtain two proxies for membership in religious communities in a county, namely the total seating capacity of churches in the county relative to population in 1850, 1860, 1870, and 1890 (the 1880 data were never published) and the total number of members of churches in the county relative to population in 1890. Our data refer to all religious denominations listed in the US Census. These data are retrieved from ICPSR file 2896 (Haines 2010). See Appendix A for summary statistics and maps that illustrate the overall and within-state spatial variation in the main data we use (for maps that illustrate spatial variation in growing and non-growing season rainfall see Section B.9 of the Online Appendix B).

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.[17] We map the data into counties to obtain monthly rainfall at the county level. Appendix Figure A.2 plots the standardized distributions of ln rainfall at the county level for the 1895–2000 period for each month of the year. We also use PRISM data on monthly average temperature, which we process analogously to the rainfall data.

Soil and Elevation Data. We control for 53 soil types using the US Department of Agriculture's SSURGO database.[18] We use these data to calculate the fraction of

17. See Deschenes and Greenstone (2007), who also use the PRISM data.

18. http://soils.usda.gov/surveys/geography/ssurgo/.

each county's land area that falls into the different soil categories. The source of our elevation data is the Environmental System Research Institute.[19] We calculate the fraction of each county's land area falling into the following 11 elevation bins: below 200, 200–400, 400–600, and so on up to 2000; and above 2000 meters.

Other Data. The data on land area, population, literacy, 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. Modern county-level data on US religious membership around the turn of the 21st century are retrieved from the Association of Religion Data Archives (www.theARDA.com).

5.2. Main 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.[20] The value of crops reported in the US Census corresponds to the year preceding the census years, and $\ln Y_{ct}$ on the left-hand side of (16) therefore refers to the value of crops per acre of farmland in 1909, 1919, and 1929. The corresponding

19. www.esri.com.

20. 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 $\varphi \in (0, 1)$ 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 $\sigma^2(1-\varphi)/F$. This means that average rainfall in the county is a better proxy for average rainfall on cultivated land in 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% 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 the size of religious organizations (point estimates change by very little).

TABLE 1. The effect of rainfall on agricultural productivity at the turn of the 20th century.

	(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
R^2	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 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 Sections 4 and 5.2 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. ***Significant at 1%.

rainfall in year t on the right-hand side of (16) refers to the 12 months from December of year $t-1$ to November of year t. That is, the rainfall in year t encompasses the growing season (March through November) of year t and the preceding nongrowing season (December of year $t-1$ and January and February of year t).[21] Column (2) adds a control for the rainfall in year $t-1$, which is defined analogously to the rainfall in year t and refers to the 12 months from December $t-2$ to November $t-1$. The results in columns (1) and (2) indicate that rainfall in year t enters positively and statistically significantly at the 1% level, whereas the effect of rainfall in year $t-1$ is statistically insignificant. The effect of rainfall in year t implies that a 1% increase in average monthly rainfall in year t raised the value of crops by around 0.5% in 1909–1929. In column (3) we add controls for average temperature in year t (December $t-1$ to November t) and $t-1$ (December $t-2$ to November $t-1$). The average temperature effects are statistically insignificant, which probably reflects that average annual temperature is not a good way of capturing the effect of temperature on agricultural output (Deschenes and Greenstone 2007; Schlenker and Roberts 2009). The (binned) scatter plots in Appendix Figure A.1 illustrate that the relationship between agricultural output and rainfall in (16) appears to describe the data quite well.

21. Defining rainfall years in this way facilitates comparisons when we estimate separate effects for rainfall during the growing and nongrowing seasons.

TABLE 2. The effect of rainfall risk on religious community size in 1890.

	Church members/population			Church seatings/population		
	Baseline (1)	Agriculture above median (2)	Agriculture below median (3)	Baseline (4)	Agriculture above median (5)	Agriculture below median (6)
Rainfall risk	1.962***	2.519**	–0.917	1.888**	5.431***	–1.331
	(0.471)	(1.065)	(0.986)	(0.801)	(1.823)	(1.095)
ln EY^R	0.270	0.323	–0.092	0.799**	1.575**	0.186
	(0.210)	(0.390)	(0.174)	(0.355)	(0.633)	(0.159)
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
Longitude and latitude	Yes	Yes	Yes	Yes	Yes	Yes
Area	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.463	0.515	0.512	0.576	0.620	0.612
Number of counties	2,693	1,341	1,341	2,651	1,322	1,323

Notes: For columns (1)–(3) the left-hand-side variable is the natural logarithm of total church members over population at the county level in 1890. For columns (4)–(6) the left-hand-side variable is ln combined church seating capacity over population 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 variable EY^R is expected agricultural output implied by the rainfall distribution in the county and is defined just after equation (17); the value for β—the effect of rainfall on agricultural output—is estimated to be 0.52 in Table 1. See Section 4 for more details on the specification and Section 5.1 for data sources. Other controls are ln land area of the county (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, longitude and latitude, 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. **Significant at 5%; ***Significant at 1%.

Rainfall Risk and Membership in Religious Communities. Tables 2 and 3 present our results on the link between membership in religious communities and rainfall risk in 1890.[22] The estimating equation is (17) and the estimation method is least squares. Religious membership in a county is measured as total church members in the county relative to population or as total church seating capacity relative to population. The main parameter of interest is the coefficient on rainfall risk, $R\text{Var}_c$, defined in (14). The control variable capturing the effect of rainfall on expected agricultural output,

22. For additional robustness checks to those in the main text further below, see Online Appendix B. There we use alternative methods to calculate standard errors (Tables B.1–B.6 and Tables B.13–B.14), examine "placebo" specifications that randomly reshuffle rainfall risk within states (Tables B.7–B.12), include lagged population and cut tail observations in population growth (Tables B.15 and B.16), estimate the effect in the 13 former British colonies that founded the United States and other groups of older states (Table B.17), and implement alternative sample splits (Tables B.18–B.19).

TABLE 3. The effect of rainfall risk on religious community size in 1860 and 1870.

	Church seatings/population 1870			Church seatings/population 1860		
	Baseline (1)	Agriculture above median (2)	Agriculture below median (3)	Baseline (4)	Agriculture above median (5)	Agriculture below median (6)
Rainfall risk	2.310**	8.011**	1.735*	1.892**	7.710**	–0.496
	(1.036)	(3.391)	(0.890)	(0.898)	(3.480)	(1.034)
ln EY^R	0.354	1.259**	0.220	–0.016	1.396*	–0.331
	(0.270)	(0.502)	(0.356)	(0.468)	(0.752)	(0.267)
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
Longitude and latitude	Yes	Yes	Yes	Yes	Yes	Yes
Area	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.390	0.384	0.509	0.351	0.339	0.476
Number of counties	2,068	1,033	1,034	1,822	909	909

Notes: The left-hand-side variable is the natural logarithm of combined church seating capacity over population at the county level in 1870 (columns (1)–(3)) and in 1860 (columns (4)–(6)). The estimating equation employed is (17). Rainfall risk is defined in equation (14) and calculated using 1895–2000 rainfall data. The variable EY^R is expected agricultural output implied by the rainfall distribution in the county and is defined just after equation (17); the value for β—the effect of rainfall on agricultural output—is estimated to be 0.52 in Table 1. See Section 4 for more details on the specification and Section 5.1 for data sources. Other controls are ln land area of the county (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, longitude and latitude, 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. **Significant at 5%; *Significant at 1%.

$EY_c^R = E\left(\prod_m R_{mc}^{\beta/12}\right)$, is calculated using a value for β of 0.52 based on the results in Table 1. Other controls are 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, longitude and latitude, average temperature over the period 1895–2000, ln land area, and state fixed effects.

We start by measuring 1890 membership in religious communities using total church members relative to population. A first impression of the association between religious membership and rainfall risk in the data can be obtained from a binned scatter plot once all controls have been partialed out. As can be seen from Appendix Figure A.3, the association between religious membership and rainfall risk appears to be positive. Table 2, column (1) summarizes our regression results using (17). The link between membership in religious communities and rainfall risk is statistically significant at the 1% level. A useful way to get a sense of the quantitative implications of the point estimate on rainfall risk is to calculate the increase in religious membership associated with a 1-standard-deviation increase in rainfall risk, which would be an increase in rainfall risk of 0.05 (see Appendix Table A.1). Such an increase in rainfall risk is associated with an increase in religious membership of about 11%.[23]

Table 2, columns (2) and (3) split the full 1890 sample 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 agricultural production risk, there should be a positive link between rainfall risk and membership in religious communities among these counties. The result in column (2) shows that the link is in fact positive and statistically significant at the 5% level. The point estimate implies that a one-standard-deviation increase in rainfall risk, which amounts to an increase in rainfall risk of 0.05 (see Appendix Table A.1), is associated with an increase in membership in religious communities of about 14% among counties with agricultural value added above the median. On the other hand, there is no statistically significant link between rainfall risk and religious membership among counties with agricultural value added below the median in column (3). In this group of counties, the agricultural sector is smaller than the manufacturing sector on average and the group is very heterogenous in terms of the share of agriculture (it contains all urban US counties). The link between membership in religious communities and rainfall risk is stronger among more agricultural counties in column (2) than among less agricultural counties in column (3), and the difference is statistically significant at the 5% level.[24]

Our second measure of 1890 membership in religious communities in a county is total church seating capacity relative to population. A first impression of the association between religious membership and rainfall risk using this alternative measure can again be obtained from a binned scatter plot once all controls have been partialed out. As can be seen from Appendix Figure A.4, the association again appears to be positive (see also Appendix Table B.22 for the regressions underlying the binned scatter plots A.3 and A.4). Table 2, column (4) summarizes our regression results using (17). The link between membership in religious communities and rainfall risk in 1890 is statistically significant at the 5% level. The point estimate implies that a one-standard-deviation increase in rainfall risk is associated with an increase in membership in religious communities of about 10%, which is very similar to the result we obtained

23. Our findings on the link between rainfall risk and religious membership 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. This could be because annual average temperature does not capture the effect of temperature on agricultural productivity well. In fact, annual average temperature is never a statistically significant determinant of the value of crops in Table 1.

24. This result is based on a model where we consider the full sample but interact all right-hand-side variables in the regression with an indicator variable that takes the value 1 if and only if counties have value added in agriculture relative to manufacturing above the median.

using church members relative to population as a measure of religious membership. Columns (5) and (6) split the sample into counties with value added in agriculture relative to manufacturing above and below the median. Among counties with agricultural value added above the median in column (5), the link between membership in religious communities and rainfall risk is statistically significant at the 1% level. The point estimate implies that a one-standard-deviation increase in rainfall risk is associated with an increase in membership in religious communities of about 30%. Among counties with agricultural value added below the median in column (6), there is no statistically significant link between rainfall risk and religious membership. The link between membership in religious communities and rainfall risk is stronger among more agricultural counties than among less agricultural counties, and the difference is statistically significant at the 5% level.[25]

Table 3 summarizes our results on the link between membership in religious communities and rainfall risk in 1870 and in 1860. The only measure of membership in religious communities available for these years is total church seating capacity relative to population. Column (1) summarizes our results for 1870. The sample is around 20% smaller than the 1890 sample. Even so, the results are similar to the ones for membership in religious communities in 1890. A one-standard-deviation increase in rainfall risk is associated with a statistically significant increase in membership in religious communities of about 12%. Columns (2) and (3) split the 1870 sample 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 almost entirely agricultural and homogenous in terms of the share of agriculture. The link between membership in religious communities and rainfall risk among more agricultural counties in column (2) is statistically significant at the 5% level. A one-standard-deviation increase in rainfall risk is associated with an increase in religious membership of about 40%. Rainfall risk shows a weaker link with membership in religious communities among less agricultural counties in column (3), but the link is still statistically significant at the 10% level. The link between membership in religious communities and rainfall risk among more agricultural

25. We also implement more detailed sample splits by agricultural share rather than just below/above median sample splits, see Table B.18 of Online Appendix B. To ensure the largest possible subsamples when we do more detailed sample splits, we pool the data for church seatings per capita in 1860, 1870, and 1890. Table B.18 columns (4)–(6) split the sample into terciles by counties' agricultural share and obtain three subsamples, a high-agriculture subsample, a middle-agriculture subsample, and a low-agriculture subsample. The effect of rainfall risk on the size of religious communities is largest among counties with agricultural shares in the top tercile and smallest among counties with agricultural shares in the bottom tercile. Among counties with agricultural shares in the middle tercile, the effect of rainfall risk on the size of religious communities is smaller than in the top tercile and larger than in the bottom tercile. Table B.18 columns (7)–(10) split the sample into quartiles based on counties' agricultural shares. The effect of rainfall risk on the size of religious communities decreases as one goes from the quartile with the highest agricultural share to the second-highest quartile. The effect of rainfall risk on the size of religious communities also decreases as one goes from the second-highest quartile to the third-highest quartile. However, there is no further decrease between the third-highest quartile and the bottom quartile, and the effect is statistically insignificant in the two bottom quartiles.

counties is stronger than among less agricultural counties, and the difference is statistically significant at the 10% level.

Table 3, column (4) reports our results on the link between membership in religious communities and rainfall risk in 1860. This sample is nearly 30% smaller than the 1890 sample and about 10% smaller than the 1870 sample. But again, results are similar to the ones we obtained for membership in religious communities in 1870 and 1890. The link between membership in religious communities and rainfall risk is statistically significant at the 5% level. A one-standard-deviation increase in rainfall risk is associated with an increase in membership in religious communities of about 10%. Columns (5) and (6) present the results when we split the sample by 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 agricultural. The link between membership in religious communities and rainfall risk among more agricultural counties in column (5) is statistically significant at the 5% level, and the point estimate implies that a one-standard-deviation increase in rainfall risk is associated with an increase in religious membership of around 40%. On the other hand, rainfall risk does not show a statistically significant link with membership in religious communities among counties with agricultural value added below the median in column (6). The link between membership in religious communities and rainfall risk among more agricultural counties is stronger than among less agricultural counties, and the difference is statistically significant at the 5% level.[26]

We do not find a statistically significant link between membership in religious communities and rainfall risk in 1850. 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; 2070 counties in 1870; and 2650 counties in 1890. Moreover, most of the counties missing in 1850 compared to 1860, 1870, or 1890 are agricultural. The consequence of the drop in sample size and sample selection between 1860 and 1850 can be illustrated by reestimating the link between membership in religious communities and rainfall risk in the 1860 subsample of counties for which there are data in 1850. This always

26. We also examine whether the effect of rainfall risk on the size of religious communities is larger in the subsample of counties where the distribution of rainfall implies low agricultural income. Our findings are summarized in Table B.19 of Online Appendix B. We pool the data for church seatings per capita in 1860, 1870, and 1890 to ensure the largest possible subsamples when we split counties both by rainfall-predicted income levels and agricultural shares. We find the effect of rainfall risk to be positive and statistically significant in the subsample of counties with rainfall-predicted incomes below median. In the subsample of counties with predicted incomes above median, the effect is positive but estimated imprecisely and statistically insignificant. We then split each of the two subsamples by the median agricultural share in the whole sample. This yields that the effect of rainfall risk on church membership is strongest among high-agriculture counties with low rainfall-predicted agricultural incomes. Hence, (i) the effect of rainfall risk on the size of religious communities is stronger among counties with low rainfall-predicted agricultural incomes and (ii) stronger among high-agriculture counties with low rainfall-predicted agricultural incomes.

TABLE 4. The effect of seasonal rainfall on agricultural productivity at the turn of the 20th century.

	(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
R^2	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 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 being split into rainfall over the growing season and nongrowing season as in equation (19): see Section 4 and Section 5.2 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 Section 3 for further details. 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. *Significant at 10%; **Significant at 5%; ***Significant at 1%.

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 4 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 season and the nongrowing season. In the early 20th-century United States, the nongrowing season went from December to February and the growing season from March to November (Covert 1912). Column (1) reproduces the specification of Table 1 that controls for rainfall in year t and year $t-1$. In column (2) we split rainfall in year t and year $t-1$ into growing-season rainfall and nongrowing-season rainfall as in (19). The estimates can be interpreted as, respectively, the effects on agricultural output of a 1% increase in monthly rainfall during the growing season and the nongrowing season in year t and year $t-1$. We find positive and statistically significant effects of growing-season and nongrowing-season rainfall in year t.[27] A 1% increase in growing-season rainfall raises agricultural output by 0.33% and a 1% increase in nongrowing-season rainfall raises output by 0.15%. Only growing-season rainfall is statistically significant in year $t-1$, with a 1% increase in growing-season rainfall raising agricultural output by 0.28%. The results in column (4) show that the effects of rainfall on agricultural output change little when we control for average growing season and nongrowing season temperatures in years t and $t-1$.[28]

Seasonal Rainfall Risk and Membership in Religious Communities. Table 5 summarizes our results on the link between membership in religious communities and rainfall risk during the growing and nongrowing seasons. The estimating equation is (17) with the rainfall risk term being replaced by (18). The control variables are the same as in Tables 2 and 3. Because rainfall during the growing season is a significant determinant of agricultural output in Table 4, we expect a positive link between membership in religious communities and growing-season rainfall risk. Nongrowing-season rainfall mattered less for agricultural output than growing-season rainfall, and we therefore expect nongrowing-season rainfall risk to matter less for membership in religious communities than growing-season rainfall risk. To get an idea of how much less important nongrowing-season rainfall risk should be according to our theoretical analysis, recall that equations (7)–(9) and (19) imply that the importance of nongrowing-season rainfall risk relative to growing-season rainfall risk for membership in religious communities is $(\beta_N/\beta_G)^2$, where β_N and β_G are the (contemporaneous) effects of nongrowing-season and growing-season rainfall on agricultural output. The formula changes somewhat when agricultural output also depends on lagged rainfall. In this case, the lagged effect of rainfall and the correlation between rainfall in different years play a role, too. In our data, the correlation between rainfall in different years is

27. In Table 4, the effect of year t growing-season rainfall is less precisely estimated than the effect of year $t-1$ growing-season rainfall and the effect of year t nongrowing-season rainfall. One reason could be related to measurement. Year t growing-season rainfall refers to March–November rainfall and some effects on agricultural output may only be realized in year $t+1$. Year t nongrowing-season rainfall refers to rainfall between December in year $t-1$ and February in year t and a larger part of its effects on agricultural output is therefore likely to be realized in year t. The same is true for year $t-1$ growing-season rainfall.

28. 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 membership in religious communities relative to the effect of growing-season rainfall risk. We elaborate on this point in the next footnote.

TABLE 5. The effect of seasonal rainfall risk on religious community size in 1860, 1870, and 1890.

	Church members/population	Church seatings/population		
	1890 (1)	1890 (2)	1870 (3)	1860 (4)
Growing-season rainfall risk	1.134***	1.273**	1.318***	1.554***
	(0.300)	(0.580)	(0.422)	(0.528)
Nongrowing-season rainfall risk	0.199	0.156	−0.118	−0.547
	(0.129)	(0.147)	(0.351)	(0.477)
*R*Cov (Growing-season, Nongrowing-season rainfall)	−0.493	−1.336	5.026*	1.026
	(0.915)	(1.040)	(2.576)	(3.356)
ln EY^R 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
Longitude and latitude	Yes	Yes	Yes	Yes
Area	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes
R^2	0.464	0.577	0.392	0.352
Number of counties	2,693	2,651	2,068	1,822

Notes: The left-hand-side variable is the natural logarithm of total church members over population or combined church seating capacity over population 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 variable EY^R is expected agricultural output implied by the rainfall distribution in the county and is defined just after equation (17); the value for β—the effect of rainfall on agricultural output—is estimated to be 0.52 in Table 1. The growing season is March–November and the nongrowing season is December–February following Covert (1912), see Section 3 for further details. See Section 5.1 data sources and Sections 4 and 5.2 for more details on the specification. Other controls are ln land area of the county (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, longitude and latitude, 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. *Significant at 10%; **Significant at 5%; ***Significant at 1%.

approximately zero. In this case, the formula for the relative importance of nongrowing-season rainfall risk for membership in religious communities relative to growing-season rainfall risk is $(\beta_{N,t}^2 + \beta_{N,t-1}^2)/(\beta_{G,t}^2 + \beta_{G,t-1}^2)$, where subscripts t and $t-1$ denote the year t and $t-1$ effects of (nongrowing- and growing-season) rainfall on agricultural output. Substituting the statistically significant rainfall effects in column (4) of Table 4 into this formula yields a value of 0.11.[29] Hence, the effect of nongrowing-season

29. 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 4 yields 0.056, which

rainfall risk on membership in religious communities should be approximately 1/10 of the effect of growing-season rainfall risk.

Table 5, column (1) reports our results on the link between membership in religious communities in 1890 measured as total church members relative to population and rainfall risk during the growing and nongrowing seasons. The link between membership in religious communities and growing-season rainfall risk is positive and statistically significant at the 1% level, whereas the link between religious membership and nongrowing-season rainfall risk is statistically insignificant. Column (2) examines the link between rainfall risk during the growing and nongrowing seasons and membership in religious communities in 1890 measured as total church seating capacity relative to population. We continue to find a positive and statistically significant link between membership in religious communities and growing-season rainfall risk, whereas the link between religious membership and nongrowing-season rainfall risk is statistically insignificant. The results for membership in religious communities in 1870 and 1860 are shown in columns (3) and (4). The link between membership in religious communities and growing-season rainfall risk is statistically significant at the 1% level, whereas the link between religious membership and nongrowing-season rainfall risk remains statistically insignificant. The covariance term is statistically insignificant in all cases except for 1870.

Accounting for Differences in National Cultures, Population Density, Literacy, 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 are not available for 1890). These data allow us to account for potential effects of national cultures on membership in religious communities in 1890. To do so, we first calculate for each county the share of the 1890 population born in 33 different foreign places and the share of the 1880 population's parents born in these places.[30] We then include these shares as additional control variables in our empirical analysis of membership in religious communities.

Table 6 presents the results when we measure membership in religious communities using total church members relative to population. The controls for first- and second-generation immigrants' countries of origin are jointly statistically significant determinants of religious membership at the 0.001% significance level in all specifications (first- and second generation immigrants' country of origin controls are

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 (other findings are unaffected).

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

TABLE 6. The effect of rainfall risk on church members in 1890: controlling for first- and second-generation immigrants' countries of ancestry.

	FG/SG (1)	+ Pop (2)	+ Literacy (3)	Agriculture above median (4)	Agriculture below median (5)	Growing and nongrowing season (6)
Rainfall risk	2.060*** (0.667)	2.178*** (0.767)	2.134*** (0.766)	2.889** (1.316)	−0.264 (0.741)	
Growing-season rainfall risk						0.893* (0.496)
Nongrowing-season rainfall risk						0.320** (0.143)
RCov (growing-season, nongrowing-season rainfall)						0.363 (1.477)
ln EY^R 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
Longitude and latitude	Yes	Yes	Yes	Yes	Yes	Yes
Area	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.495	0.514	0.515	0.603	0.568	0.516
Number of counties	2,520	2,520	2,482	1,239	1,239	2,482

Notes: The left-hand-side variable is the natural logarithm of total church members over population 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 variable EY^R is expected agricultural output implied by the rainfall distribution in the county and is defined just after equation (17); the value for β—the effect of rainfall on agricultural output—is estimated to be 0.52 in Table 1. The growing season is March-November and the nongrowing season is December–February following Covert (1912), see Section 3 for further details. 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 30. We control for ln population in 1890 (from column (2) on) and the literacy rate in 1880 (from column (3) on). Other controls are ln land area of the county (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, longitude and latitude, 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. *Significant at 10%; **Significant at 5%; ***Significant at 1%.

reported in Appendix Table B.20). The link between rainfall risk and membership in religious communities in column (1) is somewhat stronger than in Table 2, column (1) where we estimated the same specification without controls for first- and second-generation immigrants' countries of origin. Using the methodology of Altonji et al. (2005), this suggests that our results are unlikely to be biased upward by selection on unobservables (e.g., selection of groups of people with greater attachment to their religious communities into counties with greater rainfall risk). This is because for the link between rainfall risk and membership in religious communities to be upward biased, selection on unobservables would have to have the opposite effect on the link between rainfall risk and membership in religious communities than selection on observables (e.g., selection by first- and second-generation immigrants' countries of origin; see Nunn and Wantchekon 2011, for a recent application of this methodology). Results also change little in columns (2) and (3) where we control for ln population in 1890 and the literacy rate in 1880 (the literacy rate is not available for 1890) to account for potential effects of population density and literacy on church membership.[31] Columns (4) and (5) split the sample into counties with value added in agriculture relative to manufacturing above and below the median. We find a positive and statistically significant link between membership in religious communities and rainfall risk among more agricultural counties but a statistically insignificant link among less agricultural counties. Moreover, the difference between more and less agricultural counties is statistically significant at the 5% level. Finally, we consider the link between membership in religious communities and rainfall risk during the growing and nongrowing seasons in column (6). We continue to find a stronger link of membership in religious communities with growing-season rainfall risk than with nongrowing-season rainfall risk. Table 7 reports the results when we measure membership in religious communities using total church seating capacity relative to population. Again, the controls for first- and second-generation immigrants' countries of origin are jointly statistically significant determinants of religious membership at the 0.001% significance level in all specifications (first- and second generation immigrants' country of origin controls are reported in Appendix Table B.21). The link between rainfall risk and membership in religious communities in column (1) is somewhat stronger than in Table 2, column (4) where we estimated the same specification without controls for first- and second-generation immigrants' countries of origin. Results change little in columns (2) and (3) where we control for ln population in 1890 and the literacy rate in 1880. Columns (4) and (5) show a positive and statistically significant link between membership in religious communities and rainfall risk among more agricultural counties but a statistically insignificant link among less agricultural counties. Moreover, the difference between more and less agricultural counties is statistically significant at the 1% level. Finally, in column (6) we continue to find a stronger link of membership in religious communities with growing-season rainfall risk than with nongrowing-season rainfall risk.

The US Census also collected county-level data on religious membership by denomination. These data allow us to account for potential effects of denominational differences in religious culture on membership in religious communities in 1890 by controlling for the relative size of different religious denominations. To do so, we

31. See Glaeser and Sacerdote (2008) and Becker and Woessmann (2013) on the link between education and church attendance.

TABLE 7. The effect of rainfall risk on church seatings in 1890: controlling for first- and second-generation immigrants' countries of ancestry.

	+ FG/SG (1)	+ Pop (2)	+ Literacy (3)	Agriculture above median (4)	Agriculture below median (5)	Growing and nongrowing season (6)
Rainfall risk	2.394*** (0.676)	2.394*** (0.677)	2.000*** (0.504)	4.423*** (1.217)	0.269 (0.540)	
Growing-season rainfall risk						1.383*** (0.458)
Nongrowing-season rainfall risk						−0.0107 (0.0975)
*R*Cov (growing-season, nongrowing-season rainfall)						0.718 (0.753)
ln EY^R 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
Longitude and latitude	Yes	Yes	Yes	Yes	Yes	Yes
Area	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.609	0.609	0.617	0.656	0.698	0.617
Number of counties	2,520	2,502	2,471	1,234	1,234	2,471

Notes: The left-hand-side variable is the natural logarithm of combined church seating capacity over population 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 variable EY^R is expected agricultural output implied by the rainfall distribution in the county and is defined just after equation (17); the value for β—the effect of rainfall on agricultural output—is estimated to be 0.52 in Table 1. The growing season is March–November and the nongrowing season is December–February following Covert (1912), see Section 3 for further details. 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 30. We control for ln population in 1890 (from column (2) on) and the literacy rate in 1880 (from column (3) on). Other controls are ln land area of the county (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, longitude and latitude, 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. ***Significant at 1%.

first calculate the share of total church members in each county belonging to 12 different denominations and proceed analogously with total church seating capacity.[32] We then include these denomination shares as additional controls when we examine the link between rainfall risk and membership in religious communities.[33] Table 8, Panel A, reports results when we measure membership in religious communities and the relative size of denominations using total church members. The set of controls for first- and second-generation immigrants' countries of origin and the set of controls for the religious denominations present in a county are both jointly statistically significant determinants of religious membership at the 0.001% significance level in all specifications. The link between rainfall risk and membership in religious communities in column (1) is somewhat stronger than in Table 2, column (1) where we estimated the same specification without controls for immigrants' countries of origin and for denominations present in a county. Hence, the methodology of Altonji et al. (2005) again suggests that our results are unlikely to be biased upward by selection on unobservables. Results change little in column (2) where we control for ln population in 1890 and the literacy rate in 1880. When we split the sample into counties with value added in agriculture relative to manufacturing above and below the median, the link between membership in religious communities and rainfall risk is positive and statistically significant among more agricultural counties in column (3) but not among less agricultural counties in column (4). Moreover, the difference between more and less agricultural counties is statistically significant at the 5% level. When we consider the link between growing-season and nongrowing-season rainfall risk on the one hand and membership in religious communities on the other in column (5), the link continues to be stronger for growing-season rainfall risk.

Table 8, Panel B, presents results when we measure membership in religious communities and the relative size of denominations using total church seating capacity. Again, the set of controls for first- and second-generation immigrants' countries of origin and the set of controls for religious denominations present in a county are both jointly statistically significant determinants of religious membership at the 0.001% significance level in all specifications. The link between rainfall risk and membership in religious communities in column (1) is somewhat stronger than in Table 2, column (4) where we estimated the same specification without controls for

32. The denominations are taken from Gutmann's (2007) classification of 19th-century religious denominations into Baptists, Congregationalists, Conservatives, Disciples of Christ, Episcopalians, Jews, Lutherans, Methodists, Mormons, Presbyterians, Reformed, and Roman Catholics.

33. We do not examine the effect of rainfall risk on the size of specific denominations, as there is no information on denominational differences in insurance provision and substitutability among denominations. For example, the size of denominations does not seem a useful proxy for insurance provision, as sustaining informal insurance requires suppressing free riding, which is more difficult to accomplish in larger religious communities (Iannaccone 1992). When we use the US General Social Survey data mentioned in the introduction to check for denominational differences in the help individuals expect from their congregation in case of illness or some other difficult situation, we find that differences are statistically insignificant for all denominations in the previous footnote except Conservatives (mainly Mennonites and Quakers, who are more likely to expect help from congregants).

TABLE 8. The effect of rainfall risk on religious community size: controlling for religious denominations.

	Baseline (1)	+ Pop and literacy (2)	Agriculture above median (3)	Agriculture below median (4)	Growing and nongrowing season (5)
	Panel A: Church members/population				
Rainfall risk	2.244*** (0.602)	2.201*** (0.648)	2.854** (1.169)	0.411 (0.768)	
Growing-season rainfall risk					1.044** (0.494)
Nongrowing-season rainfall risk					0.276* (0.148)
*R*Cov (growing-season, nongrowing-season rainfall)					0.238 (1.256)
Denomination shares	Yes	Yes	Yes	Yes	Yes
All controls Tables 6&7 (column (1))	Yes	Yes	Yes	Yes	Yes
Population and Literacy	No	Yes	Yes	Yes	Yes
R^2	0.547	0.567	0.647	0.603	0.568
Number of counties	2,482	2,482	1,239	1,239	2,482
	Panel B: Church seatings/population				
Rainfall risk	2.216*** (0.586)	2.143*** (0.580)	4.206*** (1.308)	0.450 (0.583)	
Growing-season rainfall risk					1.358*** (0.461)
Nongrowing-season rainfall risk					0.0448 (0.112)
*R*Cov (Growing-season, Nongrowing-season rainfall)					0.925 (0.723)
Denomination shares	Yes	Yes	Yes	Yes	Yes
All controls Tables 6&7 (column 1)	Yes	Yes	Yes	Yes	Yes
Population and literacy	No	Yes	Yes	Yes	Yes
R^2	0.629	0.633	0.672	0.712	0.633
Number of counties	2,471	2,471	1,234	1,234	2,471

Notes: The left-hand-side variable is the natural logarithm of total church members over population (Panel A) or combined church seating capacity over population (Panel B) at the county level in 1890. See Section 4 for more details on the specification and Section 5.1 for data sources. Denomination shares refer to either church members of 12 different denominations divided by the total church members (Panel A) or church seating capacity of these denominations divided by total church seating capacity (Panel B); the denominations are listed in footnote 32. See the notes to Table 7 for a description of the first-generation (FG) and second-generation (SG) national cultures variables as well as the other controls. The method of estimation is least squares. Standard errors (in parentheses) account for arbitrary heteroskedasticity and are clustered at the state level. *Significant at 10%; **Significant at 5%; ***Significant at 1%.

immigrants' countries of origin and religious denominations. Results change little in column (2) where we control for ln population in 1890 and the literacy rate in 1880. When we split the sample into counties with value added in agriculture relative to manufacturing above and below the median, the link between membership in religious communities and rainfall risk is positive and statistically significant among more agricultural counties in column (3) but not among less agricultural counties in column (4), and the difference is statistically significant at the 5% level. Finally, in column (5) we find that the link with religious membership is stronger for growing-season rainfall risk.

5.3. The Persistent Effects of Rainfall Risk on Modern Religious Communities

An interesting issue is whether the effects of agricultural production risk on 19th-century religious membership persist to the turn of the 21st century. County-level data on US religious membership around the turn of the 21st century are collected by the Glenmary Research Center and distributed by the Association of Religion Data Archives (www.thearda.com). The data archive has information on church *members* according to each denomination's membership definition for 1980 and 1990 and on church *adherents* for 1980, 1990, 2000, and 2010. Church adherents include members and other regular attendants to religious services.[34] Our measures of modern county-level religious membership only count denominations that we could classify as belonging to meta-denominations present in our 19th-century data.[35]

Our empirical analysis is based on the following estimating equation:

$$\ln\left(\frac{\textit{Modern church members or adherents}_c}{\textit{Population}_c}\right) = \varphi + \gamma \ln EY_c^R + \sum_{i=1}^{I} \varphi_i X_{ic} + \rho \ln\left(\frac{\textit{1890 church members}_c}{\textit{Population}_c}\right) \tag{20}$$

where $EY_c^R = E\left(\prod_m R_{mc}^{\beta/12}\right)$ with β being estimated using (16), and X_c stands for county characteristics like soil quality or ruggedness of the terrain. Our main interest is in the parameter ρ—the extent to which differences in historical church membership across counties persist to around the turn of the 21st century—when historical church membership is instrumented with rainfall risk, $R\text{Var}_c$. The resulting estimate indicates the extent to which cross-county differences in historical church membership associated with rainfall risk persist.

Table 9, Panel A, columns (1)–(3) report our results for the degree of persistence, ρ, when modern church membership in (20) is measured as average adherents over

34. The ARDA database for members does not have information on Roman Catholics, and we therefore use adherents instead.

35. As these meta-denominations constitute the vast majority of modern US church members and adherents, we get almost identical results when we use all denominations (available upon request). The meta-denominations are Baptists, Congregationalists, Conservatives, Disciples of Christ, Episcopalians, Jews, Lutherans, Methodists, Mormons, Presbyterians, Reformed, and Roman Catholics; see Gutmann (2007).

TABLE 9. Persistence of religious membership—two-stage least squares estimates.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: Church adherents/population 1980–2010									
ln Church members per capita in 1890	0.501*** (0.140)	0.437** (0.214)	0.363* (0.201)	0.501*** (0.178)	0.459*** (0.156)	0.457*** (0.169)	0.488*** (0.185)	0.453*** (0.167)	0.452** (0.181)
Rainfall risk							0.999 (0.864)	0.387 (0.807)	0.301 (0.858)
Instrument	Rainfall risk	Rainfall risk	Rainfall risk	Church seatings 1870	Church seatings 1870	Church seatings 1870	Church seatings 1870	Church seatings 1870	Church seatings 1870
Controls	See below	See below	See below	See below	See below	See below	See below	See below	See below
Number of counties	1,333	1,235	1,235	1,188	1,154	1,154	1,188	1,154	1,154
Kleibergen–Paap F-Statistic	6.90	5.05	6.12	7.45	11.41	12.27	7.51	10.88	11.57
Anderson–Rubin Wald test (p-value)	0.01	0.02	0.04	0.07	0.04	0.05	0.08	0.06	0.07
Panel B: Church members/population 1980–1990									
ln Church members per capita in 1890	0.605*** (0.183)	0.667** (0.328)	0.577* (0.312)	0.584** (0.230)	0.574*** (0.180)	0.561*** (0.192)	0.572** (0.235)	0.564*** (0.190)	0.551*** (0.203)
Rainfall risk							0.930 (0.931)	0.579 (0.937)	0.569 (0.930)
Number of counties	1,333	1,235	1,235	1,188	1,154	1,154	1,188	1,154	1,154
Kleibergen–Paap F-Statistic	6.90	5.05	6.12	7.45	11.41	12.27	7.51	10.88	11.57
Anderson–Rubin Wald test (p-value)	0.02	0.03	0.04	0.06	0.02	0.02	0.07	0.02	0.03

TABLE 9. Continued.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Instrument	Rainfall risk	Rainfall risk	Rainfall risk	Church seatings 1870	Church seatings 1870	Church seatings 1870	Church seatings 1870	Church seatings 1870	Church seatings 1870
All controls, Table 2 (Panels A and B)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
All controls, Table 6 (Panels A and B)	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Denomination shares (Panels A and B)	No	No	Yes	No	No	Yes	No	No	Yes

Notes: The left-hand-side variable is the average of the natural logarithm of total church adherents over population for the years 1980–2010 in Panel A and the average of the natural logarithm of total church members over population for the years 1980 and 1990 in Panel B. In columns (1)–(3) the excluded instrument is rainfall risk; in columns (4)–(9) it is the natural logarithm of church seating/population at the county level in 1870). Standard errors (in parentheses) account for arbitrary heteroskedasticity and are clustered at the state level. *Significant at 10%; **Significant at 5%; ***Significant at 1%.

the 1980–2010 period and historical membership in 1890 is instrumented with rainfall risk. We only consider counties with an above-median agricultural share in 1890, as our empirical analysis using historical data yielded an effect of rainfall risk on religious membership for counties with agricultural shares above the median but not for below-median agricultural counties. Column (1) reports results with the controls of Table 2. Column (2) adds the controls for countries of origin of immigrants of Table 6 and column (3) the controls for the size of different religious denominations of Table 8. In addition to point estimates and standard errors, the table reports the Kleibergen–Paap F-statistic of instrument strength. As the instrument appears sometimes weak, we also report the Anderson–Rubin test of statistical significance for ρ, which is robust to weak instruments (e.g., Andrews and Stock 2005). It can be seen that the point estimates of ρ are between 0.36 and 0.5 and statistically significant at standard levels. The 0.36 point estimate, for example, implies that slightly above 1/3 of the historical church membership associated with rainfall risk persists to around the turn of the 21st century.

It is interesting to compare our estimate of the persistence of cross-county differences in historical church membership associated with rainfall risk and the persistence of historical church membership no matter what the source of historical cross-county differences in church membership is. This "average" degree of persistence can in principle be obtained by estimating (20) with least squares. However, in our case this approach clearly does not work, as 1890 membership is certainly measured with error and least-squares estimation yields (downward) biased results in this case. To address this issue we estimate the "average" degree of persistence, ρ, in (20) by instrumenting church membership in 1890 with church seatings in 1870.[36] This yields a consistent estimate when measurement error in 1890 membership is unrelated to measurement error in 1870 seatings, which does not seem unreasonable as these data were collected a generation apart. Table 9, Panel A, columns (4)–(6) report our results. Overall, the degree of persistence we estimate is similar to what we obtained in columns (1)–(3), which indicates that historical differences in cross-county church membership associated with rainfall risk persist about as much as historical differences in church membership associated with other sources.

Table 9, Panel A, columns (7)–(9) augment the specifications in columns (4)–(6) with a direct effect of rainfall risk. This allows us to capture any effects of rainfall risk on modern religious membership conditional on 1890 membership. Our results indicate that the direct effect of rainfall risk is statistically insignificant. Hence, rainfall risk appears to affect modern church membership through persistent effects on 19th-century church membership rather than any direct effect during the 20th century.

36. Using 1890 church seatings as an instrument is most likely not a good alternative, as 1890 seatings and members were collected at the same time and are likely to reflect the same measurement errors. When there are no data for 1870 seatings in a county we use the average of 1870 seatings in directly neighboring counties (if available).

Table 9, Panel B reports our results when using average members over the 1980–1990 period as the proxy for modern religious membership. This yields qualitatively similar results as our analysis based on adherents but stronger persistence of historical membership to modern times. Hence, overall our empirical analysis indicates considerable persistence of the effect of rainfall risk on membership in religious communities. This is consistent with recent evidence on the persistence of various cultural traits transmitted either within families or within broader communities (e.g., Bao et al. 1999; Bisin and Verdier 2000; Bengtson et al. 2009; Alesina and Giuliano 2010; Fernández 2011; Giavazzi et al. 2014).

6. Conclusion

Is the spread of religious communities related to economic risks faced by individuals? The available microeconomic evidence indicates that religious communities provide some informal insurance against idiosyncratic risk to their members. We argued that, as a result, membership in religious communities should be more prevalent where populations face greater common risk. Intuitively, this is because we found that for individual risk aversion in the empirically relevant range, idiosyncratic risk and rainfall risk aggravate each other in the sense that a bad realization of one risk reduces consumption utility more, the worse the realization of the other risk. Hence, individuals gain more from mutual insurance against idiosyncratic risk when greater common risk makes the worst case scenario of bad realizations of both idiosyncratic and common risks more probable.

In our empirical analysis, we used common rainfall risk as a driver of common county-level agricultural production risk in the 19th-century United States. We found that a larger share of the population was organized into religious communities in counties with greater common agricultural risk, holding expected agricultural output constant. The link between common risk and membership in religious communities became somewhat stronger when we controlled for first- and second-generation immigrants' countries of origin and for the religious denominations present in a county. This suggests that our finding of a positive link between rainfall risk and religious community membership is unlikely to reflect the selection of groups of people with greater attachment to their religious communities into counties with greater rainfall risk. We also argued that our finding is unlikely to reflect the coping theory of religiosity, which points to psychological benefits of religiosity when individuals are dealing with adverse events that are unpredictable. This is because we found cross-county differences in rainfall risk to be very persistent over time and because the coping theory of religiosity has been found to apply to religious beliefs rather than church attendance.

If rainfall risk affects the value of church membership through agricultural production risk, there should be a positive link between the share of the population organizing into religious communities and rainfall risk in predominately agricultural counties. Moreover, the link between membership in religious communities and rainfall risk should be stronger in more agricultural counties than less agricultural counties. We found empirical support for both of these implication of our model. In line with our model, we also found the link between membership in religious communities and rainfall risk to be stronger for rainfall risk during the growing season. Our estimates of the effect of rainfall risk on membership in religious communities imply that a 1-standard-deviation increase in rainfall risk was associated with an increase in membership in religious communities of around 10% across all counties. Among more agricultural counties, a one-standard-deviation increase in rainfall risk was associated with an increase in membership in religious communities between 20% (in 1890) and 50% (in 1860).

We also investigated whether the effects of agricultural production risk on 19th-century religious membership persisted to modern times. Our empirical results indicate that among historically more agricultural counties – the group of counties where we found an effect of rainfall risk on historical religious membership – more than 1/3 of 19th-century differences in religious membership associated with rainfall risk persist to the turn of the 21st century.

Appendix A: Tables and Figures

TABLE A.1 Summary statistics.

	1890			1870			1860			1850		
Variable	Obs	Mean	StdDev	Obs	Mean	StdDev	Obs	Mean	StdDev	Obs	Mean	StdDev
Panel A: Summary statistics full sample												
ln Church members/population	2,693	−1.33	0.56	–	–	–	–	–	–	–	–	–
ln Church seatings/population	2,651	−0.45	0.63	2,068	–0.79	0.69	1,822	–0.68	0.69	1,448	–0.75	0.73
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

TABLE A.1. Continued.

Variable	1890 Obs	1890 Mean	1890 StdDev	1870 Obs	1870 Mean	1870 StdDev	1860 Obs	1860 Mean	1860 StdDev
Panel B.1: Summary statistics for counties with agricultural share above the median									
ln Church members/population	1,341	−1.39	0.59	–	–	–	–	–	–
ln Church seatings/population	1,322	−0.49	0.69	1,033	−0.82	0.74	909	−0.72	0.71
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 B.2: Summary statistics for counties with agricultural share below the median									
ln Church members/population	1,341	−1.27	0.52	–	–	–	–	–	–
ln Church seatings/population	1,323	−0.41	0.56	1,034	−0.76	0.64	909	−0.64	0.65
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	0.57	0.25	1,034	0.67	0.22	909	0.71	0.23

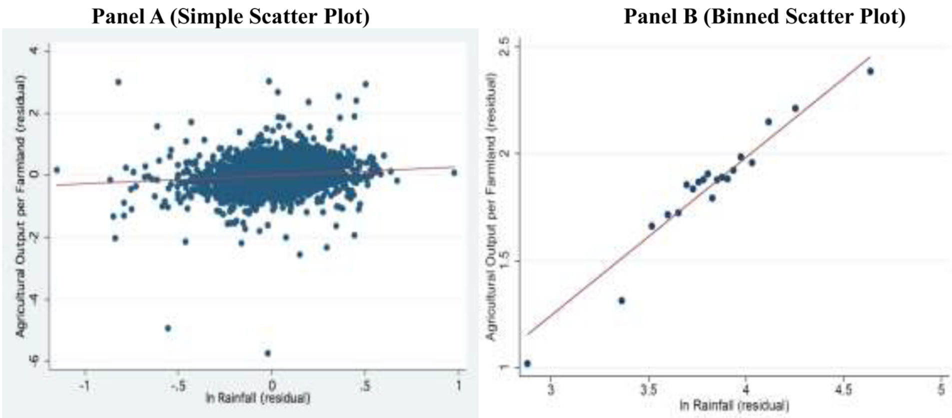


FIGURE A.1. Notes: Panel A is a simple scatter plot and Panel B a binned scatter plot. Both are based on the residuals from a regression of the county-level natural logarithm (ln) of the value of crops produced per acre (horizontal axis) and of rainfall (vertical axis) in 1909, 1919, and 1929 on county 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 for more details on the specification.

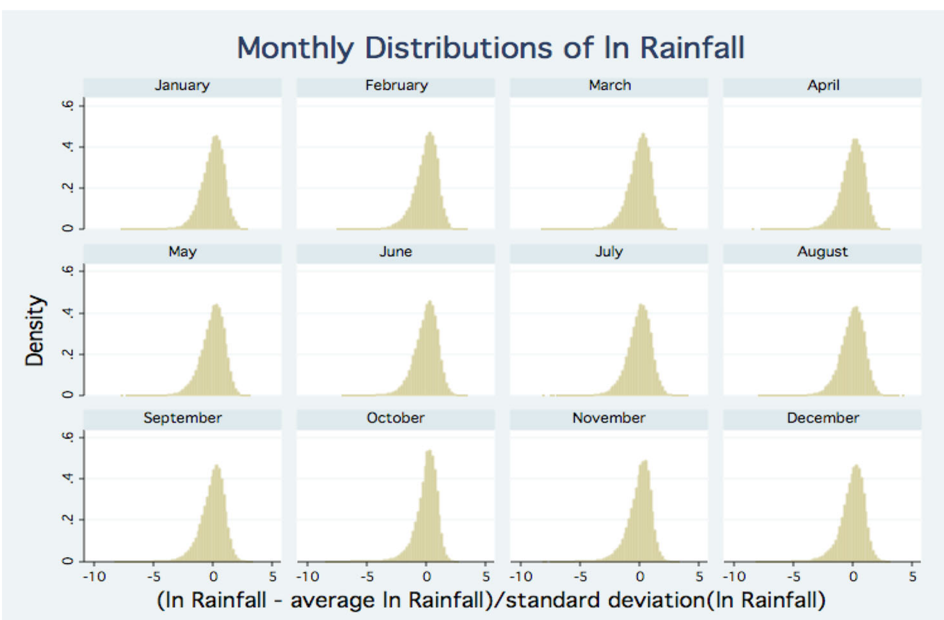


FIGURE A.2. Notes: Standardized distributions of the natural logarithm (ln) of rainfall 1895–2000 at the county level by month.

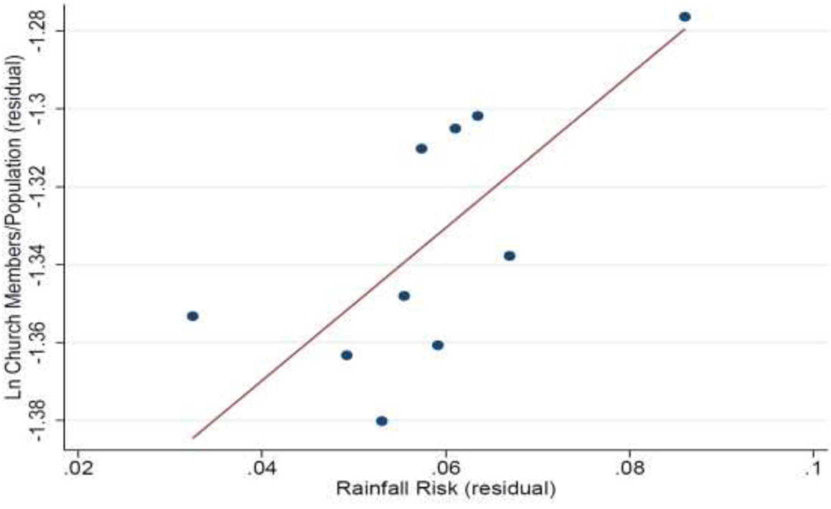


FIGURE A.3. Notes: Binned scatter plot based on the residuals from a regression of the county-level natural logarithm (ln) of total church members over population (horizontal axis) and of rainfall risk (vertical axis) in 1890 on state fixed effects and all other controls included in Table 2, column (1). See the note to Table 2 for a list of controls.

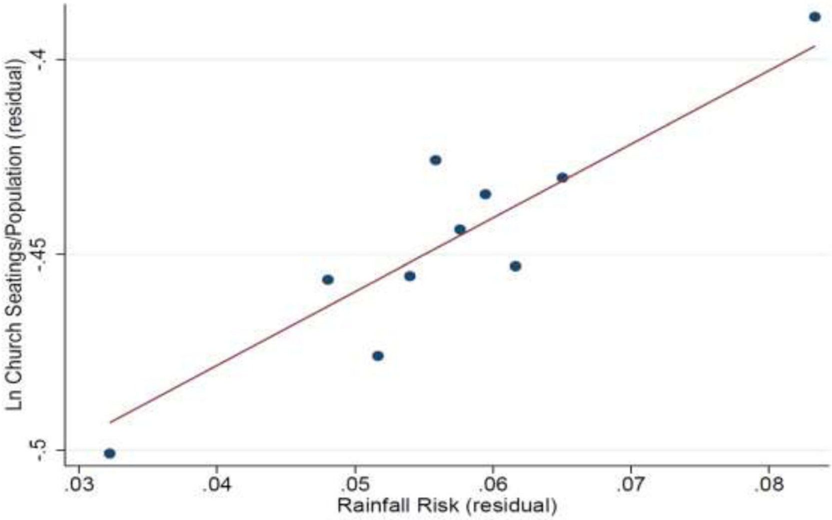
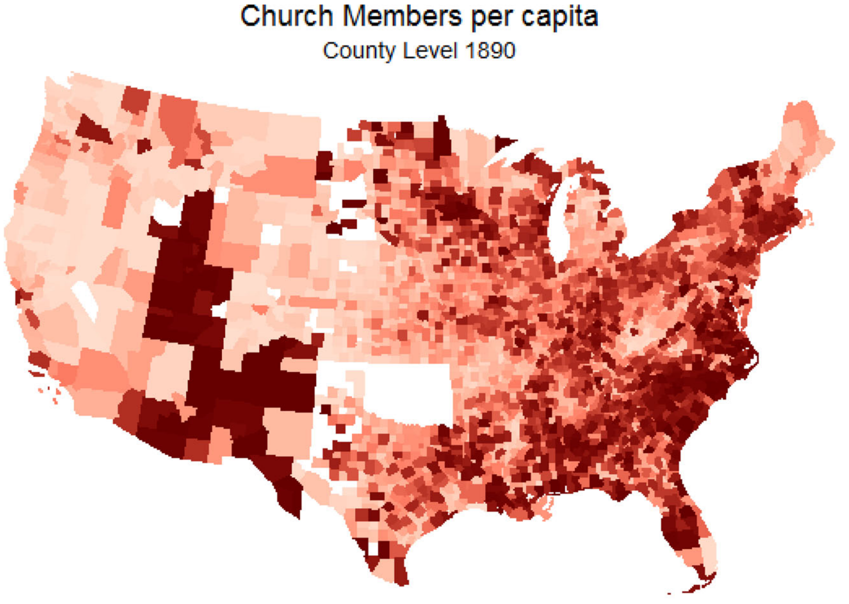


FIGURE A.4. Notes: Binned scatter plot based on the residuals from a regression of the county-level natural logarithm (ln) of combined church seating capacity over population (horizontal axis) and of rainfall risk (vertical axis) in 1890 on state fixed effects and all other controls included in Table 2, column (1). See the note to Table 2 for a list of controls.



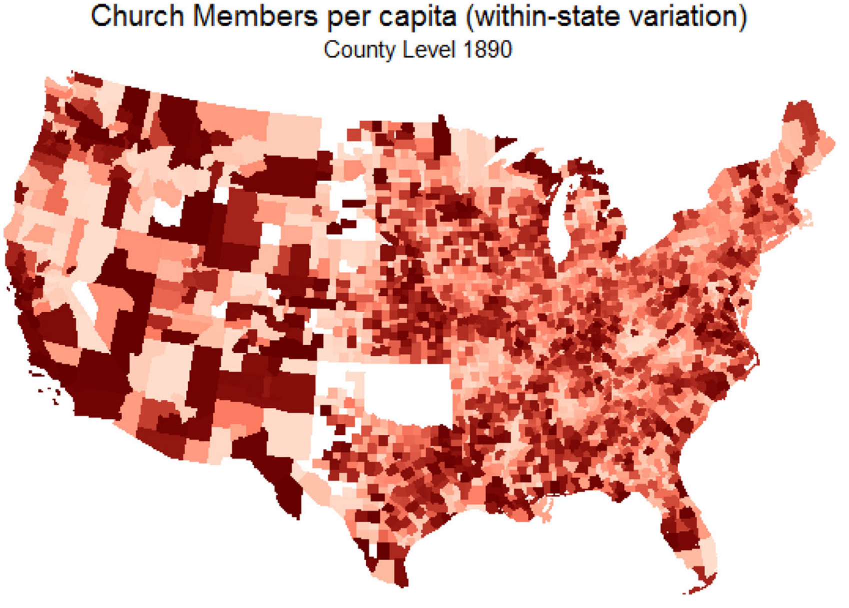
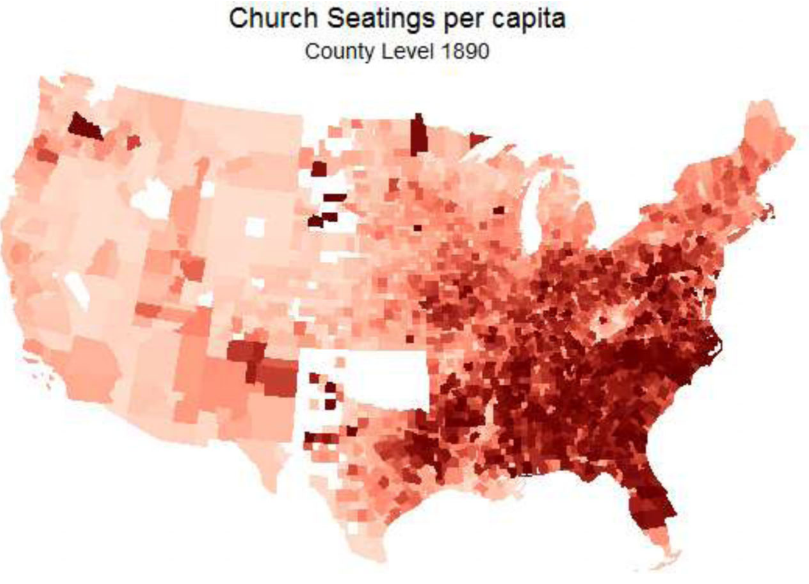


FIGURE A.5. Notes: A darker color refers to higher values of church members per capita, church seatings per capita, lnEY, and rainfall risk. Maps displaying within-state variation are based on demeaned values (which are deviations from the state average). White polygons denote missing observations.



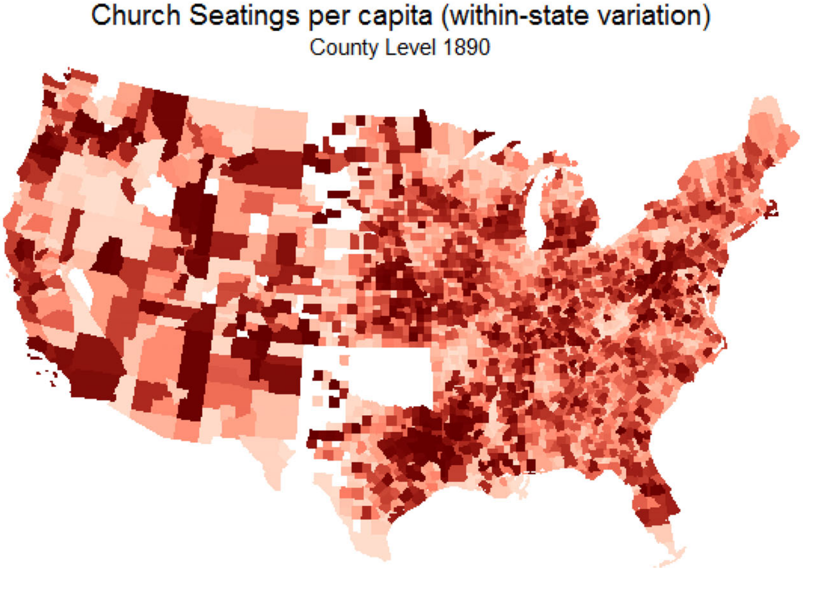
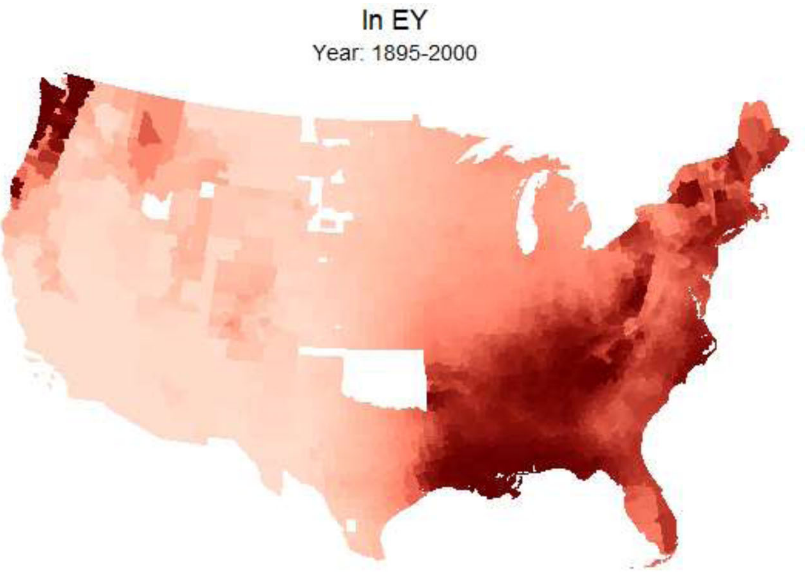


FIGURE A.5. Continued



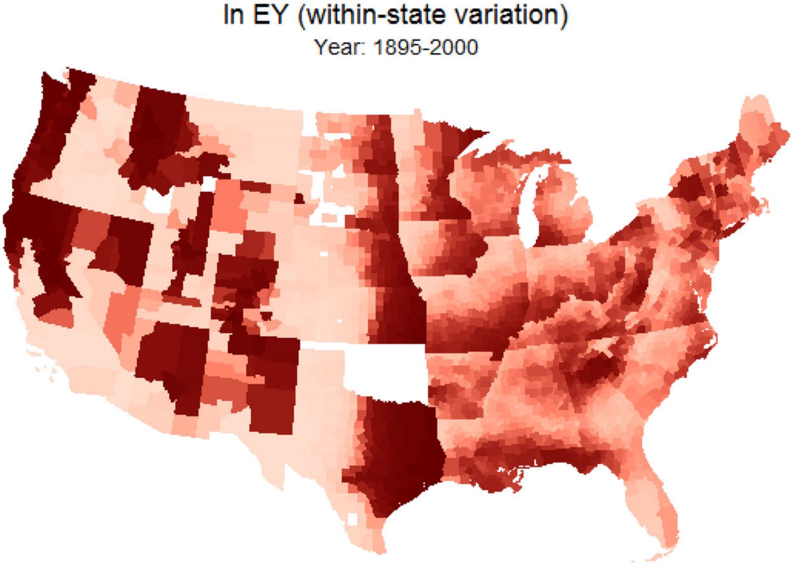
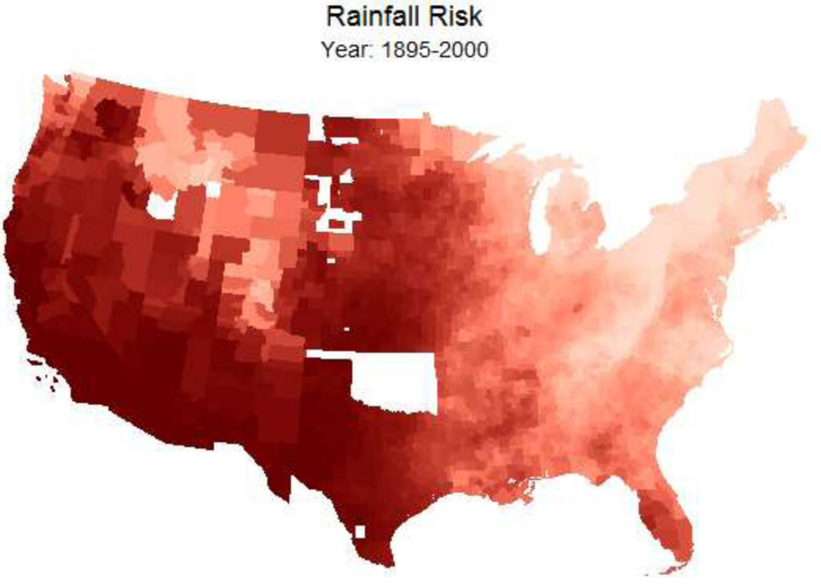


FIGURE A.5. Continued



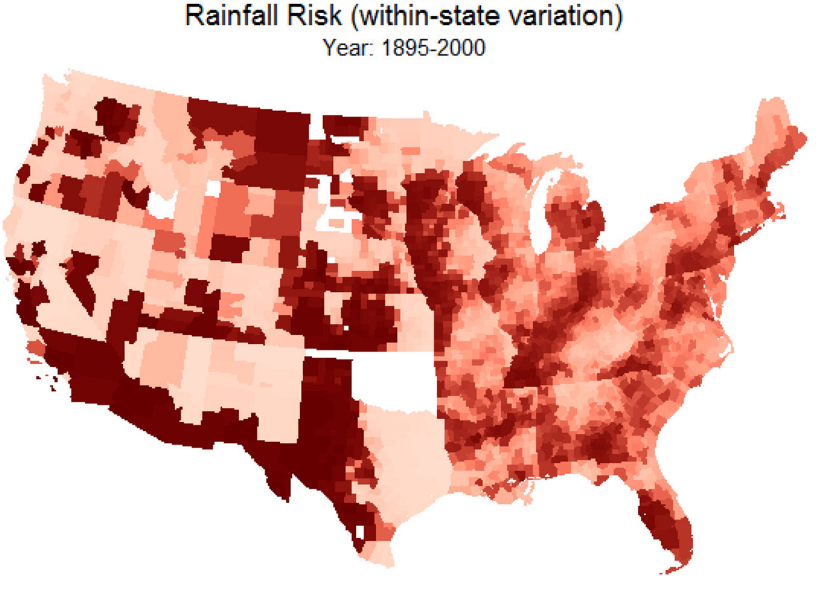


FIGURE A.5. Continued

References

Abramitzky, R. (2008). “The Limits of Equality: Insights From the Israeli Kibbutz.” *The Quarterly Journal of Economics*, 123, 1111–1159.

Ager, P., C. W. Hansen, and L. Lønstrup (2016). “Church Membership and Social Insurance: Evidence from the Great Mississippi Flood of 1927.” *Discussion Papers of Business and Economics 7/2016*, Department of Business and Economics, University of Southern Denmark.

Alderman, H. and C. H. Paxson (1994). “Do the Poor Insure? A Synthesis of the Literature on Risk and Consumption in Developing Countries.” In *Economics in a Changing World. Vol. 4: Development, Trade, and Environment*, edited by E. L. Bacha. MacMillan, UK.

Alesina, A. and P. Giuliano (2010). “The Power of the Family.” *Journal of Economic Growth*, 15, 93–125.

Altonji, J. G., T. E. Elder, and C. R. Taber (2005). “Selection on Observed and Unobserved Variables: Assessing the Effectiveness of Catholic Schools.” *Journal of Political Economy*, 113, 151–184.

Andrews, D. and J. Stock (2005). “Inference with Weak Instruments.” National Buereau of Economic Research Technical Paper 0313.

Attanasio, O. P. and G. Weber (1989). “Intertemporal Substitution, Risk Aversion, and the Euler Equation for Consumption.” *The Economic Journal*, 99, 59–73.

Azzi, C. and R. G. Ehrenberg (1975). “Household Allocation of Time and Church Attendance.” *The Journal of Political Economy*, 83, 27–56.

Banerjee, A. V. and E. Duflo (2011). *Poor Economics: A Radical Rethinking of the Way to Fight Global Poverty*. PublicAffairs, USA.

Bao, W., L. B. Whitbeck, D. R. Hoyt, and R. D. Conger (1999). “Perceived Parental Acceptance as a Moderator of Religious Transmission among Adolescent Boys and Girls.” *Journal of Marriage and Family*, 61, 362–374.

Barro, R. J. and R. M. McCleary (2003). “Religion and Economic Growth Across Countries.” *American Sociological Review*, 68, 760–781.

Becker, S. O. and L. Woessmann (2013). “Not the Opium of the People: Income and Secularization in a Panel of Prussian Counties.” *American Economic Review, Papers and Proceedings*, 103, 539–544.

Belcher, J. R. and C. J. Tice (2011). “Protestant Church Charity: History, Trends, and Implications.” *Journal of Religion & Spirituality in Social Work: Social Thought*, 30, 164–177.

Bengtson, V. L., C. E. Copen, N. M. Putney, and M. Silverstein (2009). “A Longitudinal Study of the Intergenerational Transmission of Religion.” *International Sociology*, 24, 325–345.

Bentzen, J. (2015). “Acts of God: Religiosity and Natural Disasters Across Subnational World Districts.” *Univ. of Copenhagen Dept. of Economics Discussion* Paper No. 15–06.

Berman, E. (2000). “Sect, Subsidy, and Sacrifice: An Economist’s View of Ultra-Orthodox Jews.” *Quarterly Journal of Economics*, 115, 905–953.

Bisin, A. and T. Verdier (2000). “Beyond the Melting Pot: Cultural Transmission, Marriage, and the Evolution of Ethnic and Religious Traits.” *Quarterly Journal of Economics*, 115, 955–988.

Bodnar, J. (1985). *The Transplanted: A History of Immigrants in Urban America*. Indiana University Press, USA.

Bovee, D. S. (2010). *The Church and the Land: The National Catholic Rural Life Conference and American Society, 1923–2007*. The Catholic University of America Press, USA.

Bremner, R. H. (1994). *Giving: Charity and Philanthropy in History*. Transaction Publishers, USA.

Chen, D. L. (2010). “Club Goods and Group Identity: Evidence from Islamic Resurgence during the Indonesian Financial Crises.” *Journal of Political Economy*, 118, 300–354.

Chiappori, P. A. and M. Paiella (2011). “Relative Risk Aversion is Constant: Evidence from Panel Data.” *Journal of the European Economic Association*, 9, 1021–1052.

Cnaan, R. A., S. C. Boddie, F. Handy, G. Yancey, and R. Schneider (2002). *The Invisible Caring Hand: American Congregations and the Provision of Welfare*. New York University Press, New York, USA.

Covert, J. (1912). “Seedtime and Harvest: Cereals, Flax, Cotton, and Tobacco.” *United States Department of Agriculture*, Bureau of Statistics Bulletin, Washington (DC), USA.

Davis, L. (2014). “Individual Responsibility and Economic Development: Evidence from Rainfall Data.” Working Paper, Union College, USA.

Dehejia, R., T. DeLeire, and E. F. P. Luttmer (2007). "Insuring Consumption and Happiness Through Religious Organizations." *Journal of Public Economics*, 91, 259–279.

Dercon, S. (2004). "Risk, Insurance, and Poverty: A Review." *Insurance Against Poverty*, edited by S. Dercon. Oxford University Press, UK.

Deschenes, O. and M. Greenstone (2007). "The Economic Impacts of Climate Change: Evidence from Agricultural Output and Random Fluctuations in Weather." *American Economic Review*, 97(1), 354–385.

Durante, R. (2010). "Risk, Cooperation, and the Economic Origins of Social Trust: An Empirical Investigation." Working paper, Hal-00972949.

Fernández, R. (2011). "Does Culture Matter?" In *Handbook of Social Economics*, edited by J. Behnabib, A. Bisin, and M. O. Jackson. North Holland, Amsterdam, Netherlands.

Franck, R. and L. R. Iannaccone (2014). "Religious Decline in the 20th Century West: Testing Alternative Explanations?" *Public Choice*, 159, 385–414.

Franke, G., H. Schlesinger, and R. C. Stapleton (2006). "Multiplicative Background Risk." *Management Science*, 52, 146–153.

Giavazzi, F., I. Petkov, and F. Schiantarelli (2014). "Culture: Persistence and Evolution." National Buerea of Economics Working Paper No. 20174.

Gill, A. and E. Lundsgaarde (2004). "State Welfare Spending and Religiosity: A Cross-National Analysis." *Rationality and Society*, 16, 399–436.

Gjerde, J. (1985). *From Peasants to Farmers. The Migration from Balestrand, Norway, to the Upper Middle West*. Cambridge University Press, UK.

Glaeser, E. L. and B. I. Sacerdote (2008). "Education and Religion." *Journal of Human Capital*, 2, 188–215.

Gollier, C. (2004). *The Economics of Risk and Time*. MIT Press, USA.

Gruber, J. H. (2005). "Religious Market Structure, Religious Participation, and Outcomes: Is Religion Good for You?" *The B. E. Journal of Economic Analysis & Policy*, 5, Article 5.

Gruber, J. H. and D. M. Hungerman (2007). "Faith-Based Charity and Crowd-out during the Great Depression." *Journal of Public Economics*, 91, 1043–1069.

Gutmann, M. P. (2007). *Great Plains Population and Environment Data: Social and Demographic Data, 1870–2000*. Inter-University Consortium for Political and Social Research, Ann Arbor, USA.

Haines, M. R. (2010). *Historical, Demographic, Economic, and Social Data: The United States, 1790–2002*. Inter-University Consortium for Political and Social Research, Ann Arbor, USA.

Harris, B. and P. Bridgen (eds.) (2007). *Charity and Mutual Aid in Europe and North America Since 1800*. Routledge, New York, USA.

Hungerman, D. M. (2005). "Are Church and State Substitutes? Evidence from the 1996 Welfare Reform." *Journal of Public Economics*, 89, 2245–2267.

Hungerman, D. M. (2009). "Crowd-Out and Diversity." *Journal of Public Economics*, 93, 729–740.

Iannaccone, L. R. (1992). "Sacrifice and Stigma: Reducing Free-Riding in Cults, Communes, and other Collectives." *Journal of Political Economy*, 100, 271–291.

Iannaccone, L. R. (1998). "Introduction to the Economics of Religion." *Journal of Economic Literature*, 36, 1465–1495.

Kimball, M. S. (1988). "Farmers' Cooperatives as Behavior toward Risk." *American Economic Review*, 78(1), 224–232.

Lindert, P. H. (2004). *Growing Public: Social Spending and Economic Growth Since the Eighteenth Century*. Cambridge University Press, UK.

McBride, C. R. (1962). *Protestant Churchmanship for Rural America*. Judson Press, USA.

McCleary, R. M. and R. J. Barro (2006a). "Religion and Economy." *Journal of Economic Perspectives*, 20(2), 49–72.

McCleary, R. M. and R. J. Barro (2006b). "Religion and Political Economy in an International Panel." *Journal for the Scientific Study of Religion*, 45, 149–175.

Miller, L., P. Wickramaratne, M. J. Gameroff, M. Sage, C. E. Tenke, and M. M. Weissman (2012). "Religiosity and Major Depression in Adults at High Risk: A Ten-Year Prospective Study." *American Journal of Psychiatry*, 169, 89–94.

Miller, L., R. Bansal, P. Wickramaratne, X. Hao, C. E. Tenke, M. M. Weissman, and B. S. Peterson (2014). "Neuroanatomical Correlates of Religiosity and Spirituality: A Study in Adults at High and Low Familial Risk for Depression." *JAMA Psychiatry*, 71, 128–135.

Nemeth, R. J. and D. A. Luidens (1994). "Congregational vs. Denominational Giving: An Analysis of Giving Patterns in the Presbyterian Church in the United States and the Reformed Church in America." *Review of Religious Research*, 36, 111–122.

Nunn, N. and L. Wantchekon (2011). "The Slave Trade and the Origins of Mistrust in Africa," *American Economic Review*, 101(7), 3221–3252.

Overacker, I. (1998). *The African American Church Community in Rochester, New York, 1900–1940*. University of Rochester, USA.

Pargament, K. I. (1997). *The Psychology of Religion and Coping*. Guilford Press, USA.

Parker, C. H. (1998). *The Reformation of Community: Social Welfare and Calvinist Charity in Holland, 1572–1620*. Cambridge University Press, UK.

PRISM Climate Group (2011). Oregon State University. http://prism.oregonstate.edu. Accessed on 21 September, 2011.

Pullan, B. (1998). "Support and Redeem: Charity and Poor Relief in Italian Cities from the Fourteenth to the Seventeenth Century." *Continuity and Change*, 3, 177–208.

Pullan, B. (2005). "Catholics, Protestants, and the Poor in Early Modern Europe." *The Journal of Interdisciplinary History*, 35, 441–456.

Putnam, R. D. (2000). *Bowling Alone: The Collapse and Revival of American Community*. Simon and Schuster, USA.

Rosenzweig, M. R. (1988a). "Risk, Private Information, and the Family." *American Economic Review*, 78(2), 245–250.

Rosenzweig, M. R. (1988b). "Risk, Implicit Contracts, and the Family in Rural Areas of Low Income Countries." *The Economic Journal*, 98, 1148–1170.

Rosenzweig, M. R. and O. Stark (1989). "Consumption Smoothing, Migration, and Marriage: Evidence from Rural India." *Journal of Political Economy*, 97, 905–926.

Ruggles, S., J. T. Alexander, K. Genadek, R. Goeken, M. B. Schroeder, and M. Sobek (2010). *Integrated Public Use Microdata Series [Machine-Readable Database]*. University of Minnesota.

Scheve, K. and D. Stasavage (2006). "Religion and Preferences for Social Insurance." *Quarterly Journal of Political Science*, 1, 255–286.

Schlenker, W. and M. J. Roberts (2009). "Nonlinear Temperature Effects Indicate Severe Damages to US Crop Yields under Climate Change." *Proc. Natl. Acad. Sci. USA*, 106, 15594–15598.

Smith, T. W., P. Marsden, M. Hout, and J. Kim (2013). *General Social Surveys, 1972–2012 [Machine-Readable Data File]*. The Roper Center for Public Opinion Research, University of Connecticut.

Szasz, F. M. (2004). *The Protestant Clergy in the Great Plains and Mountain West, 1865–1915*. University of Nebraska Press, USA.

Townsend, R. M. (1995). "Consumption Insurance: An Evaluation of Risk Bearing Systems in Low-Income Economies." *Journal of Economic Perspectives*, 9(3), 83–102.

Trattner, W. I. (1974). *From Poor Law to Welfare State: A History of Social Welfare in America*. Free Press, USA.

USDA (1923). *Agriculture Yearbook. United States Department of Agriculture*. Washington (DC). USA.

USDA (1925). *Agriculture Yearbook. United States Department of Agriculture*. Washington (DC), USA.

USDA (2007). "Usual Planting and Harvesting Dates for US Field Crops." *Agricultural Handbook Number 628*. United States Department of Agriculture, Washington (DC), USA.

Vissing-Jorgensen, A. and O. P. Attanasio (2003). "Stock-Market Participation, Intertemporal Substitution, and Risk Aversion." *American Economic Review*, 93(2), 383–391.

Wooldridge, J. (2012). *Introductory Econometrics: A Modern Approach*. South Western, USA.

Supplementary Data

Supplementary data are available at *JEEA* online.