Jewish Persecutions and Weather Shocks: 1100-1800*

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Abstract

What factors caused the persecution of minorities in medieval and early modern Europe? We build a model that predicts that minority communities were more likely to be expropriated in the wake of negative income shocks. Using panel data consisting of 1,366 city-level persecutions of Jews from 936 European cities between 1100 and 1800, we test whether persecutions were more likely in colder growing seasons. A one standard deviation decrease in average growing season temperature increased the probability of a persecution between one-half and one percentage points (relative to a baseline probability of two percent). This effect was strongest in regions with poor soil quality or located within weak states. We argue that long-run decline in violence against Jews between 1500 and 1800 is partly attributable to increases in fiscal and legal capacity across many European states.

Key words: Political Economy; State Capacity; Expulsions; Jewish History; Climate

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1 Introduction

Throughout most of preindustrial history, religious minorities were the victims of persecution. Violence against religious and ethnic minorities remains a major problem in many developing countries today (Horowitz, 2001; Chua, 2004). In contrast, religious persecution in the developed world is much less common than it used to be.[1] This paper investigates why some states persecuted minorities more than others in pre-industrial Europe and why this persecution gradually decreased between 1500 and 1800.

To answer these questions, we focus on the persecution of the Jews in medieval and early modern Europe. Violence against Jews was caused by many factors, including religiously motivated antisemitism. We choose, however, to build on the claim advanced by historians that Jews were convenient scape-goats for social and economic ills.[2] To test this hypothesis, we exploit variation in reconstructed city-level temperature to investigate whether expulsions and other forms of violence against Jews were associated with colder weather. We do this using panel data comprising 1,366 city-level persecutions of Jews from 936 European cities which are recorded as having Jewish populations between the years 1100 and 1800 in the 26-volume *Encyclopedia Judaica* (2007) and data on yearly growing season temperature (April to September) constructed by Guiot and Corona (2010).

We find that a one standard deviation decrease in average growing season temperature (about one-third of a degree celsius) raised the probability that a community would be persecuted from a baseline of about 2% to 2.5-3% in any given five-year period. During a period of sustained colder temperature, the probability that an average Jewish community would face expulsion or another form of violence over a fifty year period went from about 18% to between 22% and 26%.[3]

To clarify our empirical analysis, we develop a model that outlines the political equilibrium under which premodern rulers would tolerate the presence of a Jewish community. We show why this equilibrium was vulnerable to shocks to agricultural output and why this vulnerability may have been greater in locations with poor quality soil and in weak states that were more susceptible to popular unrest. Consistent with our theoretical framework, we find the empirical relationship between temperature shocks and persecutions was strongest in regions controlled by weak states and with poor soil quality.

A growing literature attributes the emergence of modern political and economic institutions to the transition from extractive to inclusive institutions between 1500 and 1800 (North et al., 2009; Acemoglu and Robinson, 2012). We provide new evidence concerning this transition. In extractive societies, toleration for minority

[1] Excepting, of course, the large-scale killings associated with the genocides of the mid-twentieth century. The decline in religious persecution is especially evident when measured on a per capita basis. For a detailed discussion of the decline of mass killings and persecutions over time see Pinker (2011).

[2] Important historical contributions include Baron (1965*a*,*b*, 1967*a*,*b*, 1975); Chazan (2006, 2010); Israel (1985); Jordan (1989, 1998); Mundill (1998, 2010); Poliakov (1955); Richardson (1960); Roth (1961); Stow (1981, 1992) and many others.

[3] Under the baseline risk, the probability of no persecution over fifty years is $0.98^{10} = 0.817$. The probability of no persecution occurring over a fifty year period assuming a 3% risk every five years is $0.97^{10} = 0.737$.

groups was always conditional; negative economic shocks led to the unraveling of this toleration and to persecutions and expulsions. Our analysis shows that the relationship between negative economic shocks and the persecution of Jews was weaker in stronger states. We support these results with extensive narrative evidence consistent with the hypothesis that more centralized states as well as better integrated markets played an important role in reducing the vulnerability of minority groups to economic shocks and in shaping Europe's gradual transition from extractive to inclusive institutions.

We follow a number of papers that use weather to identify the impact of economic shocks on violence and conflict in preindustrial or developing economies. Oster (2004) finds that cold weather shocks were associated with witchcraft trials in early-modern Europe. Miguel (2005) finds that extreme levels of precipitation were associated with a higher number of witchcraft deaths in modern Tanzania. In a historical context, both Zhang et al. (2006) and Tol and Wagner (2010) find a connection between colder weather and warfare in preindustrial China and Europe respectively. Bai and Kai-sing Kung (2011) examine the relationship between climate and conflicts between nomads and the state on the borders of premodern China. Jia (2013) examines the effect weather-induced harvest failure had on civil conflict and revolts in Imperial China. Chaney (2013) provides evidence that sharp deviations in the Nile floods strengthened the power of religious leaders who could threaten the political authorities with revolt. Fenske and Kala (2013) show that positive climate shocks (a decrease in temperature in this context) in sub-Saharan Africa increased slave exports and thus had a perverse effect on economic performance and welfare.[4]

By establishing temperature shocks as a potential trigger for persecutions of Jews in preindustrial Europe, our findings also complement two important recent contributions on the persistence of antisemitic attitudes: Voigtländer and Voth (2012) and Grosfled et al. (2013). Voigtländer and Voth (2012) use data from the massacres that followed the Black Death to establish the persistence of antisemitic cultural traits at the local level in Germany. They show these cultural factors were an important precondition for antisemitic violence in the 1920s and for support for the Nazi party. Grosfled et al. (2013) examine the persistence of anti-market sentiments in Imperial Russia's Pale of Settlement where Jews were confined during much of the eighteenth and nineteenth centuries. They argue that within the Pale, non-Jews developed a set of anti-Jewish and anti-market values which have persisted to this day. Our findings are complementary to these studies as we shed light on the timing and causes of antisemitic violence across Europe between 1100-1800.[5] We delineate the

[4]Hsiang and Burke (2013); Hsiang et al. (2013) survey a range of quantitative studies that find a causal link between climate change and social conflict. Madesam et al. (2013) find that weather has an effect on the ability of political groups to organize in the modern US. In addition there are several recent papers which investigate the effect of weather on economic outcomes. For example, Jones and Olken (2010) look at the effect of weather on exports, Maccini and Yang (2009) investigate the effect of weather shocks on children's health, and Dell et al. (2012) investigate the negative effects of warm temperatures on developing economies. Durante (2009) explores the relationship between climatic variability in the past and trust today across European countries. Anderson (2012) finds that lower temperatures were associated with more sentences being passed down by the Portuguese Inquisition.

[5]Antisemitism is a nineteenth century term. Nevertheless, following Langmuir (1990), it has also been used by medieval historians to describe the rise of virulent anti-Jewish hatred and violence after 1100, a development which was based upon a common set of tropes, which sought to blame Jews for personal misfortunes and tragedies (i.e., in the case of ritual murder accusations) or for general social ills (i.e., in the charges of host desecration, well poisoning, coin-clipping, or diabolism). See

circumstances under which negative supply shocks were more likely to trigger expropriations and expulsions in societies that were permeated with antisemitism and thus contribute to a growing literature on the causes of persecution.[6]

Finally, our findings are related to a growing literature on the economic history of the Jews in medieval and early modern Europe. Barzel (1992) and Koyama (2010*b*) study why the Jews were expelled from medieval England. Pascali (2012) examines the consequences of Jewish expulsions from Italy in the early modern period. He finds that cities that had either Jewish pawn banks or *Monti di Pietà* charitable Christian lending institutions are significantly more financially developed today while those parts of Italy that were ruled by Spain and expelled their Jewish communities in 1541 remain comparatively underdeveloped. Botticini and Eckstein (2012) provide a novel explanation for why Jews specialized as moneylenders during the middle ages. Our theoretical and empirical results complement their account by explaining why this specialization, despite making Jews especially valuable to medieval rulers, ultimately placed Jewish communities in a political equilibrium in which they were vulnerable to persecution and expulsion.

2 Weather Shocks and Jewish Persecutions

Jews in early medieval Europe specialized as merchants and moneylenders (Botticini and Eckstein, 2012, 153-200). Rulers encouraged Jewish settlement in order to promote economic development. The Bishop of Speyer in 1084 wrote: 'When I wished to make a city out of the village of Speyer, I Rudiger, surnamed Huozmann, bishop of Speyer, thought that the glory of our town would be augmented a thousandfold if I were to bring Jews' (quoted in Chazan, 2010, 101).

A political equilibrium emerged that enabled European rulers to benefit financially from the presence of Jewish communities but which left the Jews themselves vulnerable to persecution and the threat of expulsion. Over time, Jews specialized as moneylenders (Botticini and Eckstein, 2012, 201-247).[7] Jewish usury was frequently condemned by the Church, but it was protected by secular rulers both because credit was understood to be crucial to the medieval economy and because it provided rulers with an accessible tax base. The Diet of Mainz proclaimed that, 'as loans are necessary and Christians prohibited to lend on profit, the Jew must be allowed to fill the gap' (Stein, 1956, 144).[8]

Moore (1992, 42-43) and Stacey (2000, 163-166).

[6]For example, Glaeser (2005) studies the incentives politicians have to incite hatred against particular groups; Mitra and Ray (2013) provides a theory of ethnic conflict and applies it to Hindu-Muslim violence in India; Johnson and Koyama (2014) examine the relationship between the rise of the French state and the decline in trials for witchcraft; Vidal-Robert (2011) studies what factors were associated with more trials by the Spanish Inquisition; and Acemoglu et al. (2011) estimate the economic costs of the Holocaust in Russia.

[7]See Baron (1967*b*, 135). Emery (1959); Lipman (1967); Mundill (1991) and Botticini (1997) provide excellent empirical studies of how medieval Jewish moneylenders operated. For analysis of the tightening of the usury prohibition see Chazan (1973–1974) and Koyama (2010*a*).

[8]As Baron wrote: 'Many Jews and Christians alike realized that, next to the religious tradition, the main reason for the former's toleration in western lands was the rulers' self-interest in the revenue derived from them' (Baron, 1967*b*, 198).

As outsiders in a society that defined itself in opposition to unbelievers, Jews aroused suspicion from others.[9] But it was in the long-run interest of secular rulers to protect their Jewish communities. According to medieval political theory: Jews were serfs of the exchequer because, in return for protection against violence, they had submitted to the king and could therefore be taxed at his discretion (Baron, 1967*b*). Rulers exploited Jews as 'fiscal sponges' to use a contemporary metaphor: 'No sooner did they suck up the money [from the population through their usury], than the overlords proceeded to squeeze it out of them into their own pockets' (Baron, 1967*b*, 199).[10] The problem with this arrangement was that medieval rulers struggled to make credible commitments. They were often unable to protect Jewish communities from popular unrest or anti-semitic violence and frequently faced the temptation to expropriate Jewish communities for short-run gain.

The Pastoureaux or Shepherds' Crusade of 1320 illustrates how weather shocks disrupted the political equilibrium that protected Jews in medieval states. The Jews were allowed to resettle in France in 1315 on the condition that they act as moneylenders and fiscal agents for the crown. A succession of disastrous harvests occurred between 1315 and 1321. Campbell describes it as possibly 'the single worst subsistence crisis, in terms of relative mortality, in recorded European history' (Campbell, 2010, 7).[11] These shocks produced civil unrest across swathes of northern Europe. In France, the *Pastoureaux* first attacked royal castles in Normandy and the Paris region, then they moved south where they persecuted Jews throughout Languedoc in cities like Saintes, Verdun, Grenade, Castelsarrasin, Toulouse, Cahors, Lézat, Albi, Auch, Rabastens and Gaillac (Barber, 1981*a*, 12).

The 'brunt of peasant violence fell upon the Jews, for they . . . could be blamed for the economic hardships which the lower classes had recently been suffering' (Barber, 1981*b*, 163).[12] The king protected the Jews where possible, but massacres occurred wherever royal authority was weak. This example illustrates the connection

[9]See Moore (2008, 26-42). This hostility could manifest itself among elite groups as well as among peasants. In Renaissance Italy, Jewish moneylenders lent to the poor and were often championed by them, and were typically, instead, opposed by city elites (Botticini, 2000). It is important to stress that we do not attempt to provide an economic or rational choice explanation for the virulent antisemitism that emerged in medieval Europe and which had a variety of sources (see Trachtenberg, 1943; Voigtländer and Voth, 2012). Menache (1985, 1997) analyzes the importance of the blood libel myth in generating an atmosphere conducive to expulsion. What we do attempt to explain is why negative economic shocks led to the expulsion and expropriation of Jewish communities in some polities but not in others.

[10]In France, this implicit agreement first appears to have been stated in 1198 when the Jews were readmitted into the Royal Domain by Philip Augustus (Moore, 2008, 41). In England, where it was perhaps most fully developed, it followed the massacres of Jews in York and the establishment of the Exchequer of the Jewry in 1194 (Cramer, 1940; Stacey, 1985, 1995; Dobson, 2003; Brown and McCartney, 2005; Koyama, 2010*b*).

[11]It was followed by the so-called Great Bovine Pestilence, which wiped out 60% of livestock on the continent (Slavin, Forthcoming).

[12]Tension had been building for some time as a result of the poor harvests, and the peasants undertook religious demonstrations and parades aimed at ending the famine (Barber, 1981*b*, 162-163). Contemporaries also mention that they were incited by debtors of the Jews (Barber, 1981*b*, 146). Nirenberg argues that 'the shepherds and the townspeople who supported them' understood this relationship, and 'recognized that the heavy taxes placed on Jews were a form of indirect taxation on Christians' (Nirenberg, 1996, 48). When the *Pastoureaux* attacked Jews and looted their possessions in face of the royal attempts to protect them 'they were both attacking a much-resented aspect of administrative kingship and dramatizing the state's inability to protect its agents, the Jews' (Nirenberg, 1996, 50). Note that this is an instance of peasants attacking Jews; in other cases townspeople targeted the Jews. This means that it is difficult to generalize about which economic strata would have the strongest incentive to expropriate the Jewish community in the event of a negative shock to the agrarian economy.

between a subsistence crisis, political unrest and antisemitic violence in a state that was unable to protect its Jewish minority. There are many other examples of persecutions that follow this pattern of weak polities being unable to credibly commit to their agreements with Jewish communities in the face of economic shocks. In the next section we develop a model that clarifies the mechanisms that connected weather shocks to subsistence crises and political unrest and then to antisemitic violence.

3 A Model of Protection and Persecution

To explore the relationship between political stability, income shocks, and expulsions, we construct a simple model of the ruler's decision to expropriate or protect a minority community. Standard models of an autocratic state struggle to explain why rulers would ever expel a valuable fiscal resource like the Jews. To understand why expulsions occurred, therefore, we need a model in which the sovereign cannot credibly commit to protect a vulnerable minority.[13]

3.1 Set-up

There are two sectors: an agrarian sector A and a commercial sector M. The latter is dominated by the minority (Jewish) community. The ruler can impose a tax on each sector of T^A and T^M and choose to protect the minority community or to expropriate and expel them. We denote this decision by $\phi_{it} \in \{0, 1\}$. If the ruler chooses to protect the minority community ($\phi_{it} = 0$) he imposes on them a tax equal to $T_t^M = \bar{T}$, where $\bar{T}$ maximizes revenue conditional on the minority community continuing to engage in its valuable economic activities. Alternatively, the ruler can expropriate the minority ($\phi_{it} = 1$), in which case he obtains Φ_t in period t and zero for all future periods.

Agricultural output in region i in period t, Q_{it}, is determined by inelastically supplied labor inputs l, which we normalize to 1, an exogenous temperature shock ω_{it} drawn from the positive real line, the quality of the soil $x_i \in (0, 1)$ where higher values of x correspond to worse quality soil, and a constant Π_i that captures other time invariant features of the environment. We specify agricultural output as: $Q_{it} = \Pi_i - x_i/\omega_{it}$. This formulation captures the following empirical regularities: (1) colder temperatures were associated with lower yields in Europe in the medieval and early modern periods; and (2) better soil quality mitigates the negative effect of a weather shock.[14]

As in Acemoglu and Robinson (2006), negative shocks can cause political unrest. $\underline{Q}$ is the level of output required for subsistence. If output falls below this threshold there is potential for unrest. γ_{it} is the strength

[13]We build on the reasoning developed by Acemoglu (2003) in that the Jews cannot make a Coasian bargain with the ruler in order to avoid expulsion. We do not model the initial decision of a Jewish community to settle in a community. This is because most Jewish communities in western and central Europe were established prior to the onset of major expulsions and persecutions. Modeling such a decision would involve Jews deciding whether to settle in an area based on their expectation of future persecution. We discuss this possibility more in Appendix C.

[14]This specification can be generalized without modifying our results. The main assumption we make: that the effect of cold weather is exacerbated in areas with poor quality soil is supported by a large amount of literature in agronomy. We do not include storage technology in our formulation as medieval peasants did not store grain (McCloskey and Nash, 1984).

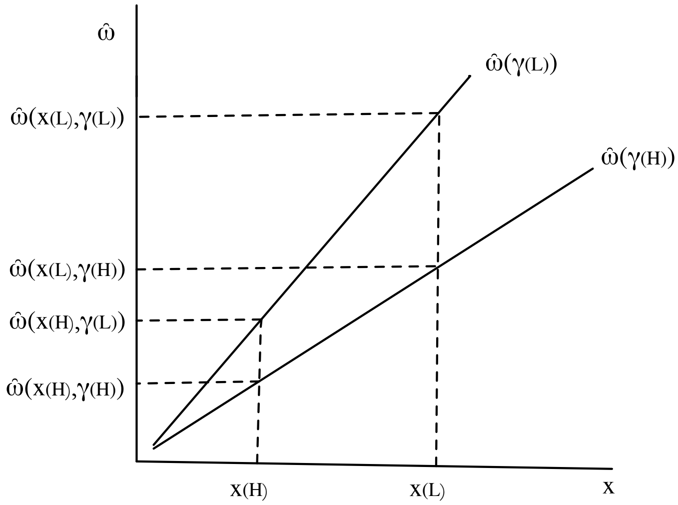


Figure 1: Regions with worse soil quality and low state capacity find it more difficult to satisfy the no-rebellion constraint compared with regions with higher quality soil and high state capacity.

of the ruler in region i in period t. Stronger rulers (higher values of γ) are better able to resist or suppress unrest. The rebellion constraint is therefore: $\gamma_{it} + Q_{it} - \underline{Q} - T^A_{it} \geq 0$. The payoff of a rebellion for the ruler is $-\Lambda$ where $\Lambda > 0$.[15]

A ruler can prevent a rebellion by transferring resources to the peasantry (i.e., allowing T^A to become negative). The maximum amount of resources he can transfer to the agricultural sector is equal to the amount of money he obtains from the minority community. Hence the no-rebellion constraint can be fully written out as:

$$\gamma_{it} + \Pi_i - \frac{x_i}{\omega_{it}} - \underline{Q} + (1 - \phi_t)\bar{T} + \phi\Phi \geq 0 \; . \tag{1}$$

Let the threshold temperature consistent with the rebellion constraint holding with equality be $\hat{\omega} = x/(\gamma_{it} + \Pi_i - \underline{Q} - (1 - \phi_t)\bar{T} + \phi\Phi)$. Figure 1 depicts how $\hat{\omega}$ varies with soil quality (x) and state capacity (γ). Societies with low quality soil ($x(L)$) and low state capacity ($\gamma(L)$) will be most vulnerable to periods of cold weather.

The probability that the weather is cold enough to cause a rebellion is given by: $p_t(\Pi_i, \gamma_{it}, x_i, \phi_{it}) = ($ Prob $\omega_{it} < \hat{\omega}_i | \Pi_i, \gamma_{ti}, x_i, \phi_i)$. This is larger if there is no minority community to expropriate (ϕ^1_{it}) and if state capacity (γ_{ti}) is low or agricultural constrains (x) are high. In what follows $p_{t+1}(\phi^0)$ reflects the future probability of the rebellion constraint being violated in the absence of the minority community and $p_{t+1}(\phi^1)$ reflects the future probability of the rebellion constraint being violated if the ruler protects the minority community.

3.2 The Ruler's Maximization Problem

The order of play is as follows: first x_{it} is realized; then based on the observed level of agricultural output Q_{it}, ruler i decides whether or not to expropriate the minority community. This the game can be solved by

[15] In keeping with the historical evidence, the minority community are expropriated during any rebellion.

studying the ruler's maximization problem:

$$\begin{aligned} \max_{\{\phi_t\}} U_t =& T_t^A + T_t^M - p_t(\phi_{t-1})\Lambda + \delta U_{t+1}(\phi_t) \\ \text{subject to} \quad & \gamma_{it} + \Pi_i - \frac{x_i}{\omega_{it}} - \underline{Q} + (1-\phi_t)\bar{T} + \phi\Phi \geq 0 \ , \end{aligned} \tag{2}$$

where $T_t^M = (1-\phi_t)\bar{T} + \phi_t\Phi$ and $U_{t+1}(\phi_t)$ is a continuation payoff that can take one of two values: $U_{t+1}(\phi^0)$ if the ruler chooses to protect the minority community in the previous period and $U_{t+1}(\phi^1)$ if the minority community has been expelled. We derive this condition in full in Appendix E. There are three cases to consider and we proceed by partitioning the parameter space as follows.

Case 1: The rebellion constraint does not bind: $\gamma_{it} + \Pi_i - x_i/\omega_{it} - \underline{Q} - (1-\phi_t)\bar{T} > 0$. Under a grim-trigger strategy in which the minority community never return if they are expelled, we show in Appendix E that a ruler protects the minority if the following condition holds:

$$\delta\big(U_{t+1}(\phi^0) - U_{t+1}(\phi^1)\big) + \delta\big(p_{t+1}(\phi_t^1) - p_{t+1}(\phi_t^0)\big)\Lambda\big) \geq \Phi - \bar{T} \ , \tag{3}$$

Equation 3 says that a ruler will not expropriate the minority community if he is patient enough (δ is high) and if the difference between what he obtains through expropriation (Φ) and what he can get in taxation ($\bar{T}$) is not too great. Furthermore, the bigger the difference between $p(\phi^0)$ and $p(\phi^1)$, the increased probability of revolt when there are no resources from the Jewish community to redistribute, the greater the incentive the ruler has to protect the minority community.

Case 2: The rebellion constraint binds: $\gamma_{it} + \Pi_i - x_i/\omega_{it} - \underline{Q} - (1-\phi_t)\bar{T} < 0$ but $\gamma_t + \Pi - x_i/\omega_{it} - \underline{Q} + \phi\Phi \geq 0$. The ruler can only prevent a rebellion by expropriating the minority community and using their resources to appease or suppress the rebellion. Since as a result of the rebellion the minority community will be destroyed regardless, it is always in the interest of the ruler to expropriate.

Case 3: The rebellion constraint is violated even if the ruler expropriates the minority community: $\gamma_{it} + \Pi_i - x_i/\omega_{it} - \underline{Q} + \phi\Phi < 0$. The temperate shock is so large that the ruler cannot prevent a rebellion. During the unrest the minority community is expropriated. This analysis generates the following predictions:

Prediction 1: Cold Weather and Expulsions Periods of cold weather (low values of ω_{it}) make it more likely that the rebellion constraint will bind or be violated and will thus be associated with the expropriation and expulsion of minority communities. Negative weather shocks disrupted the political equilibrium that made toleration possible forcing rulers to expel minority groups even it if was in his long-term interest to tolerate and protect them.

Prediction 2: Soil Quality Low values of x_i exacerbate the effect of negative weather shocks on agricultural output reflecting the fact that regions with lower quality soil were more vulnerable to negative weather shocks. This result holds even though in a Malthusian world, we expect population density to adjust so that per capita incomes are invariant to factors such as soil quality. Conversely highly quality soil corresponding to values of $x_i \to 0$ mean that agricultural output is less responsive to weather shocks and cold weather is less likely to generate unrest.[16]

Prediction 3: State Capacity Greater state capacity (higher γ_{it}) enables a ruler to survive realizations of cold weather. Increases in state capacity makes it less likely that the rebellion constraint will be violated due to cold weather. In stronger states, expropriations and expulsions are more likely to be driven by a breakdown in the long-term relationship between the minority community and the ruler represented by Eq. 3 than by shocks to agricultural production.[17]

4 Empirical Analysis: The Effect of Weather Shocks on Jewish Persecutions

Our main empirical specification is as follows:

$$y_{it} = \beta \text{ Weather}_{it} + \eta_i + \mu_t + \mathbf{X}'_{\mathbf{it}}\boldsymbol{\Omega} + \varepsilon_{it} \ , (4)$$

where y_{it} is a binary variable measuring whether an expulsion or other violent act against Jews occurred in city i during period t. When we include all violent acts against Jews in the dependent variable we call this measure *Persecutions*. When we only include expulsions, this variable is labeled *Expulsions*. $Weather_{it}$ is a measure of temperature for city i in time t expressed as the degrees celsius deviation from the 1961-1990 average. We report both estimates in which we include a full vector of city fixed effects, η_i, as well as the difference-in-differences estimates which include time dummies, μ_t. In our baseline regressions we use five-year averaged data so that we have 140 observations for each city.[18] We do this primarily because of potential measurement error in both the persecutions data and the weather variable (Guiot and Corona, 2010).[19] In Section 5 we show our results are robust to using yearly data with city fixed effects and year dummies. All regressions include controls for the ten years surrounding the Black Death in Europe (1346-1355) and a

[16]There are several reasons why we expect regions with poor quality soil to be more vulnerable to climatic shocks. First, higher quality soil is more robust to extreme variations in temperature (Porter and Semenov, 2005). Consistent with this, Malik and Temple (2009) find that regions with poor soil quality appear to experience greater volatility in agricultural output. Second, it took decades or even centuries for populations to adjust to economics shocks, even in the Malthusian environment of medieval and early modern Europe (Lee and Anderson, 2002; Crafts and Mills, 2009). 'There were slow but substantial oscillations in both fertility and the real wage, reminiscent of a graph of room temperature in a house in which there is a very long delay between a change in the reading on a room thermostat and a reaction in the central heating boiler' (Wrigley and Schofield, 1981, 451). This meant that in practice incomes were not equalized across regions with different quality soils.

[17]In terms of the model, the *Pastoureaux* example corresponds to the case where γ was low: the King was unable to keep order and as a result the minority group where expropriated by the rebelling peasantry. We provide several other detailed examples in Appendix D.

[18]That is, seven centuries of data times twenty five-year periods in each century.

[19]For instance, several medieval edicts of expulsion allowed the Jews a period of time of up to six months to leave the city. Thus for several cities different sources record different dates of expulsion for a single event e.g. the city of Cologne decided not to renew the permit it granted Jews to reside in the cities in 1423 but only enforced the expulsions of the Jewish community itself in 1424.

measure of urban density around city i at time t.[20]

Data

In order to measure violence against Jews, we use city–level data on the presence of a Jewish community in Europe between 1100 to 1800 taken from the twenty-six volume *Encyclopedia Judaica* (2007). There are 1,069 cities in our complete data set. This number falls to 936 after we introduce our urban density control variable.[21] Figure 2 illustrates the geographic coverage of our Jewish city data and the distribution of persecutions for the entire period. The *Encyclopedia* typically mentions when Jews entered a city, when they were expelled, when there was some other violent act perpetrated against them, and when they were allowed re-entry (if ever). We are interested in all of these pieces of information since in order to model the probability of violence against Jews, we need to know when that city had a Jewish population.[22]

Using these data, we construct a variable called 'Jewish Presence' which is equal to one during all the years there is a known Jewish community in the city and zero otherwise. There is a Jewish community present in the average city about 40% of the time. Our dependent variable *Persecution* is binary and measures whether there is either an expulsion or other major violent act (i.e. a pogrom) against Jews in a city in a given five-year period. There are 1,366 such events in our base data set: 821 expulsions and 545 pogroms. Our other dependent variable is *Expulsion* and measures whether there is an expulsion or not in the city during the five-year period.

We restrict our analysis to use only the sample of cities that currently have a Jewish population. Cities without a Jewish population are treated as missing variables. This approach is consistent with a conventional strategy used in discrete-time survival analysis as discussed by Box-Steffensmeier and Jones (2004) and Yamaguchi (1991). Furthermore, our results will also be easier to interpret than with the alternative Cox hazard models.

In order to measure weather shocks (ω_{it}) we employ data on reconstructed temperature for medieval and early modern Europe provided by Guiot and Corona (2010).[23] Guiot and Corona (2010) collect information from numerous proxy sources including ninety-five tree ring series, sixteen indexed climatic series based on historical documents, ice-core isotopic series, and pollen-based series to construct a thirty-two point grid of reconstructed temperature during the growing season (April to September) for all of Europe between 900 and the present-day. Their historical temperature reconstructions are based on a model mapping proxies into growing season temperatures. This model is calibrated using actual temperature data from 1850–2007. We

[20]See Appendix D for a discussion of the Black Death and violence against Jews. See Appendix C for further description of the population density measure. We use a linear probability model. When we re-do our analysis using a logit estimator the results are unchanged. We prefer the linear probability model because of the large number of city and time dummies included in most regressions as well as for its ease of interpretation.

[21]We lose some cities in the East. Excluding the urban density control and including these cities doesn't change our estimation results.

[22]A more detailed description of all our data is contained in Appendix C.

[23]Numerous studies argue that there is a strong relationship between cold temperature and reduced agricultural output in western Europe (see Galloway, 1986, for a survey of this literature). Wheat and other grains can survive cold winter temperatures, but they are strongly affected by cold and wet weather during the growing season.

use geospatial software to interpolate the temperature for the area between the grid points so that we have a smooth map for each year. Finally, we extract the yearly temperatures for each of our cities. We follow Guiot and Corona (2010) in expressing the temperature data in terms of differences relative to the 1961–1990 average.

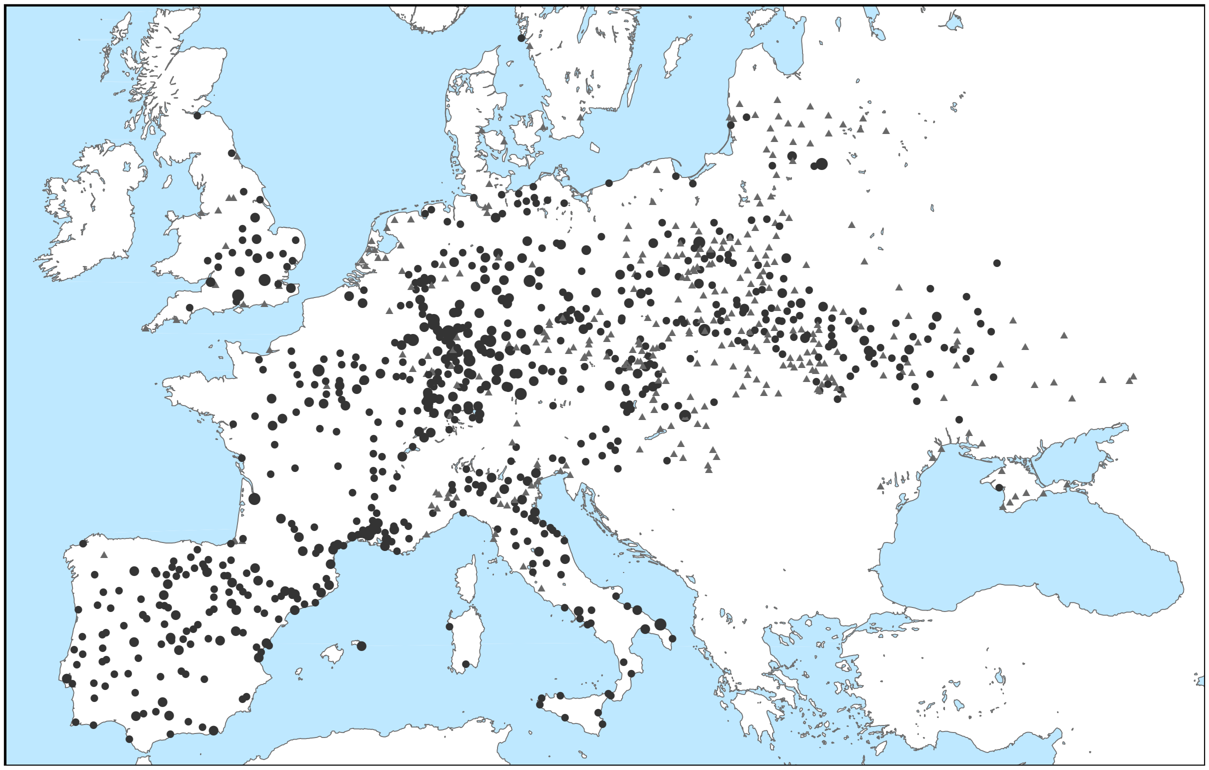


Figure 2: Jewish Cities and Persecutions, 1100-1800. Symbols represent a city that had a Jewish population at some time between 1100 and 1800. Circles represent a Jewish city that has at least one persecution. Larger circles represent more persecutions. Triangles are Jewish cities in our data that never persecute. Source: *Encyclopedia Judaica* (2007).

To address potential bias stemming from unobserved economic development of a city or its access to markets, we construct a measure of urban density. This approach is consistent with other work on early modern Europe which relies on urbanization data in lieu of estimates of per capita GDP or market development.[24] Our urban density variable is called *PopDensity* and is based on the Bosker et al. (2013) dataset of cities. As our Jewish cities do not correspond perfectly to the Bosker et al. cities, we use geospatial software to create a population heat map for every century based on all Bosker et al. cities with populations greater than 5,000. Each point on the map is assigned a population number based on the inverse distance-weighted value of all Bosker et al. cities within 1 degree of the point (about 100 kilometers depending on the latitude).[25]

[24] See De Long and Shleifer (1993); Acemoglu et al. (2005) and Nunn and Qian (2011) amongst many others

[25] We provide more details about the construction of this and other variables in Appendix C and descriptive statistics are in Appendix A.

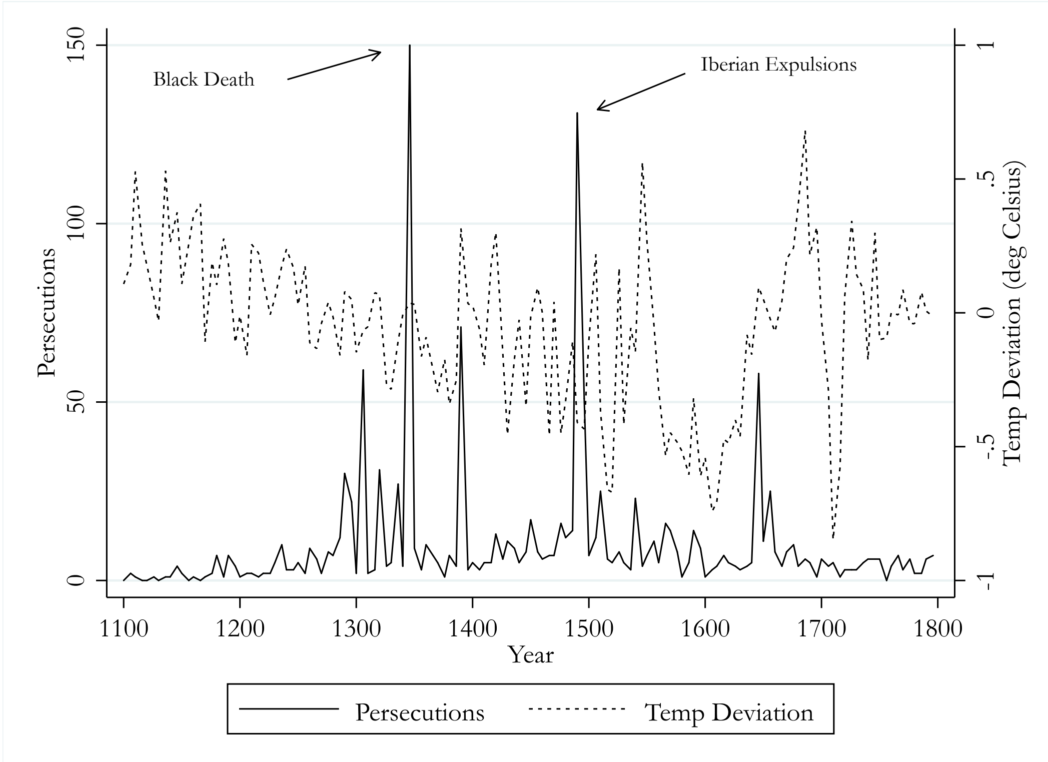


Figure 3: Jewish persecutions and temperature deviations. Source: *Encyclopedia Judaica* (2007) and Guiot and Corona (2010).

One other potential source of bias in our estimates is the disproportionate effect of the Black Death on Jewish persecutions in the years immediately following its arrival in Europe in 1348. Figure 3 shows how average temperature and the total number of persecutions varied over time. The Black Death is an obvious outlier.[26] Jewish communities faced unprecedented levels of persecution during the first wave of the plague – being singled out as scapegoats and easy targets of expropriation and popular violence as the existing social order weakened. Figure 3 also suggests the Black Death was correlated with warming temperatures. Since we do not want to identify the effect of temperature on antisemitic violence using a disproportionate number of observations obviously due to epidemiological causes, we choose to control for the Black Death years by including separate dummy and slope variables for the years 1346-1355.

4.1 Baseline Results

In Panel A of Table 1 we report the results of estimating Equation 4 using *Persecution* as the dependent variable in columns (1)-(3) and *Expulsion* as the dependent variable in columns (4)-(6). Robust standard errors clustered on the nearest weather grid point from Guiot and Corona (2010) are reported in parentheses.[27]

[26] Another potentially influential set of data points are associated with the Iberian national expulsions at the end of the fifteenth century. We will exclude these from our regressions in Panel B of Table 1 to demonstrate the robustness of our baseline results.

[27] These grid points are reproduced as the red dots in Appendix C, Figure 13. Cities closer to a given grid point receive more correlated weather shocks. In contrast, weather shocks are a random walk over time, thus the weather-grid seems the appropriate level of clustering.

In specification (1) we report the β under OLS regression with controls included but no fixed effects. The negative sign implies that colder weather raises the probability of a persecution of Jewish communities. The size of the coefficient, -0.016, may be interpreted as a one degree decrease in five-year average temperature leads to a 1.6 percentage point increase in the probability of a major act of violence against Jews over the same five years. When we include city fixed effects in specification (2), this probability increases to 2.1 percentage points. When we add the five-year time dummies in specification (3), the difference-in-differences estimate shrinks relative to the fixed effects estimate and is 1.3 percentage points.

Although a one degree decrease in temperature is convenient to consider it is also quite large. Under the fixed effects specification in column (2), a one standard deviation decrease, or 1/3 of a degree, in temperature increases five-year expulsion probability by 0.64 percentage points relative to a baseline of about 2%. Another way of interpreting the coefficient would be to recognize that between the end of the fourteenth century and the middle of the seventeenth century Europe experienced colder and more volatile weather.[28] Between 1400 and 1600, average temperatures in Europe were between 0.10 and 0.20 degrees cooler than during the surrounding centuries. If a Jewish community was subjected to many years, say fifty, of temperatures one standard deviation below average, then how much did persecution probability increase? According to specification (2), the answer is the probability goes from about 18% to 24%. If the cold temperatures were sustained for one hundred years, then the probability goes from 33% to 41%.

The estimated coefficient on temperature deviation we obtain in our difference-in-differences specification in column (3) is smaller than the coefficient we obtain in our fixed effects regressions. This is consistent with both temperature shocks and persecutions being correlated across cities within a given five-year period.[29] When it is cold in Northern France it also tends to be cold in Northern Germany and this could cause more persecutions in both places. The time dummy eliminates this common cross-sectional variation. As such, we interpret the coefficient in the diff-in-diff regressions as a lower bound on the of the size of the effect we are estimating. In the case of specification (3) the coefficient implies an increase in persecution probability from 18% to 22% over a fifty year period.

[28]This is known as the Little Ice age. Some scholars have questioned the value of terms such as the 'medieval warm period' or the 'Little Ice Age' because within period variation is often much larger than between period variation (Kelly and Ó Gráda, 2010, e.g.). However, it remains widely accepted that 'bad weather—heavy rainfall, cool and wet summers, severe floods—became very much more frequent during the last two centuries of the Middle Ages, and suggest that, at last in north-western Europe, climatic disasters were in fact more numerous and severe than they had been earlier. This is supported by other evidence: the extension of the glaciers in the Alps; the lowering of the upward limits of cultivation and of tree growth in hilly areas; the inundation of the coastal lowlands in the Netherlands, and the increasing soil moisture in the valley of central Europe, where, in some instances, cultivation had to be abandoned' (Pounds, 1974, 136).

[29]The between standard deviation for the weather variable is about 1/3 of the within standard deviation. Similarly, the between variation in *Persecution* is 1/5 of the within variation (see Table 5 in Appendix A).

	Panel A: Baseline Effect of Weather on Persecutions and Expulsions					
	Persecution			Expulsion		
	(1)	(2)	(3)	(4)	(5)	(6)
Weather	-0.0156**	-0.0212***	-0.0128*	-0.0150***	-0.0194***	-0.0034
	(0.00569)	(0.00658)	(0.00740)	(0.0015)	(0.0015)	(0.0027)
Controls	Y	Y	Y	Y	Y	Y
City dummies	N	Y	Y	N	Y	Y
Time dummies	N	N	Y	N	N	Y
Observations	55908	55908	55908	55908	55908	55908
F Stat	3.505	4.024	5.129	3.655	4.851	3.774

	Panel B: Excluding the Iberian National Expulsions					
	Persecution			Expulsion		
	(1)	(2)	(3)	(4)	(5)	(6)
Weather	-0.00817**	-0.0127***	-0.0140**	-0.0075***	-0.0108***	-0.0047*
	(0.00379)	(0.00445)	(0.00708)	(0.0014)	(0.0014)	(0.0026)
No Iberian National	Y	Y	Y	Y	Y	Y
Controls	Y	Y	Y	Y	Y	Y
City dummies	N	Y	Y	N	Y	Y
Time dummies	N	N	Y	N	N	Y
Observations	55463	55463	55463	55463	55463	55463
F Stat	2.572	2.973	5.026	2.559	3.063	3.471

Table 1: Baseline Results. *Notes:* Observations are at the city x five-year level between 1100 and 1799. In both panels the dependent variable is either *Persecution* (0 or 1 if either an expulsion or other violent acts against Jews occurs) or *Expulsion*. Panel A uses the full sample. In Panel B the Iberian national expulsions in 1492 (Spain) and 1497 (Portugal) are excluded. All regressions include as controls a dummy and slope variable for the ten years surrounding the Black Death and a measure of population density (see the Data Appendix). Coefficients are reported with standard errors clustered at the weather-grid level. ***, **, and * indicate significance at the 1%, 5%, and 10% levels respectively.

When we restrict our attention to explaining just expulsions in columns (4)-(6) of Panel A of Table 1 we get similar results under OLS and FE estimation. The difference-in-differences estimate, however, is insignificant and 1/4 the size of the comparable estimate using persecutions as the dependent variable. This is probably due to the fact that many, though by no means all, of the expulsions in our data take place at the national level.[30] As such, the time dummies absorb a lot of the variation in this estimate.

One potential objection to the results we present in Panel A of Table 1 is that the national expulsions from Spain (1492) and Portugal (1497) may be unduly influencing our estimates. There is no doubt that these expulsions represent a significant portion of our data (116 expulsions in total) and some scholars argue that the politics surrounding these events are inconsistent with our supply-shock hypothesis (Gerber, 1992). Nonetheless, in Panel B of Table 1 we replicate the results in Panel A after excluding the Iberian national

[30]259 out of the 823 expulsions were undertaken at the national level.

expulsions. In general, the coefficients shrink slightly, however, under the difference-in-differences specifications (3 and 6) the coefficients increase in size and are more precisely estimated. This robustness is consistent with the time dummies taking out a lot of the variation from national expulsions. Overall, our main results are robust to the exclusion of the Iberian expulsions.

The results in Table 1 provide strong empirical support for the first prediction of our model: periods of cold weather disrupted the political equilibria of pre-industrial European societies and increased the likelihood that minority communities would be persecuted. However, on their own, these regressions do not shed light on the mechanisms connecting negative weather shocks to Jewish persecutions.

4.2 Mechanisms

Our theoretical framework suggests that the effect of weather shocks on Jewish persecutions should be greatest in areas with more marginal quality soil (Prediction 2) and in societies with weak political institutions (Prediction 3). In this section we test these predictions by estimating a series of specifications based on:

$$y_{it} = \alpha \text{ Weather}_{it} + \beta \text{ Mechanism}_{it} + \zeta \text{ Mechanism}_{it} \cdot \text{Weather}_{it} + \eta_i + \mu_t + X_{it}^{\prime}\Omega + \varepsilon_{it} \ , \tag{5}$$

where y_{it} is our measure of persecution or expulsion in city i in period t. Mechanism$_{it}$ is one of our measures of soil suitability or state capacity for city i in period t. We always code the mechanism variable to be either a 0 or 1 such that 1 corresponds to our theoretically predicted higher probability of a persecution (e.g. poor soil or low state capacity). Mechanism$_{it}\cdot$Weather$_{it}$ is an interaction variable of the mechanism with the temperature shock. η_i and μ_t are city and time dummies respectively, X_{it} is a vector of control variables, and ε_{it} is an i.i.d. error term. We are interested in three quantities: the effect of weather on persecution probability in cities where the mechanism is not present, α; the indirect effect of the mechanism on persecution probability, ζ; and the total effect of weather on persecution probability in cities where the mechanism binds, which is given as, $\frac{\partial y}{\partial weather} = \alpha + \zeta \cdot$ Mechanism.

The first mechanism we investigate in Table 2 is whether cities surrounded by low quality soil were more likely to persecute their Jewish communities. In columns (1) and (2) we test this hypothesis using our preferred measure of agricultural productivity – wheat suitability taken from the FAO (Fischer et al., 2002). This database is constructed by combining characteristics of wheat (optimal growing temperature, soil type, etc.) with highly disaggregated climatic and geographic data covering variables such as precipitation, cloud cover, ground-frost frequency, soil types and slope characteristics. The data have a spatial resolution of 0.5 degree x 0.5 degree (or about 60 x 60 kilometers at 45 degrees latitude, typical for France).[31] We extract the wheat suitability for each of our cities using geospatial software and then follow a similar strategy as Nunn and Qian (2011) in creating a dummy variable equal to one if a city has an agricultural sector that is either moderately

[31]We assume 'intermediate' inputs. Appendix C describes these data in more detail. We also report results using the data on land available for cultivation of any crop from Ramankutty et al. (2002) as robustness check. These data and results are described in Appendix B.

or significantly constrained in its wheat cultivation. This is the main variable *LowSuitability* that we use in our regressions.

Regressions (1) and (2) show that cities with soil unsuited for agriculture were more likely to persecute Jews. In the fixed effects regression in column (1) the coefficient on ζ is -0.015 and statistically significant.[32] This accounts for more than half of the overall effect of weather on persecutions reported at the bottom of the column as -0.026. The results are similar under the difference-in-differences specification in column (2), though the coefficients on both the overall effect of weather and its indirect effect through soil suitability are smaller.

We next test whether persecutions were more likely in cities associated with relatively weak polities. To do this we employ the disaggregated data from the State Antiquity Index of Bockstette et al. (2002). These data include a measure for modern-day countries of whether that area was a stable state for fifty year intervals from 1 B.C. to the present-day. Specifically, every modern day country, in each fifty year period, is assigned three numbers. The first is a one if there was a government above tribal level and a zero otherwise. The second number is a one if the government is locally based, 0.50 if it is foreign based, and 0.75 if in between. The third number measures how much of the territory of the modern government was ruled by the polity during the fifty year period.[33] These scores are then multiplied by each other and then by 50. This results in a panel of scores for present-day countries measuring in every fifty year period whether it was an autonomous nation (a score of 50) if it had a tribal level of government (score of 0) or something in between. Bockstette et al. (2002) then aggregate these data to get a single score for state antiquity of modern countries. We are interested in the disaggregated historical data, however. Thus, after interpolating between fifty-year periods, we extract their values for each of our cities using geospatial software. We then create a dummy variable for each city equal to one if that region has a score less than the average for the rest of the sample and zero otherwise. We call this dummy *LowAntiquity*.[34]

The regression results in columns (3) and (4) of Table 2 support our theoretical prediction that cities in regions with weaker states will be more likely to persecute Jewish populations. The coefficient on the indirect effect of *LowAntiquity* (which is a proxy for γ) are negative in both the FE and the diff-in-diff specifications. The diff-in-diff estimate reported in column (4) is significant at the 10% level. Furthermore, when compared to the total effects reported at the bottom of the table, the estimates suggest that being in a low state capacity region accounts for something on the order of half of the increased probability of persecution due to negative weather shocks. The estimated effect size of -0.031 in the fixed effects specification is one of the largest coefficients we find. It suggests an increase by 8 percentage points (from 18% to 26%) in the probability of a persecution over a fifty year period of sustained temperatures one standard deviation below the norm. The difference-in-differences estimate in column (6) suggests an increase of 6 percentage points. The coefficients on the direct effect of *LowAntiquity* are positive which suggests that, regardless of weather, Jewish communities

[32] The direct effect of *LowSuitability* is not reported since it is a time-invariant variable and thus absorbed by the fixed effects.

[33] The values for this last measure are 1 point if over 50%, 0.75 points if between 25% and 50%, 0.5 points if between 10% and 25%, 0.3 points if less than 10%.

[34] Descriptive statistics are in Appendix A.

in low state capacity regions were more likely to be persecuted.

As an alternative measure of state capacity, we construct a dummy variable called *NoState* for whether or not the territory of a modern country was part of a centralized state in the medieval or early modern period. The dates we choose for the formation of centralized states are based on a detailed reading of the historical literature. For England we choose 1688 as the Glorious Revolution is associated with the establishment of Parliamentary supremacy, the formation of the Bank of England and a national debt.[35] For France we use 1661 which marks the onset of the personal rule of Louis XIV and the reforms of Colbert (see Collins, 1988).[36] For Spain we employ 1714 which marks the unification of the crowns of Aragon and Castile. For Portugal we use 1750 to mark the prime ministership of Pombal. For Scotland we choose the Act of Union of 1707. Countries which were only unified in the post 1800 period receive a zero. These include Italy (unified in 1866) and Germany (unified in 1870).

In columns (5) and (6) of Table 2 we report our estimates using NoState. The variable is coded so that 1 represents no centralized state and 0 is after the date we choose for centralization. The regression results support our hypothesis that strong centralized states were less likely to persecute Jewish communities because of supply shocks. Both the fixed effects and the difference-in-differences specifications suggest a large and significant effect of weather on persecution probability in weak states.

One potential concern with our estimates might be that what *LowAntiquity* or *NoState* are really proxies for is rule of law. Our hypothesis is that it was strong and stable states, not necessarily states with rules protecting capital and other forms of property, that were more likely to be able to commit to rent-seeking arrangements with Jewish communities. To allay these concerns, in columns (7)-(10) of Table 2 we test whether the Acemoglu et al. (2005) measures of constraint on executive and protection of capital predict persecutions. We re-code their constraints variables so as to be comparable to our *LowAntiquity* variable by turning them into dummy variables where countries with constraints below the sample average get a one and high constraint countries are zeroes. We then interpolate these values between centuries and extract their values for each city (descriptive statistics are in Appendix A). We call the variable measuring (lack of) constraints on the executive *LowConstraint*. The variable measuring (lack of) protection of capital is *LowCapital*.

The regression results showing the effect of *LowConstraint* on persecution probability are in columns (7) and (8). The fixed effects specification indicates that cities located in regions with less constraint were *less* likely to persecute Jews. Furthermore, the interaction of *LowConstraint* with *Weather* has the wrong sign. Under the difference-in-differences specification, both the coefficient on the direct effect of *LowConstraint* and its interaction *Weather* are consistent with zero. When we look at our measure of low constraint on capital predation, *LowCapital* in columns (9) and (10), the results are very similar. The sign on the direct effect of *LowCapital* is negative indicating that less constraint in an area is associated with less persecution. The sign

[35]We also experimented with earlier dates such as 1535 in order to capture to revolution in government that Geoffrey Elton associated with the reforms of Thomas Cromwell and 1485 which marks the accession of the Tudor dynasty (Elton, 1953).

[36]We also experimented with an earlier date of 1539 which was when the Ordinance of Villers-Cotterêts was issued.

on the interaction is positive. Also, as with *LowConstraint*, under the diff-in-diff specification in column (10) the coefficient on *LowCapital* is consistent with zero. This is unsurprising as in many European states it was parliaments or merchants who demanded that Jews be expelled (see Stacey, 1997; Koyama, 2010*b*). Overall, these regressions support our theoretical prediction that it was state capacity that determined whether a Jewish community would be persecuted during times of economic crisis.

The empirical findings we report in Table 2 support our theoretical predictions and shed light on why Jewish communities were persecuted during the early-modern period. They also suggest why these persecutions ultimately became less likely over time – the growth of strong, centralized, states was associated with less persecution of Jews (at least through the weather channel). In the next section we investigate the robustness of these results.

5 Robustness

In the previous section, our empirical results were all based on five-year averaged data. We used these in order smooth potential inaccuracies in persecution data and in our weather proxies. In this section, we show our results are robust to using yearly data.

Table 3 columns (1) and (2) show the results from estimating equation 4 using yearly data. In column (1) we report the specification with city fixed effects. Our coefficient of interest is negative, which implies colder growing seasons are associated with a higher probability of persecution. As expected, the estimated effect, -0.0055, is about 1/5 the size of the fixed effects estimate using the five year data. A one degree decrease in average growing season temperature is associated with a half-percent increase in persecution probability. The difference-in-differences specification in column (2) is the same size as the FE coefficient and retains significance at the 5% level.

Columns (3)-(8) report the results from estimating equation 5 testing the effect of our hypothesized mechanisms using the yearly data. In (3) and (4) we report the effect of soil suitability on persecution probability. In the diff-in-diff estimate, the treatment effect for poor soil suitability cities is about -0.006, whereas for cities with better agricultural suitability there is no effect of weather on persecution probability.

	Dependent Variable: Persecution									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Weather	-0.0104	-0.00588	-0.0137*	-0.00642	0.0305**	0.0235	-0.0235**	-0.0146*	-0.0347***	-0.0171
	(0.00680)	(0.00840)	(0.00669)	(0.00757)	(0.0144)	(0.0153)	(0.00897)	(0.00875)	(0.00824)	(0.0109)
LowSuitability x Weather	-0.0151**	-0.00900*								
	(0.00627)	(0.00491)								
LowAntiquity			0.00649	0.0220***						
			(0.00484)	(0.00512)						
LowAntiquity x Weather			-0.0176	-0.0134*						
			(0.0105)	(0.00788)						
NoState					-0.0182***					
					(0.00586)					
NoState x Weather					-0.0520***	-0.0363***				
					(0.0145)	(0.0135)				
LowConstraint							-0.0150**	0.00290		
							(0.00636)	(0.00711)		
LowConstraint x Weather							0.0131	0.00611		
							(0.0109)	(0.0102)		
LowCapital									-0.0159	0.00145
									(0.0101)	(0.00703)
LowCapital x Weather									0.0198**	0.00576
									(0.00745)	(0.00935)
Weather + Interaction	-0.0255***	-0.01488**	-0.0313***	-0.0198**	-0.0215***	-0.0128*	-0.0104	-0.0085	-0.0149**	-0.0114
	(0.0068)	(0.0075)	(0.0095)	(0.0088)	(0.0065)	(0.0074)	(0.0066)	(0.0096)	(0.0056)	(0.0074)
Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
City Dummies	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Time Dummies	N	Y	N	Y	N	Y	N	Y	N	Y
Observations	55908	55908	55908	55908	55908	55908	55908	55908	55908	55908
F-Stat	5.249	5.391	3.278	5.563	7.124	6.475	2.927	3.192	4.578	3.220

Table 2: Mechanisms. *Notes:* Observations are at the city x five-year level between 1100 and 1799. The dependent variable is *Persecution* (0 or 1 if either an expulsion or other violent acts against Jews occurs). All Mechanism variables are 0 or 1. See text and the Data Appendix for descriptions of the Mechanism variables. All regressions include as controls a dummy and slope variable for the ten years surrounding the Black Death and a measure of population density (see the Data Appendix). *Weather + Interaction* is the total effect of temperature on persecution probability measured as the sum of the coefficient on *Weather* plus that on the relevant Mechanism interaction term. Coefficients are reported with standard errors clustered at the weather-grid level. ***, **, and * indicate significance at the 1%, 5%, and 10% levels respectively.

	Dependent Variable: Persecution							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Weather	-0.00550**	-0.00547**	-0.00217	-0.00338	-0.00221	-0.00316	0.00704*	0.00326
	(0.00205)	(0.00262)	(0.00242)	(0.00322)	(0.00175)	(0.00254)	(0.00302)	(0.00400
LowSuitability x Weather			-0.00463*	-0.00272				
			(0.00244)	(0.00186)				
LowAntiquity					0.00715*	0.0184***		
					(0.00418)	(0.00438)		
LowAntiquity x Weather					-0.00755**	-0.00463**		
					(0.00307)	(0.00208)		
NoState							-0.00525	
							(0.00381)	
NoState x Weather							-0.0126***	-0.00873***
							(0.00347)	(0.00333)
Weather + Interaction			-0.00680***	-0.0061**	-0.0098***	-0.0078***	-0.0056***	-0.0055**
			(0.00213)	(0.0026)	(0.0030)	(0.0028)	(0.0020)	(0.00262)
Yearly Data	Y	Y	Y	Y	Y	Y	Y	Y
Controls	Y	Y	Y	Y	Y	Y	Y	Y
City Dummies	Y	Y	Y	Y	Y	Y	Y	Y
Time Dummies	N	Y	N	Y	N	Y	N	Y
Observations	276569	276569	276569	276569	276569	276569	276569	276569
F-Stat	4.017	5.289	5.759	5.077	4.249	5.754	4.943	6.570

Table 3: Regressions using Yearly Data. *Notes:* Observations are at the city x year level between 1100 and 1799. The dependent variable is *Persecution* (0 or 1 if either an expulsion or other violent acts against Jews occurs). All Mechanism variables are 0 or 1. See text and the Data Appendix for descriptions of the Mechanism variables. All regressions include as controls a dummy and slope variable for the ten years surrounding the Black Death and a measure of population density (see the Data Appendix). *Weather + Interaction* is the total effect of temperature on persecution probability measured as the sum of the coefficient on *Weather* plus that on the relevant Mechanism interaction term. Coefficients are reported with standard errors clustered at the weather-grid level. ***, **, and * indicate significance at the 1%, 5%, and 10% levels respectively.

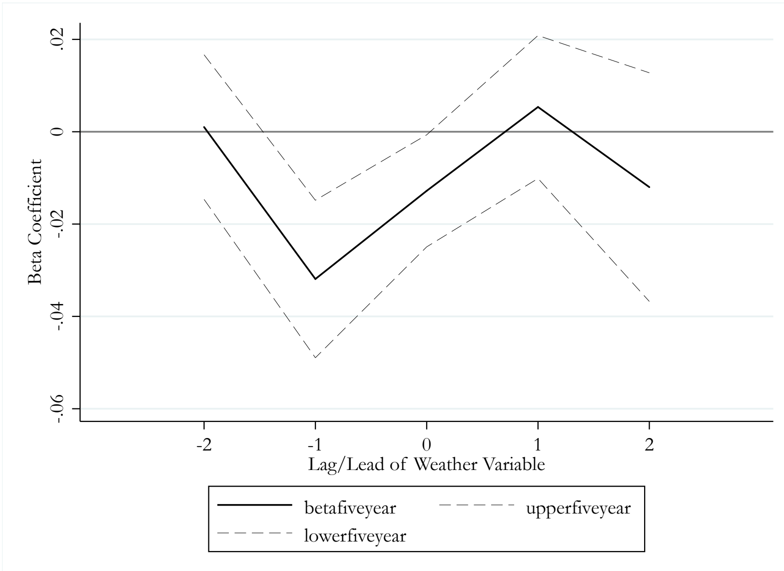
We obtain similar results analyzing our measure of state capacity in columns (5)-(8). Our largest estimate for the effect of weather on persecutions is in the FE regression in column (5) using *LowAntiquity* as the proxy for capacity. It suggests cities in regions with weak states are about 1% more likely to persecute Jews when the growing season is 1 degree cooler. Considering that the baseline probability of persecution in the one-year data is 0.017%, this treatment effect is huge. When we include year dummies in specification (6) this effect shrinks to about -0.008, which is still very large. Our results are slightly smaller, but comparable when we look at the effect of our *NoState* dummy in columns (7) and (8). Overall, the results using the yearly data support the conclusions we reached with the five-year sample.

A vital assumption of our identification strategy is that the weather data are random and, thus, unrelated to unobservables that could potentially lead to bias in our estimates. We perform placebo tests in order to test this assumption. To do this, we re-estimate equation 4 replacing the value for a city's current weather with those from previous years and for future years. The theoretical relationship between lagged weather and current persecution probability is somewhat ambiguous. There could be a relationship between earlier negative weather shocks and current persecution probability, though we would certainly expect this relationship to weaken the further back in time one looks. However, there should be no relationship whatsoever between current persecution probability and future weather.

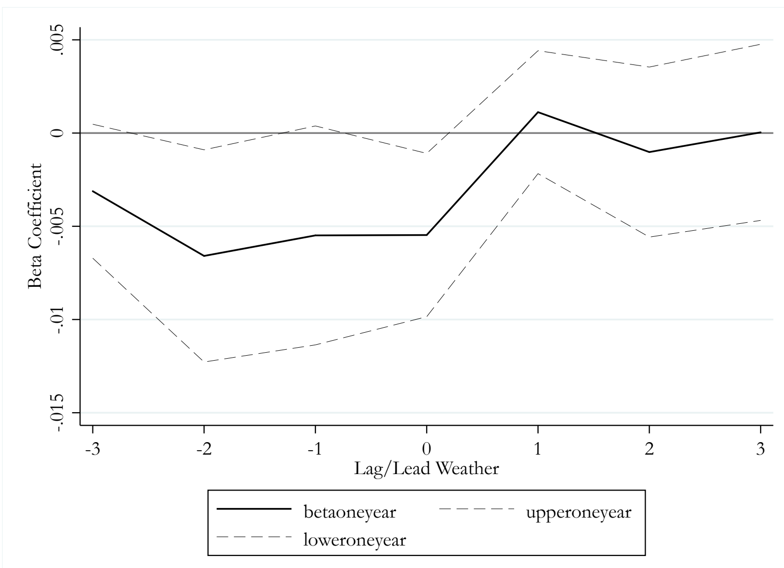
We perform the placebo tests using both the five-year and the one-year data sets. For the five-year data, we look at the previous and forward ten years of data. For the one-year sample we investigate the previous and forward 3 years. We report the results of our placebo regressions in Tables 8 and 9 in Appendix B. The resulting coefficients are depicted in Figures 4a and 4b below. Figure 4a shows the coefficients along with the 10% confidence interval for the five-year data. As expected, there is no significant relationship between the forward +1 and forward +2 values for weather. The current year is, of course significant and negative. The lag -1 five years are even more negative and significant than the current five year period. This could be due to either bias in the weather proxies, or it could mean that a poor growing season in the previous year is more likely to affect persecution in the following years, when food supplies start to run low. In any case, the lagged effect disappears by the lag -2 five year period, as we would expect.

The placebo coefficients using the one-year data are plotted in Figure 4b. As expected, the current and lagged variables up to 2 years are negative and significant (borderline for the lag -1 year). By year lag -3, however, the coefficient estimate is approaching zero. More importantly, all of the forward values for weather are robustly estimated as zeroes. This is strong evidence that the weather variable exhibits a random walk and is, thus, plausibly exogenous. In Appendix B we perform further robustness checks by controlling for spatial and serial correlation and using an alternative measure of agricultural suitability.

Overall, our findings identify two forces that appear to have played a significant role in persecution probability. First, temperature shocks were worse in locales with relatively unproductive agriculture. Second, Jewish communities located in relatively weak polities were more likely to be persecuted during periods of adverse



(a) Placebo regressions using five-year data. Dotted lines are 10% confidence intervals. Underlying regressions are in Table 8 in Appendix B.



(b) Placebo regressions using one-year data. Dotted lines are 10% confidence intervals. Underlying regressions are in Table 9 in Appendix B.

Figure 4: Placebo tests.

weather. This is consistent with our theoretical prediction that in the face of negative economic shocks, weak rulers were less able to uphold the extractive rent-seeking arrangements that protected Jewish communities. In the next section, we discuss additional evidence supportive of this explanation as well as assessing other hypotheses that may explain why Jewish persecutions declined during the later early-modern period.

6 Discussion: The Decline of Jewish Persecutions

We have documented a robust relationship between periods of colder weather and Jewish persecutions. This treatment effect is larger in cities with poor soil and is larger in cities located in weak states. Our data demonstrate that Jewish persecutions were particularly intense in late medieval and Renaissance Europe. However, after around 1500 the number and frequency of persecutions declined. Figure 5 depicts the probability of persecutions over time alongside a plot of average temperature deviation by century.

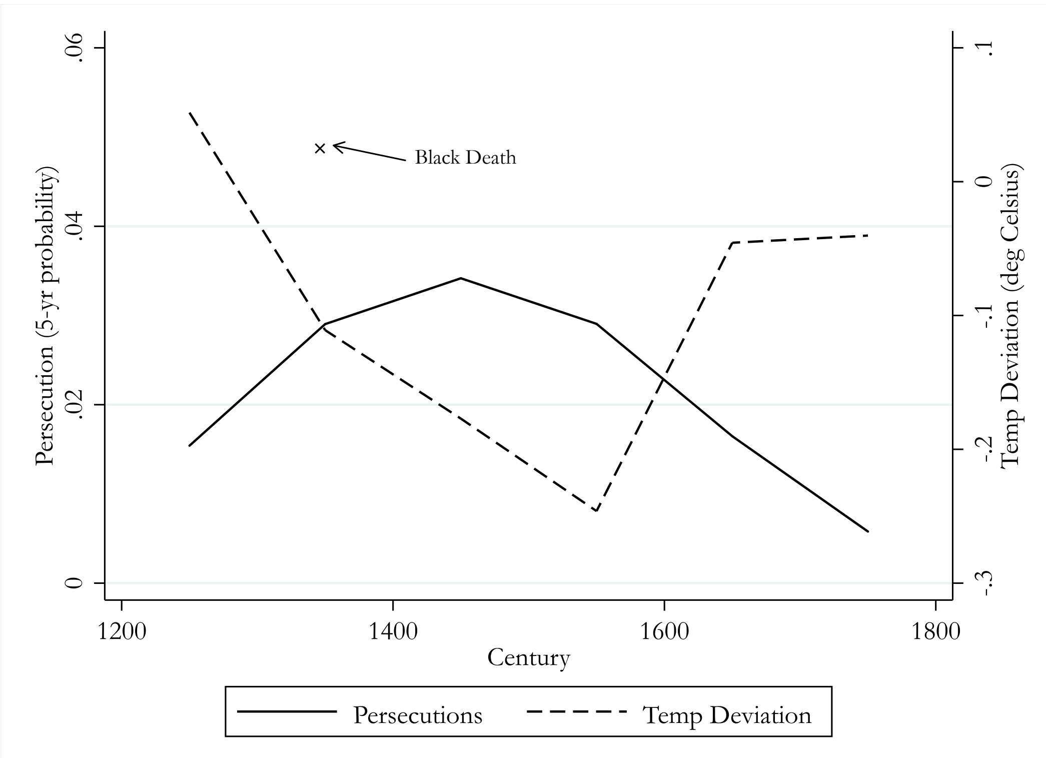


Figure 5: Probability of Persecution and Temperature Deviation by Century. Left axis measures the probability of a persecution of a Jewish community in any given five year period during that century. Right axis measures each century's average temperature deviation from the 1961-1990 average in degrees celsius. Probabilities exclude the Black Death years (1345-1354). The x indicates what the probability of persecution would be in the fourteenth century if Black Death persecutions included.

In this section we will discuss four possible reasons for this decline: (1) that there were simply fewer Jewish communities to expel by the seventeenth century; (2) that improved agricultural productivity, or, better integrated markets and could have reduced vulnerability to climatic shocks; (3) that the rise of stronger states could have led to more robust protection for religious and ethnic minorities; (4) that negative weather shocks weakened. Finally, while our data do not directly address it, it is possible that the impact of the Reformation and the Enlightenment may have reduced antisemitic attitudes. We also discuss this last alternative briefly.

6.1 The Decline of Western and Central European Jewry?

During the medieval period Jewish populations were widely distributed across Europe, but many of these were destroyed by late sixteenth century. This fact alone does not, however, fully account for the decline in persecutions. In our dataset there were thirty-one recorded persecutions in England in addition to seven city-level expulsions before the general expulsion of all Jews from the country in 1290. In comparison, there are no recorded persecutions after 1655. We can see the difference still more clearly by examining the territories that comprise modern France. In our dataset there are fifty-nine city-level persecutions prior to 1600, in addition to numerous expulsions both local and national (a total of 174 cities expelled Jews). After 1600, however, we find only three persecutions. In Table 12 in Appendix C we calculate the number of city-years that a Jewish community was present in various countries in our data before and after 1600. The table clearly shows that, at least in the case of Spain and Portugal, the reason they stopped persecuting Jewish communities after 1600 is because they did not have any openly acknowledged communities after the national expulsions of 1492 and 1497.[37] However, Spain and Portugal are extreme cases. The data in Table 12 show that, while there was definitely a movement of Jewish communities eastward towards countries like Poland after 1600, there were still many Jews in most of the countries in our sample. Furthermore, the last column of Table 12 shows that, even if we express expulsion probability in per city-year terms, there was a marked decline in Jewish persecution after around 1600.

6.2 Greater Agricultural Productivity or Increased Market Integration?

Another possible explanation for the reduction in the number of Jewish persecutions in western Europe and the breakdown in the relationship between temperature and persecutions is that an increase in agricultural productivity, or increased market integration, made European economies less vulnerable to supply shocks. Certainly, from the eighteenth century onwards, Malthusian conditions weakened and *per capita* incomes gradually increased. Nunn and Qian (2011), for example, document the role played by the potato in increasing population density and urbanization after 1700. However, the frequency of Jewish persecutions declined from around 1500 onwards—a period when the European economy remained Malthusian and agricultural productivity low.[38] Thus the Columbian Exchange occurred too late to explain the decline of Jewish persecutions.

[37] The Inquisition conducted intense persecutions of *conversos*. We discuss this issue in Appendix C.

[38] Recent research finds evidence that the Malthusian equilibrium weakened in England during the seventeenth century (see, for instance, Crafts and Mills, 2009). But the overwhelming consensus is that agricultural productivity remained low outside England and the Netherlands throughout the seventeenth century (see Allen, 2000, amongst many others).

	Dependent Variable: Wheat Price (log)								
	Full Sample			Before 1600			After 1600		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Weather	-0.0896***	-0.0443***	-0.0168**	-0.1925***	-0.0590*	-0.0191	-0.0674***	-0.0310***	-0.0152*
	(0.0113)	(0.0153)	(0.0082)	(0.0147)	(0.0323)	(0.0184)	(0.0102)	(0.0119)	(0.0082)
Lag Grain Price			0.6616***			0.6020***			0.6421***
			(0.0261)			(0.0108)			(0.0285)
Market dummies	Y	Y	Y	Y	Y	Y	Y	Y	Y
Year dummies	N	Y	Y	N	Y	Y	N	Y	Y
Observations	16171	16171	15193	6232	6232	6232	9885	9885	9385
R-square	0.78	0.91	0.95	0.75	0.89	0.93	0.89	0.93	0.96

Table 4: Grain Price Regressions. *Notes:* Observations are at the city x year level between 1100 and 1799. The dependent variable is the log of wheat prices in silver equivalents. Coefficients are reported with standard errors clustered at the city level. ***, **, and * indicate significance at the 1%, 5%, and 10% levels respectively.

Nevertheless, better market integration might be responsible for temperature shocks having a weaker impact on Jewish persecutions. To assess this, we use a panel of wheat prices from Allen and Unger. This dataset contains grain prices for 193 cities worldwide. We use wheat prices from 98 of these cities.[39] In Table 4 we run a series of regressions of *Weather* on the log of wheat prices in the cities in this unbalanced panel. In columns (1) and (2) we report our fixed effects and difference-in-differences estimates using the entire panel. These regressions support our theoretical hypothesis that negative weather shocks adversely affect grain markets. The coefficient on *Weather* in specification (1) implies a one degree celsius decrease in temperature increases wheat prices by about 9%. This estimate is halved in the diff-in-diff regression. In column (3) we include a lag of the dependent variable to account for potential serial correlation and the estimate shrinks further while retaining the negative sign and its significance.[40] This is consistent with our mechanism: temperature shocks affected agricultural output as measured by grain prices.[41]

In columns (4)-(9) we split the sample to assess whether temperature shocks affected grain prices less after 1600 than before. Before 1600, the fixed effects specification implies that a one degree centigrade decrease in average temperature is associated with a 19% increase in grain prices (col. 4). In the period after 1600, this effect is half as large (col 7.). This suggests that increased market integration reduced vulnerability to climatic shocks. Similar to the regressions on the whole sample, when we include time dummies and a lag of the dependent variable, these effect sizes shrink considerably. Overall, these results suggest better markets and improvements in agricultural technology did mean that European economies were less vulnerable to climate

[39] Figure 14 in Appendix C shows their locations. Descriptive statistics are in Appendix A.

[40] A Fisher-type unit root test on the data convincingly rejects the null of a unit root. This implies the inclusion of the lagged dependent variable term is unnecessary. Nonetheless, we include it as cautionary measure.

[41] While these coefficients are small, they are also consistent with what we know about medieval and early modern agriculture. Grain market prices were highly regulated and local governmental authorities provisioned cities during periods of scarcity so adjustment to exogenous shocks was often through quantity rather than through price (for a discussion of the French case see Kaplan (2013)).

shocks after 1600. Nevertheless, while the effect of climate on agricultural prices weakened after 1600, it did not disappear. Therefore, improvements in market integration are unlikely to be solely responsible for the marked decline in Jewish persecutions that occurred in the early modern period.

6.3 Greater State Capacity?

Our model suggests that in societies with greater state capacity the relationship between weather shocks and Jewish persecutions should be weaker. We also find significant support for this proposition through our *NoState* and *LowAntiquity* variables. Unfortunately, it is difficult to test this hypothesis more directly since reliable and continuous data on tax revenues and other measures of state capacity are only available for the major European states after 1500 (and in some cases 1650) (Dincecco, 2009; Karaman and Pamuk, 2013).[42] This timing for data availability is, of course coincident with the rise of strong centralized states. Furthermore, estimates of tax revenues generally do not exist for the many city-states and smaller political units that comprise much of our data.

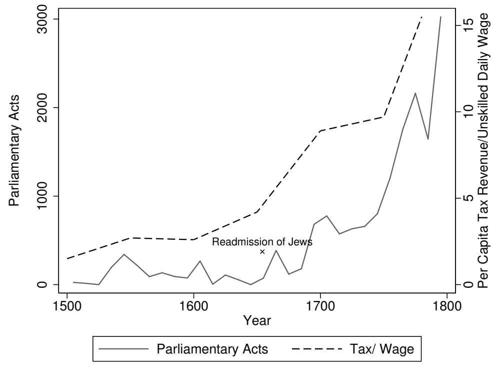
Nonetheless. there is significant narrative evidence supporting our argument that increases in fiscal capacity in western Europe were linked to the decision to admit and protect Jewish communities. For example, Oliver Cromwell invited Jews to return to England in 1655 (Kaplan, 2007, 326). Figure 6a depicts the rise of state capacity in England as measured by tax revenue and the increase in legislative activity by Parliament. The English Jewish community was initially viewed as a transitory group of alien merchants with limited rights. Their position was uncertain and in 1660 a petition came before Parliament to expel them. This petition was ignored, but it was only after the Glorious Revolution that the permanent status of Jews in England was fully recognized and accepted (Katz, 1994, 140-141 and 188). Despite the unpopularity of the English Jewish community, they were no longer subject to persecutions and violence after this official recognition.[43]

A similar process took place in France. Figure 6b traces the dramatic increase in the capacity of the central state after around 1630 using tax revenues and counts of royal edicts issued. Cardinal Richelieu played a crucial role establishing the French tax state and in protecting Portuguese crypto-Jews from being persecuted as heretics because of their value as merchants and financiers. Israel describes this as 'a classic instance of *raison d'État* politics and mercantilism' the result of which was to have 'made possible that steady transition from the 1630s down to the 1680s by when the Portuguese communities in France had cast off all remaining pretense and openly organized as Jewish congregations with rabbis and services in Hebrew' (Israel, 1985, 96-97). By 1722 the right of all French Jews to openly practice their religion was recognized in law.

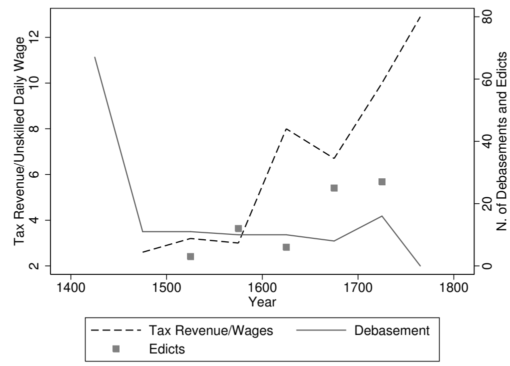
The Dutch Republic offered permanent protection to Jews after its declaration of independence from Spain, with large numbers of so-called crypto-Jews arriving in 1593. The rights of Jews to practice their religion was codified in 1619. Figure 6c plots the relationship between toleration offered to the Jews and the rise

[42] In Appendix D Figure 18 depicts the rise in tax revenues (measured in silver) for the seven largest European states between 1500 and 1800.

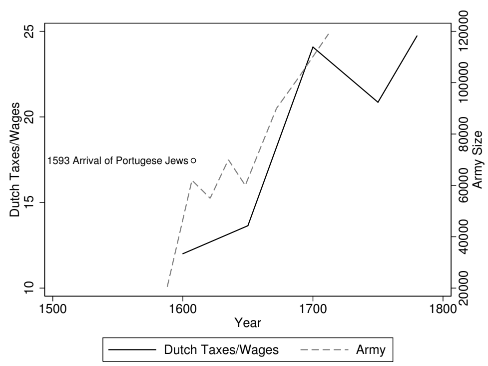
[43] For details on the survival on antisemitic stereotypes and attitudes in England after the re-admittance of Jews into the country see Poliakov (1955, 203-209) and Felsenstein (1999).



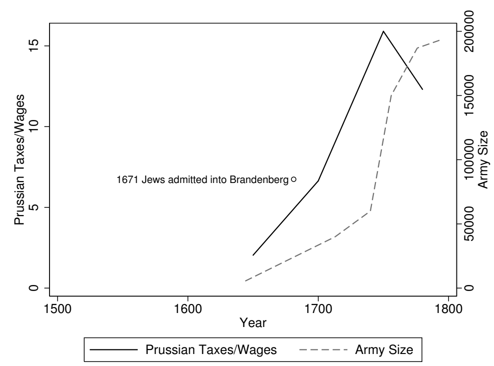
(a) England.



(b) France.



(c) Dutch Republic.



(d) Prussia.

Figure 6: The rise of state capacity in early modern: tax revenue data is from Karaman and Pamuk (2013); data on English Parliamentary Acts is from Bogart and Richardson (Forthcoming). Data on Royal Edicts is from Johnson and Koyama (2013*b*); data on debasements is from Shaw (1896). Army size data is from van Nimwegen (2006).

of the Dutch state as measured by taxation per capita over real wages and by the wartime strength of the Republic's armed forces. Figure 6d depicts similar data for Prussia. While there had been a long history of Jewish settlement in lands controlled by Prussia, it was only in the late seventeenth century that Frederick William (1650-1688) gave the Jews a charter, which established their permanent residency. This occurred at the same time as the Elector invested in fiscal capacity and built a professional standing army that would propel Prussia to the status of a major European power.

There can be no doubt that popular antisemitism survived the emergence of stronger nation states in the early modern period.[44] But the evidence suggests that these new states were less responsive to it. The increases in state capacity that occurred from 1600 onwards, documented by Dincecco (2009); Karaman and Pamuk (2013) and Johnson and Koyama (2013*b*), led to the formation of polities that were less vulnerable to political unrest, and better at reducing interfaith violence, all factors that led to fewer persecutions and expulsions.[45] This

[44]There is little evidence of a lessening in antisemitic attitudes. *Judensau*—woodcut images denigrating Jews—remained common in Germany until 1800. Poliakov (1955, 174-202) examines a large number of antisemitic treatises published in France during the seventeenth century that suggest that antisemitism was widespread and conventional in both elite and popular circles.

[45]Historians and sociologists have also argued that the birth of new nation states in the late medieval period was often accompanied by the expulsion of the Jews and other 'alien' populations (Baron, 1967*a*; Menache, 1987; Barkey and Katznelson,

is consistent with the findings that stronger states were responsible for ending the European witch-hunts in the late seventeenth century (Levack, 1996; Johnson and Koyama, 2014) and with the argument that the rise of larger and more centralized states led to a gradual increase in bounds of religious toleration in the early modern period (Johnson and Koyama, 2013*a*).[46]

Jews continued to suffer persecutions and massacres in early modern Europe but these occurred in the ungoverned periphery and not in the new nation states of western Europe. The worst massacres occurred during the Khmelnytsky Uprising which saw the Ukraine breakaway from Poland-Lithuania in the mid-seventeenth century (Stampfer, 2003). It goes without saying that this increase in state capacity was a two-edge sword: it could be used to persecute as well as protect. In the twentieth centuries, the capacity of modern states made possible the industrial horrors of the Holocaust. But in the period between 1600 and 1800 it was associated with a reduction in violence against minority groups.

6.4 Colder Weather?

The period 1400 to 1800 is known as the Little Ice age. This name is perhaps slightly misleading as there was a lot of variation in climate within this long-period. For example, Crowley and Lowery (2000) notes that the medieval warm period comprised three distinct and temporal separate peaks in temperature: 1010-1040, 1070-1105, and 1155-1190 and that average temperatures in the medieval warm period were only $0.2°C$ warmer than during the Little Ice Age. Consequently, some scholars have questioned the value of terms such as the 'medieval warm period' or the 'Little Ice Age' because within period variation is often much larger than between period variation (Kelly and Ó Gráda, 2010, e.g.). However, it remains widely accepted that 'bad weather—heavy rainfall, cool and wet summers, severe floods—became very much more frequent during the last two centuries of the Middle Ages, and suggest that, at last in north-western Europe, climatic disasters were in fact more numerous and severe than they had been earlier. This is supported by other evidence: the extension of the glaciers in the Alps; the lowering of the upward limits of cultivation and of tree growth in hilly areas; the inundation of the coastal lowlands in the Netherlands, and the increasing soil moisture in the valley of central Europe, where, in some instances, cultivation had to be abandoned' (Pounds, 1974, 136). Our data support this: between 1400 and 1600, average temperatures in Europe were between 0.10 and 0.20 degrees cooler than during the surrounding centuries.

The weather became warmer in the seventeenth century—although the late seventeenth century again saw extremely cold winters due to a decline in solar activity known as the Maunder Minimum. It seems likely that improved summer growing conditions might be one factor that helps to explaining the diminishing frequency

2011). This factor was certainly important in explaining the expulsion of Jews from England in 1290 and Spain in 1492. But it was not in general true of medieval persecutions or expulsions. For studies of the expulsion of Jews from England see Leonard (1891); Elman (1937); Ovrut (1977); Menache (1987); Stacey (1997, 2000); Mundill (1998); Katznelson (2005); Koyama (2010*b*). For studies of the expulsion of Jews from Spain see Kamen (1988); Gerber (1992); Roth (1995).

[46] According to Hecksher: 'The same tendency is manifested in the fact that the Jews were placed on a new footing in the 17th century in most western and central European countries. This should certainly not be regarded as a general pro-Jewish feeling on the part of mercantilists. No such sentiment was ever felt among those in power . . . this much is clear, that the leaders of mercantilist policy wished to extend toleration even to the Jews, and that this toleration was determined primarily by commercial considerations' (Heckscher, 1955, 305).

of Jewish persecutions. However, many scholars have argued that cold weather and particularly low winter temperatures during this period were associated with the political turbulence known as the crisis of the seventeenth century (Parker, 2013). Certainly, a sustained improvement in climatic conditions did not begin until the eighteenth century. Thus we do not believe that improving climatic conditions can completely explain the decline in Jewish persecutions.

6.5 Other Factors?

A final factor we do not consider in detail is the importance of changing cultural values and beliefs as emphasized by Mokyr (2002, 2009). The Reformation did not lead to a marked decline in religious tension or antisemitism. Martin Luther was an anti-Semite; he penned the book *The Jews and their Lies* in 1543 and railed against them for usury: 'they [the Jews] are nothing but thieves and robbers who daily eat no morse and wear no thread of clothing which they have not stolen and pilfered from us by means of their accursed usury'. He was also an advocate of expulsion: 'eject them forever from this country. For, as we have heard, God's anger with them is so intense that gentle mercy will only tend to make them worse and worse, while sharp mercy will reform them but little' (Luther, 1553). From the end of the seventeenth century onwards, however, the Enlightenment may have played a role in reducing antipathy towards Jews (at least among elites) (Kamen, 1967; Grell and Porter, 2000). Data does not exist that sheds light on the role played the Enlightenment in increasing religious toleration. Certainly, by deemphasizing the importance of revealed religion, the Enlightenment created a religiously neutral sphere where Christians and Jews could meet on an equal footing (Low, 1979). Nevertheless many Enlightenment figures including Voltaire, Edward Gibbon and Edmund Burke voiced anti-Jewish views (see Sutcliffe, 2000). Voltaire for example, described the Jewish nation as 'the most detestable ever to have sullied the earth'. It was only in the late eighteenth century that Enlightenment views began to exert a decisive influence on the treatment of Jews in Europe, generating the move towards Jewish emancipation. This intellectual movement, shaped by Moses Mendehlsson (1729-1786), Christian von Dohm (1751-1820), and many others, came too late to help explain the end of large-scale Jewish persecutions in western and central Europe.[47]

7 Conclusion

This paper examines the effect of negative supply shocks on the treatment of religious or ethnic minorities. We use a simple political economy model to study the conditions under which rulers will find it beneficial to expel or expropriate a minority community. In our empirical analysis, we exploit the fact that the economies of medieval and early modern Europe were predominantly agrarian and use exogenous variation in temperature during the growing season to identity the effect of supply shocks on the probability of a Jewish community

[47]Influenced by the Enlightenment, Habsburg emperor Joseph II began the process of granting Jews civic rights in 1782. But it was the French Revolution and the subsequent invasion of Germany by French armies that led to the imposition of Jewish emancipation in central Europe (Berkovitz, 1989; Vital, 1999). After the defeat of France, these reforms were partially reversed but the movement towards Jewish emancipation resumed and culminated with the removal of all disabilities on Jews in Austria-Hungary in 1868 and Germany in 1870 (see Katz, 1974; Mahler, 1985; Sorkin, 1987; Carvalho and Koyama, 2011).

suffering persecution. A one standard deviation decrease in average temperature increased the probability of a Jewish community being persecuted from a baseline of 2% every five years to between 2.5% and 3% – a significant increase especially considering the sustained decrease in temperatures which occurred throughout much of Europe between the late fourteenth and seventeenth centuries.

The model predicts that more developed states with greater fiscal capacity and greater political stability, were less likely to expel Jewish communities as a result of periods of cold weather. Our results support the predictions of our model: the effect of supply shocks on persecutions was larger in areas with poor soil quality and in societies with lower state capacity. Persecutions peaked in the 14th to 16th centuries. Jewish communities were most vulnerable to persecution in economically marginal communities in weak states. Increased agricultural productivity, better market integration and rise of centralized states can help account for Europe's gradual transition from extractive to inclusive economic and political institutions in the period.

Appendices for Online Publication Only

A Descriptive Statistics

Variable		Mean	Std. Dev.	Min	Max	Observations
Persecution	overall	0.022	0.148	0.000	1.000	N = 55908
	between		0.031	0.000	0.333	n = 933
	within		0.146	-0.311	1.015	T-bar = 59.92
Expulsion	overall	0.014	0.118	0.000	1.000	N = 55908
	between		0.026	0.000	0.333	n = 933
	within		0.116	-0.319	1.007	T-bar = 59.92
Weather	overall	-0.057	0.339	-1.278	1.370	N = 55908
	between		0.096	-0.502	0.293	n = 933
	within		0.328	-1.426	1.262	T-bar = 59.92
LowAntiquity	overall	0.400	0.490	0.000	1.000	N = 55908
	between		0.413	0.000	1.000	n = 933
	within		0.296	-0.568	1.383	T-bar = 59.92
LowSuitability	overall	0.724	0.447	0.000	1.000	N = 55908
	between		0.456	0.000	1.000	n = 933
	within		0.000	0.724	0.724	T-bar = 59.92
NoState	overall	0.996	0.067	0.000	1.000	N = 55908
	between		0.042	0.000	1.000	n = 933
	within		0.049	0.124	1.563	T-bar = 59.92
LowCapital	overall	0.776	0.417	0.000	1.000	N = 55908
	between		0.379	0.000	1.000	n = 933
	within		0.198	-0.120	1.766	T-bar = 59.92
LowConstraint	overall	0.408	0.491	0.000	1.000	N = 55908
	between		0.405	0.000	1.000	n = 933
	within		0.292	-0.567	1.398	T-bar = 59.92
PopDensity	overall	11.743	12.990	0.000	329.829	N = 55908
	between		10.992	0.000	129.490	n = 933
	within		8.053	-86.844	231.709	T-bar = 59.92

Table 5: Descriptive Statistics: Five-Year Data. See text and Appendix C for descriptions of data. Statistics for in-sample cities (cities with Jewish community present).

Variable		Mean	Std. Dev.	Min	Max	Observations
Persecutions	overall	0.017	0.129	0.000	1.000	N = 276569
	between		0.024	0.000	0.250	n = 933
	within		0.128	-0.233	1.015	T-bar = 296.43
Expulsions	overall	0.009	0.093	0.000	1.000	N = 276569
	between		0.018	0.000	0.250	n = 933
	within		0.092	-0.241	1.007	T-bar = 296.43
Weather	overall	-0.056	0.502	-3.375	2.476	N = 276569
	between		0.096	-0.520	0.307	n = 933
	within		0.495	-3.297	2.374	T-bar = 296.43
LowAntiquity	overall	0.402	0.490	0.000	1.000	N = 276569
	between		0.413	0.000	1.000	n = 933
	within		0.297	-0.588	1.398	T-bar = 296.43
LowSuitability	overall	0.723	0.447	0.000	1.000	N = 276569
	between		0.456	0.000	1.000	n = 933
	within		0.000	0.723	0.723	T-bar = 296.43
NoState	overall	0.995	0.067	0.000	1.000	N = 276569
	between		0.042	0.000	1.000	n = 933
	within		0.049	0.127	1.559	T-bar = 296.43
PopDensity	overall	11.750	13.004	0.000	332.577	N = 276569
	between		11.038	0.000	131.040	n = 933
	within		8.057	-87.864	233.492	T-bar = 296.43

Table 6: Descriptive Statistics: One Year Data. See text and Appendix C for descriptions of data. Statistics for in-sample cities (cities with Jewish community present).

Panel A: Full Sample

Variable		Mean	Std. Dev.	Min	Max	Observations
Wheat Price (log)	overall	-.5481949	.9844439	-4.094388	6.503165	N = 16171
	between		.8883051	-2.479377	5.800303	n = 108
	within		.462657	-3.069521	1.867991	T-bar = 149.731
Weather	overall	-.1451011	.4815194	-2.010253	1.473255	N = 16171
	between		.1448232	-.4300972	.2252928	n = 108
	within		.4683623	-2.029277	1.386332	T-bar = 149.731

Panel B: Before 1600

Variable		Mean	Std. Dev.	Min	Max	Observations
Wheat Price (log)	overall	-.8996212	.9215248	-4.094388	3.374876	N = 6232
	between		.6608324	-2.785452	2.125386	n = 72
	within		.4718699	-3.215178	1.316274	T = 86.5556
Weather	overall	-.2262956	.4559797	-1.854408	1.03061	N = 6232
	between		.2026079	-1.101377	.0991158	n = 72
	within		.4377363	-1.715658	1.076033	T = 86.5556

Panel C: After 1600

Variable		Mean	Std. Dev.	Min	Max	Observations
Wheat Price (log)	overall	-.3280944	.9601423	-3.520891	6.503165	N = 9885
	between		.891019	-2.276602	5.800303	n = 95
	within		.3273127	-2.286568	1.918294	T-bar = 104.053
Weather	overall	-.089956	.4877698	-2.010253	1.473255	N = 9885
	between		.2040523	-.6853404	.2252928	n = 95
	within		.4746888	-1.974132	1.372704	T-bar = 104.053

Table 7: Descriptive Statistics: Grain Prices. See text and Appendix C for descriptions of data.

B Further Robustness Tests

As we describe in the main paper we run several additional robustness tests on our data. This Appendix reports the most informative of these.

In order to verify the exogeneity of our weather variable, we perform several placebo tests by estimating our baseline specfcation using lags and leads of weather (see text for more description). These results are presented in Table 8 using the five-year data and in Table 9 using the one-year data. We plot the resulting estimates in Figures 4a and 4b in Section 5 of the main text.

One potential source of bias in the standard errors of our regressions stems from serial or spatial correlation (Bertrand and Mullainathan, 2004; Conley, 2008). In Table 10 we control for these potential biases using the method suggested by Conley (2008) and implemented in stata code by Hsiang (2010). We take into account spatial influence of all cities within a 300km circle surrounding each city. We also assume an AR(2) process. Overall, the estimated coefficients are robust to these controls, though coefficient sizes do shrink somewhat.

Our preferred measure of agricultural efficiency, *LowSuitability*, is constructed using constraints on wheat production. It is possible that this may be an inappropriate measure in more southern or northern latitudes where olives or barley may be more important staples. To address this concern, in Table 11 we re-estimate our main results using an alternative measure of agricultural suitability created by Ramankutty et al. (2002) which measures present-day suitability of land for cultivation of *any* crop, not just wheat (see Appendix C for more description). We create a variable based on these data called *Badsuit* so it takes a value of 1 for cities in the lower three-quarters of the sample for soil suitability. This gives us a treatment group comparable in size to when we use *LowSuitability*. The estimation results in Table 11 are similar to those we get using wheat suitability in Table 2. This suggests our hypothesis that weather shocks were worse in regions with higher agricultural constraints is robust.

	Dependent Variable: Persecution (Five-Year)				
	(2)	(3)	(5)	(6)	(7)
Weather	0.00101	-0.0319***	-0.0128*	0.00536	-0.0120
	(0.00955)	(0.0104)	(0.00740)	(0.00944)	(0.0151)
Lag/Lead	t-2	t-1	t=0	t+1	t+2
Five-Year Data	Y	Y	Y	Y	Y
Controls	Y	Y	Y	Y	Y
City dummies	Y	Y	Y	Y	Y
Time dummies	Y	Y	Y	Y	Y
Observations	55482	55696	55906	55338	54788

Table 8: Placebo tests using five-year data. *Notes:* Observations are at the city x five-year level between 1100 and 1799. The dependent variable is *Persecution* (includes both expulsions and other violent acts against Jews). All Mechanism variables are 0 or 1. See text and the Data Appendix for descriptions of the Mechanism variables. All regressions include as controls a dummy and slope variable for the ten years surrounding the Black Death and a measure of population density (see the Data Appendix). *Weather + Interaction* is the total effect of temperature on persecution probability measured as the sum of the coefficient on *Weather* plus that on the relevant Mechanism interaction term. Coefficients are reported with standard errors clustered at the weather-grid level. ***, **, and * indicate significance at the 1%, 5%, and 10% levels respectively.

	Dependent Variable: Persecution (Yearly)						
	(1)	(2)	(3)	(5)	(6)	(7)	(8)
Weather	-0.00312	-0.00659*	-0.00549	-0.00547**	0.00112	-0.00102	0.0000376
	(0.00219)	(0.00347)	(0.00358)	(0.00267)	(0.00201)	(0.00278)	(0.00288)
Lag/Lead	t-3	t-2	t-1	t=0	t+1	t+2	t+3
Yearly Data	Y	Y	Y	Y	Y	Y	Y
Controls	Y	Y	Y	Y	Y	Y	Y
City dummies	Y	Y	Y	Y	Y	Y	Y
Time dummies	Y	Y	Y	Y	Y	Y	Y
Observations	275939	276149	276359	276569	276008	275448	274891

Table 9: Placebo tests using one-year data. *Notes:* Observations are at the city x year level between 1100 and 1799. The dependent variable is *Persecution* (includes both expulsions and other violent acts against Jews). All Mechanism variables are 0 or 1. See text and the Data Appendix for descriptions of the Mechanism variables. All regressions include as controls a dummy and slope variable for the ten years surrounding the Black Death and a measure of population density (see the Data Appendix). *Weather + Interaction* is the total effect of temperature on persecution probability measured as the sum of the coefficient on *Weather* plus that on the relevant Mechanism interaction term. Coefficients are reported with standard errors clustered at the weather-grid level. ***, **, and * indicate significance at the 1%, 5%, and 10% levels respectively.

	Dependent Variable: Persecution							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Weather	-0.0212***	-0.0132*	-0.0104**	-0.0059	-0.0137***	-0.0067	0.0287	0.0276
	(0.00389)	(0.0069)	(0.0046)	(0.0083)	(0.0041)	(0.0080)	(0.03030)	(0.03168)
LowSuitability x Weather			-0.0151***	-0.0090*				
			(0.0053)	(0.0050)				
LowAntiquity					0.0065*	0.0220***		
					(0.0035)	(0.0038)		
LowAntiquity x Weather					-0.0176**	-0.0137*		
					(0.0082)	(0.0078)		
NoState							-0.0080	-0.0216*
							(0.0093)	(0.0111)
NoState x Weather							-0.0502*	-0.0406
							(0.0306)	(0.0307)
Weather + Interaction			-0.0255***	-0.0149**	-0.0313***	-0.0203**	-0.0215***	-0.0130*
			(0.0046)	(0.0069)	(0.0071)	(0.0079)	(0.0039)	(0.0070)
Correct for Spatial Dep	Y	Y	Y	Y	Y	Y	Y	Y
Correct for Serial Corr	Y	Y	Y	Y	Y	Y	Y	Y
Controls	Y	Y	Y	Y	Y	Y	Y	Y
City Dummies	Y	Y	Y	Y	Y	Y	Y	Y
Time Dummies (5-yr)	N	Y	N	Y	N	Y	N	Y
Observations	55908	55908	55908	55908	55908	55908	55908	55908

Table 10: Mechanism regressions controlling for spatial and serial correlation. *Notes:* Observations are at the city x five-year level between 1100 and 1799. The dependent variable is *Persecution* (0 or 1 if there is an expulsion and other violent act against Jews). All Mechanism variables are 0 or 1. See text and the Data Appendix for descriptions of the Mechanism variables. All regressions include as controls a dummy and slope variable for the ten years surrounding the Black Death and a measure of population density (see the Data Appendix). *Weather + Interaction* is the total effect of temperature on persecution probability measured as the sum of the coefficient on *Weather* plus that on the relevant Mechanism interaction term. We control for spatial and serial correlation using the method suggested by Conley (2008) and implemented in stata code by Hsiang (2010). We take into account spatial influence of all cities within a 300km circle surrounding each city. We also assume an AR(2) process. ***, **, and * indicate significance at the 1%, 5%, and 10% levels respectively.

	Dependent Variable					
	Persecution			Expulsion		
	(1)	(2)	(3)	(4)	(5)	(6)
Weather	-0.00876	-0.0159*	0.000288	-0.00807	-0.0138	0.00828
	(0.00743)	(0.00886)	(0.00915)	(0.00822)	(0.00914)	(0.00913)
Badsuit X Weather	-0.00730	-0.00528	-0.0161**	-0.00784	-0.00620	-0.0141*
	(0.00850)	(0.00918)	(0.00669)	(0.00867)	(0.00937)	(0.00792
Weather + Interaction	-0.0161**	-0.0212***	-0.0158**	-0.0159***	-0.0200***	-0.0058
	(0.0066)	(0.0074)	(0.00754)	(0.00484)	(0.00503)	(0.0052)
Controls	Y	Y	Y	Y	Y	Y
City dummies	N	Y	Y	N	Y	Y
Time dummies	N	N	Y	N	N	Y
Observations	54514	54514	54514	54514	54514	54514
F Stat	4.087	3.722	9.449	4.529	4.817	7.137

Table 11: Mechanism regressions using agricultural suitability data. *Notes:* Observations are at the city x five-year level between 1100 and 1799. The dependent variable is *Persecution* (includes both expulsions and other violent acts against Jews) or *Expulsion*. *Badsuit* is a measure of percentage of land suitable for the cultivation of any crop within a 5 arc-minute grid from Ramankutty et al. (2002). We code *Badsuit* so it takes a value of 1 for cities in the lower three-quarers of the sample for soil suitability. See Appendix C for more description and a map of soil suitability. All regressions include as controls a dummy and slope variable for the ten years surrounding the Black Death and a measure of population density (see the Data Appendix). *Weather + Interaction* is the total effect of temperature on persecution probability measured as the sum of the coefficient on *Weather* plus that on the relevant Mechanism interaction term. ***, **, and * indicate significance at the 1%, 5%, and 10% levels respectively.

C Data Appendix

Data on Jewish presence in cities is taken from city entries in the *Encyclopedia Judaica* 2007. The *Encyclopedia Judaica* typically mentions when Jews entered a city, when they were persecuted, when they were expelled, and when they were allowed re-entry. Using this information a database was created of 1,069 cities that had a Jewish presence at some point from 1000 to 1800. Figure 2 plots every city in our full database. In our empirical analysis we utilize the 933 cities for which we can obtain urbanization data.

The Existence of a Jewish Community

We include all cities that are recorded as having a permanent Jewish population in the period under consideration. Information on the exact date in which a Jewish community was accepted into a city is difficult to come by for many cities—particularly for the earlier centuries. In order to overcome this problem we use the date at which the Jewish community is first mentioned in a document. We then construct three years of first entry either fifty, seventy-five or one hundred years prior. For example, Jews in Chomutov (Czech Republic) were first mentioned as being massacred in 1421, so the dates 1371, 1346 and 1321 were all used as separate dates of entry. Our baseline regressions all assume that there was a Jewish presence in all cities for at least fifty years prior to their first being mentioned.

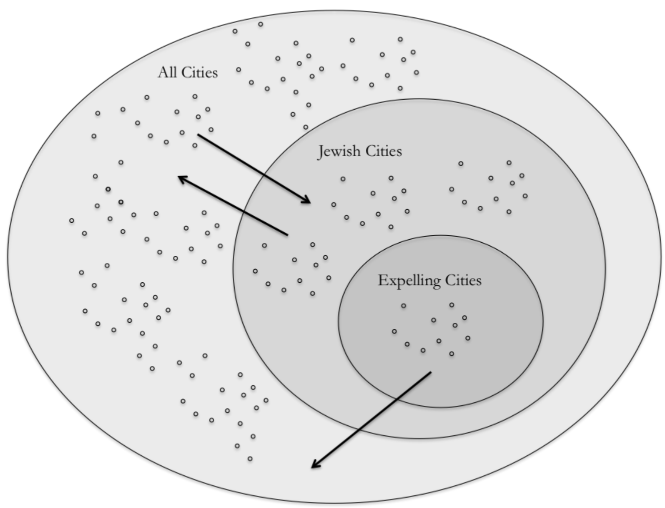


Figure 7: All the 1073 cities in our database contain Jewish communities at some point between 1100 and 1800. In any given year a city either has a Jewish community or not. Only cities with Jewish communities are included in our sample as countries liable to conduct an expulsion.

Figure 7 provides a visual representation of our data. All of the 1,069 cities in our full database possessed Jewish communities at some point between 1100 and 1800. But expulsions could only occur in cities with a Jewish population in that year. A city that had expelled its Jewish population the year previously cannot expel them again unless the Jewish community in question had returned in the meantime. Thus, our regressions use only the sample represented by the two darker sets of cities.

Table 12 shows the number of city-years in which Jews resided in each major European Country. We calculate the total number of city-years associated with a Jewish presence in our data before and after 1600. For Spain and Portugal, the lack of expulsions after 1600 is due to there being no Jews to expel. However, with the exception of Austria, these data strongly suggest that the fall in the number of persecutions in western Europe we observe was not just because there were no Jewish populations to expel.

Region	City-Years Before 1600	City-Years After 1600	Persecutions Before 1600	Persecutions After 1600	Persecutions per City Year Before/After 1600
France	25,690	6,530	247	8	7.85
England	3,665	1,420	57	0	inf
Germany	41,710	19,430	399	26	7.15
Italy	30,135	8,680	110	21	1.51
Switzerland	2,950	715	28	2	3.39
Spain	36,390	0	214	0	inf
Portugal	6,195	0	24	0	inf
Austria	4,270	1,435	18	7	0.86
Poland	16,590	24,075	52	77	0.98

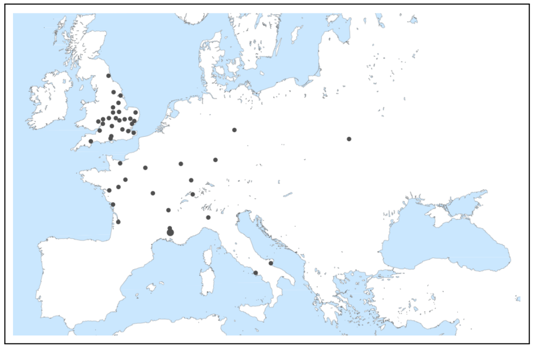
Table 12: City-years Jewish community present and persecutions before and after 1600.

Data on Persecutions

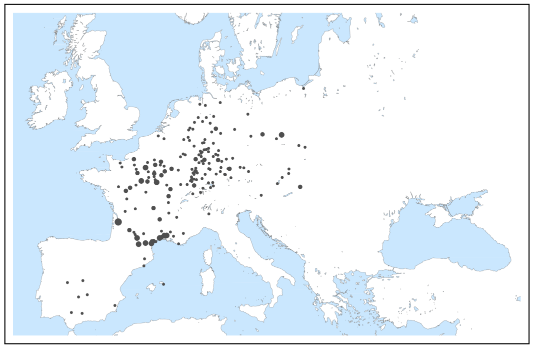
There are 1,366 persecutions in our full database: 785 expulsions and 614 pogroms. We have omitted all instances of persecution that cannot be dated. But we have included the cities in question in the sample if they had a documented Jewish population. The direction of this measurement error biases our coefficients downwards.

For example, Bonn is in our database as it had a Jewish community prior to 1100. This community was expelled and massacred in 1348 but is recorded as having returned to the city by 1381. There was also an expulsion in the fifteenth century that we omit because it is not dated. Occasionally, Jews left a city or a region for voluntary reasons. We have noted this in our database and these do not count such an observation as an expulsions even when the reasons for their leaving often had to do with the imposition of discriminatory taxes on Jews or the threat of popular violence. Figure 2 in the main text shows the distribution of expulsions across the cities in our database.

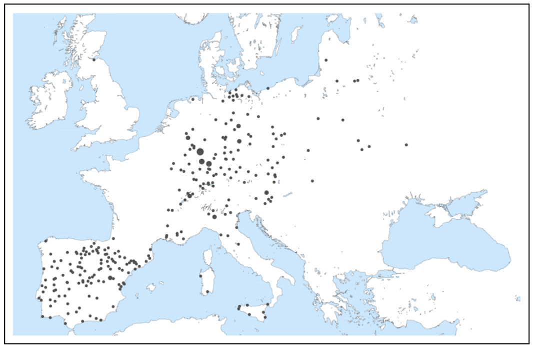
Figures 8a to 8f below plot the number of expulsions per century. Our main empirical result is the strong causal link between negative weather shocks and expulsions in the fifteenth and sixteenth centuries. Figures 8c and 8d show that the cities that drive this result are clustered in Spain, Portugal, and Germany during the fifteenth century. Expelling cities cluster in Germany, Italy, and to a lesser extent Eastern Europe in the sixteenth century.



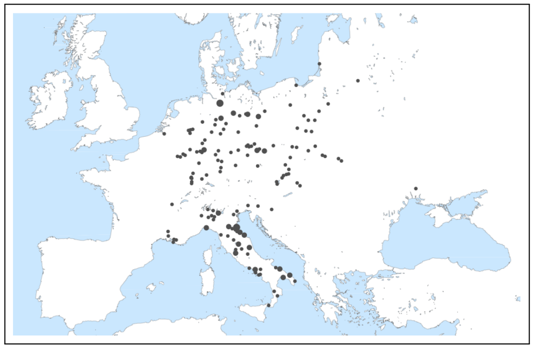
(a) 13th Century Expulsions.



(b) 14th Century Expulsions.



(c) 15th Century Expulsions.



(d) 16th Century Expulsions.

(e) 17th Century Expulsions.

(f) 18th Century Expulsions.

Figure 8: The Location of Jewish Expulsions: 1200-1800.

The Decision to Establish a Jewish Community

The majority of Jewish communities in western Europe were established between 900 and 1200. This is before the major period of Jewish expulsions and persecutions. Jewish settlement was largely driven by the expansion of the European economy known as the Commercial Revolution. There is no evidence that the decision to establish a Jewish community in this period by the likelihood of expulsion or persecution. Therefore was can treat initial Jewish settlement as exogenous.

There is more concern that Jewish settlement in the period after 1300 was affected by the fear of persecution or expulsion. However, the available historical evidence mitigates this concern somewhat. For example, we know from documentary evidence that the Jews of England settled in France following their expulsion in 1290 as this was the geographically closest and culturally most similar Jewish community (the Jews of England spoke French) despite the fact that Jews in that country had suffered numerous local persecutions and expulsions and would in fact be expelled *en masse* by Philip IV in 1306 (Huscroft, 2006; Mundill, 2010). Similarly, the Jews of France were willing to return to France after this expulsion as they indeed did in 1315 even though they faced the threat of similar events occurring in the future.

This does not mean that Jews were irrational or that they failed to perceive the threat of persecution. On the contrary, they frequently negotiated contracts which guaranteed their protection with secular rulers as a condition of settlement. However, as we argue the contracts typically proved unenforceable in the face of large negative shocks (such as those associated with bad harvests or the Black Death) (see Baron, 1965*a*, 1967*a*). Nor was there any location where Jews could go where they would be free from persecution; persecutions were less common in the Islamic Middle East but they still did take place on occasion (see Cohen, 1994). A final factor which cannot be discounted was Jewish religious tradition which encouraged Jews to see the period of exile following the destruction of the Second Temple as a period of necessary and inevitable suffering.

There were also sound economic reasons for this behavior. Jewish commercial networks required Jewish communities to be spread across a wide geographical area. This enabled them to diversify across space and smooth idiosyncratic shocks (see Botticini, 1997). Moreover, the prohibition of lending at interest meant that the demand for Jewish moneylending services was highest precisely in areas which did not have a Jewish community. This was an important factor in encouraging Jewish communities to spread across western and central Europe.

Conversion

In medieval and early modern Europe Jewish identity was both a religious and an ethnic identity. In our analysis we assume that Jewish identity is fixed. In reality of course, Jewish religious, if not ethnic, identity was a choice variable that could respond endogenously to political and economic incentives. In this section we show that treating Jewish identity and fixed in short-term is appropriate.

Jewish religious identity evolved in the long-run in response to economic and political incentives. After Judaism became a literate religion there is strong evidence suggesting that it only flourished in regions with a commercial economy and some level of urbanization while it declined in predominantly agrarian economies (see Botticini and Eckstein, 2012).

However, there is little evidence that the adherents to Judaism varied in response to short-run political variables. This is unsurprising for several reasons. First, there is a large amount of evidence that suggests that persecuting members of a particular religion tends to strengthen their belief (Stark, 1996, Chapter 8).[48] Certainly, the threat of expulsion or persecution clearly limited the attraction of converting to Judaism in the medieval period.[49] But with a few notable exceptions it did not induce Jews to convert to Christianity in large numbers. Monter observes that Islam and Judaism have never 'yielded many voluntary converts to Christianity: the history of futile Christian programs to convert Jews cannot be treated adequately without superhuman erudition and Voltairean wit' (Monter, 1994, 6).

[48] This is what one would expected from the economics of religion literature, notably (Iannaccone, 1992).

[49] While the Church taught that Jews should be tolerated as 'witnesses,' Christians who converted to Judaism were typically treated as heretics and executed.

Second, converted Jews were often not accepted into mainstream Christian society and faced hostility from both Jewish and Christian communities. A large number of conversions occurred in Spain in the aftermath of the massacres that took place in 1391. These conversions did not end Christian hostility to Jewish converts. Converted Jews—known as conversos—faced persecutions in Toledo and León in 1449, while between 1459 to 1464 there was unrest against conversos in Burgos. In the 1460s they were attacked in Jaén. Persecutions occurred in Seville, Toledo and Burgos throughout the 1460s while in 1473 conversos were massacred in Cordoba, Montoro, Bujalance, Adamar, La Rabla, Santaella, Ecija, Andújar, Ubeda, Baeza, Almódovar del Caomp and Jaén (Ruiz, 2007, 156). As is well known, this persecution of the conversos intensified after the mass expulsion of Jews from the Iberian peninsula at the end of the fifteenth century.

Third, Jews were typically given the option to convert only after or in the aftermath of a persecution of expulsion. Malkiel (2001), for example, argues that Jewish chroniclers had an incentive to elevate the choice between apostasy and death in a heroic act. However, in instances like the massacres that accompanied the First Crusade in 1096, there is little evidence that this was the case. He suggests that the crusaders murdered Jews because that was their 'primary intention' and not because 'the Jews refused conversion' (Malkiel, 2001, 259). The possibility that Jews converted to Christianity in the wake of a persecution or expulsion does not affect our theoretical or empirical analysis.

Soil Quality

We use two measures of soil quality. Our preferred measure is wheat suitability. This is taken from the FAO.

The FAO database is constructed using two types of information. Detailed information on the characteristics of 154 crops is compiled to determine what sorts of geographic and climatic conditions are optimal for growing each plant. This information is combined with climatic and geographic data collected on a very disaggregated level. The climate data include measures of precipitation, frequency of wet days, mean temperature, daily temperature range, vapor pressure, cloud cover, sunshine, ground-frost frequency, and wind speed. The geographic data include information on soil types and slope characteristics. The FAO combines these data to construct potential yields for each crop in each grid cell under different levels of inputs and management. We assume a 'moderate' level of inputs to wheat cultivation. This is consistent with farmers who produce primarily for home consumption, but with some market orientation. Figure 9 shows the resulting suitability of wheat cultivation across Europe. We extract the wheat suitability for each of our cities using geospatial software and then follow a similar strategy as Nunn and Qian (2011) in creating a dummy variable equal to one if a city has an agricultural sector that is either moderately or significantly constrained in its wheat cultivation. This is the main variable 'Poor Wheat Suitability' that we use in our regressions.

The second measure of soil quality we use is agricultural suitability created by Ramankutty et al. (2002). It measures present-day suitability of land for cultivation of *any* crop at a spatial resolution of 1.5 x 1.5 degrees. Figure 10 shows the distribution with darker areas representing regions with more suitable ecologies for agricultural production. We create a variable based on these data called *Badsuit* so it takes a value of 1 for cities in the lower three-quarters of the sample for soil suitability. This gives us a treatment group comparable in size to when we use *LowSuitability*. Results from these regressions are in Appendix B.

Urban Density

Our urban density variable is based on the Bosker et al. (2013). Figure 11 shows the location of the eighteenth century Bosker et. al. cities relative to all of our Jewish cities. The Bosker et al. cities are shown as open circles whereas the Jewish cities are points. The weakest coverage of Bosker et al. cities is in Eastern Europe, particularly, Lithuania and Ukraine.

We use geospatial software to create a heat map every century based on population of all Bosker et al. cities with populations greater than 5,000. Each point on the map is assigned a population number based on the inverse distance-weighted value of all Bosker et al. cities within 1 degree of the point (about 100 kilometers depending on the latitude of the point). The maps for each century are reproduced below as Figures 12d to 12f.

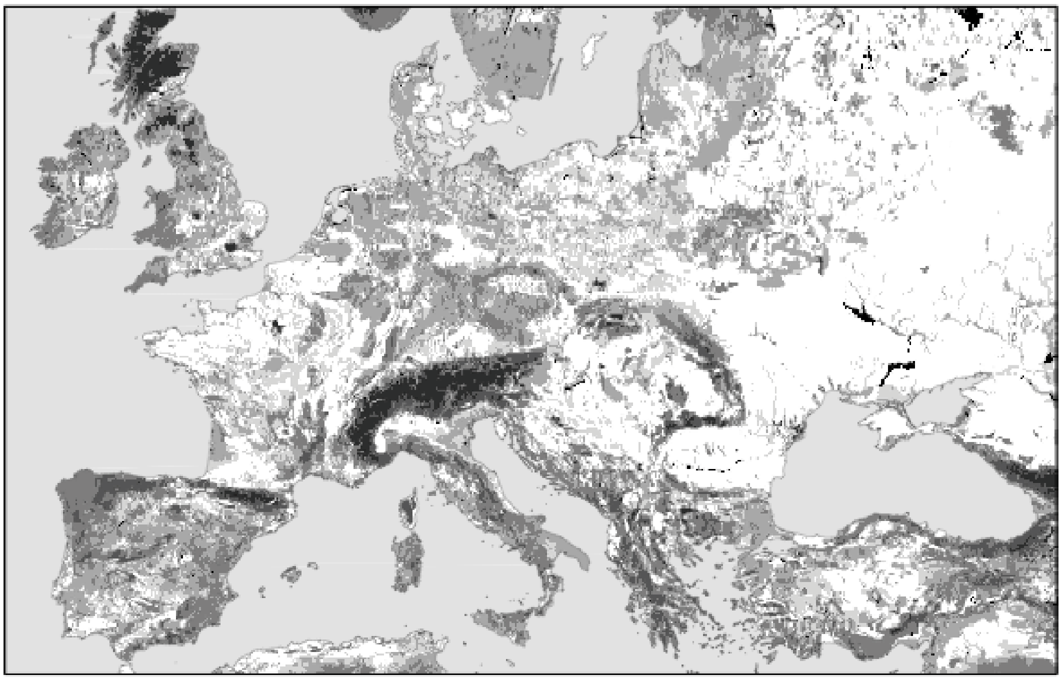


Figure 9: Wheat suitability. A lighter shade indicates that the soil is more suitable for wheat cultivation. Source: Fischer et al. (2002).

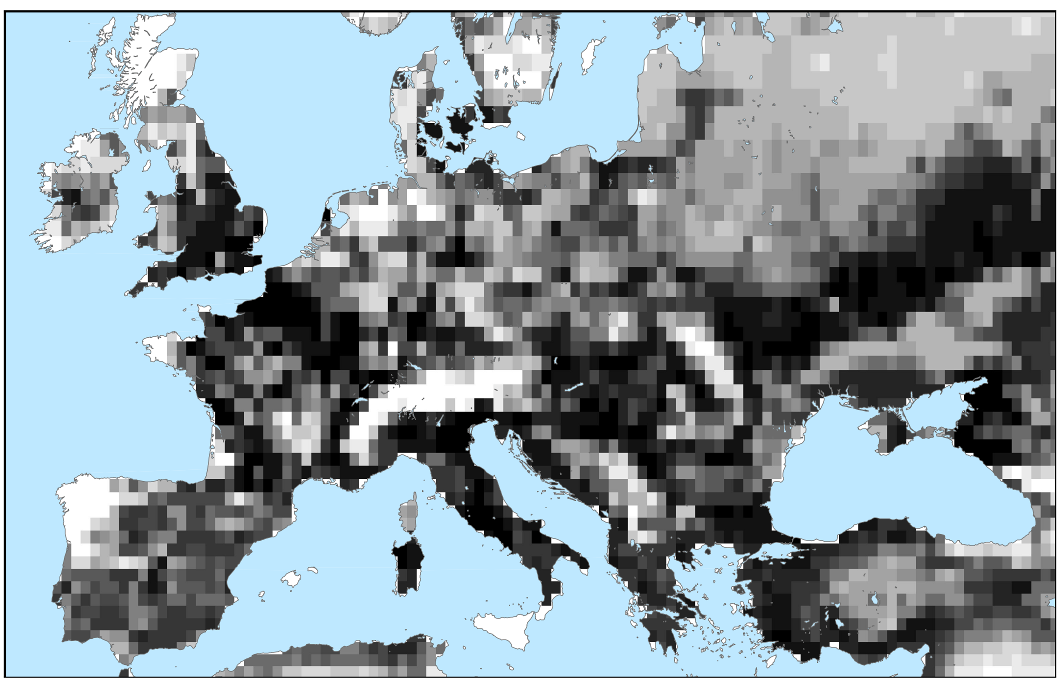


Figure 10: Agricultural Suitability. A darker shade indicates that the soil is more suitable for wheat cultivation. Source: Ramankutty et al. (2002).

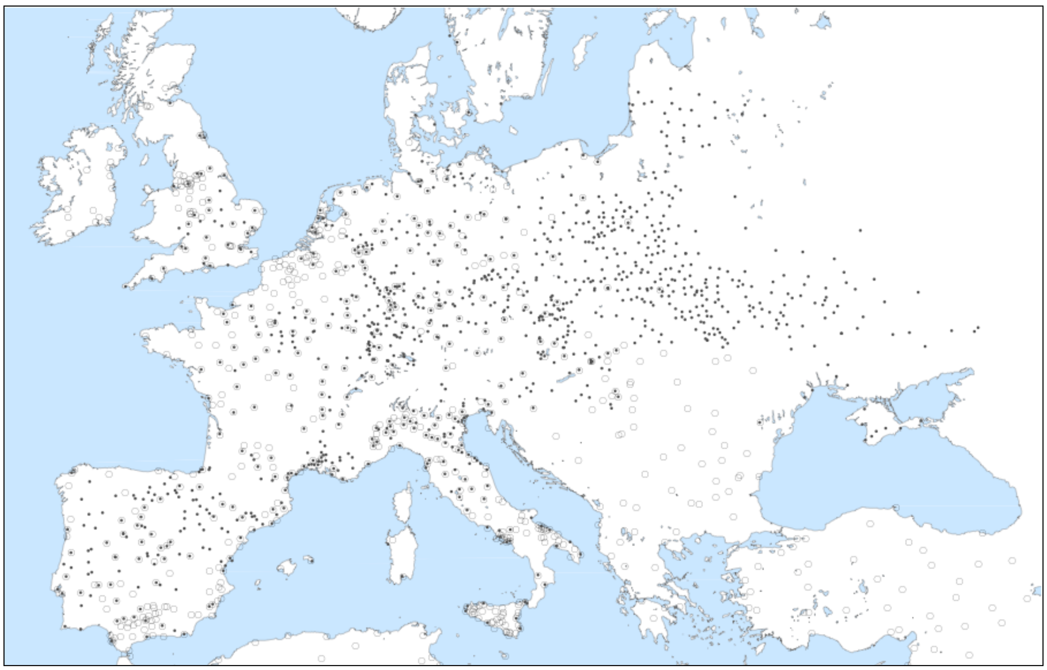
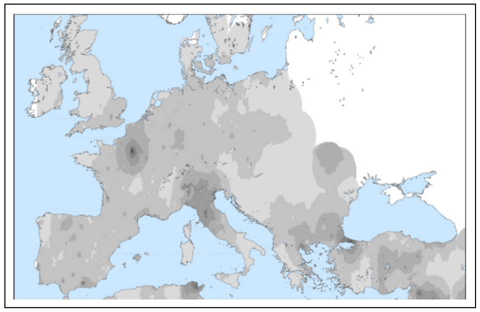
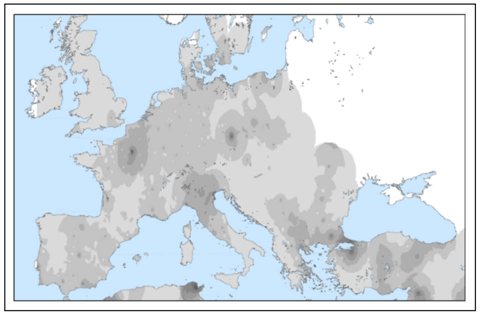


Figure 11: The Distribution of Bosker et al. (2012) cities and Jewish cities. Open circles represent Bosker et al. cities. Points represent Jewish cities in our database. Source: *Encyclopedia Judaica* (2007) and Bosker et al. (2013).

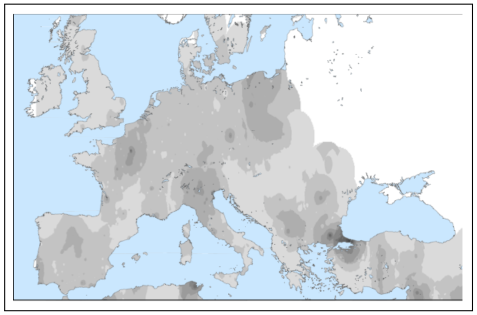
(a) 13th Century Urban Density.



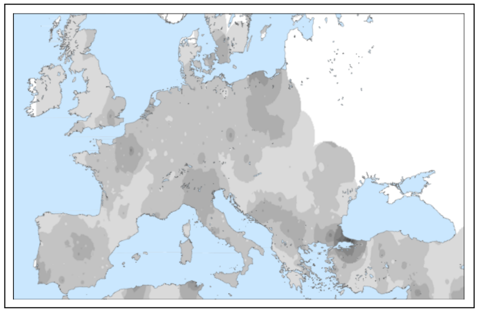
(b) 14th Century Urban Density.



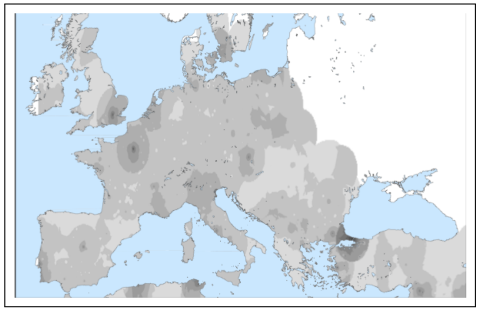
(c) 15th Century Urban Density.



(d) 16th Century Urban Density.



(e) 17th Century Urban Density.



(f) 18th Century Urban Density.

Figure 12: Urban Density and Market Access: 1200-1800.

Temperature Data

We use the temperature data of Guiot and Corona (2010) as our main variable of interest. The process for creating the city-level temperatures was as follows: First, we created a thirty-two point grid of temperatures on the map of Europe for every year between 1100 and 1799. An example of this grid for 1100 is reproduced in Figure 13 as the dark red circles. We then used geospatial software to fill in the temperature at all the points on the map using the inverse distance-weighted average of the temperature of the surrounding twenty-four grid points. Figure 13 shows the resulting heat map of temperature deviations for 1100. Finally, we extracted the temperature for each of our 1,069 cities for each of the 700 years in our data set.

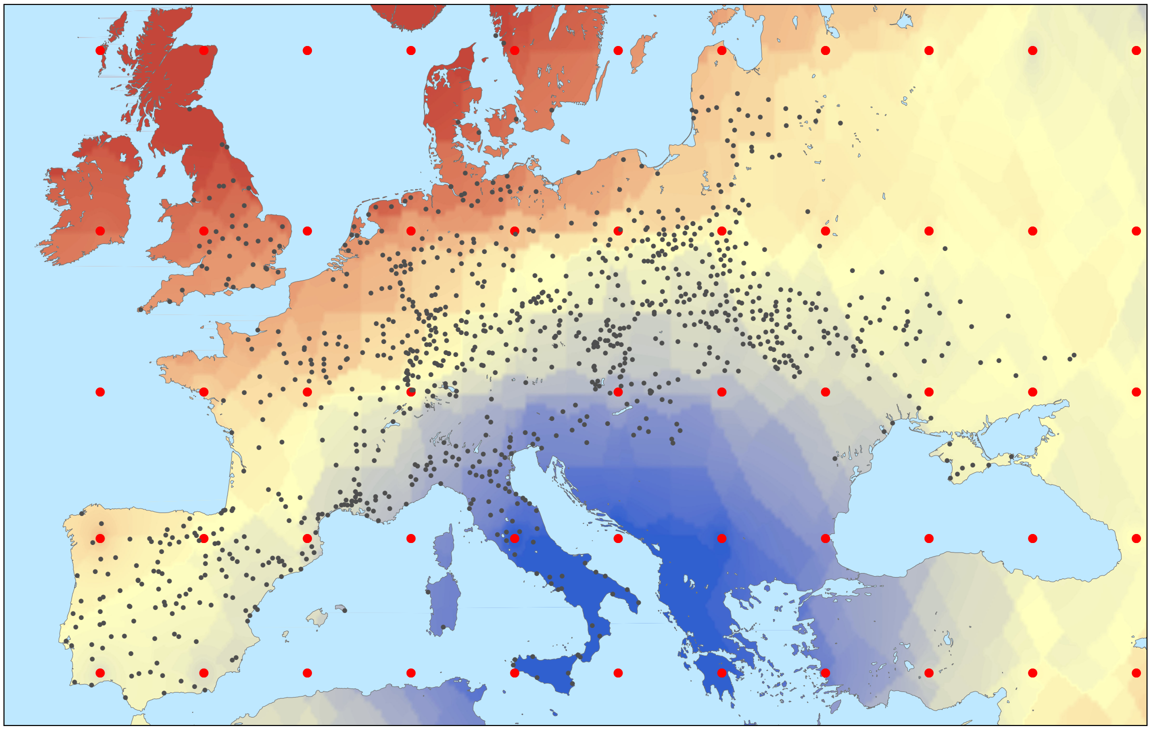


Figure 13: The Distribution of Jewish cities cities overlaid with the Guiot and Corona (2010) temperature grid and the corresponding heat map of average temperature during the growing season in 1100

Temperature is an important determinant of agricultural production. According to Porter and Gawith (1998) wheat has a lethal low temperature of $-17.2 \pm 1.2°C$, and a lethal high temperature of $47.5°C$. They note that the optimal temperature for wheat cultivation over the course of the growing season is between $17 - 23°C$ (Porter and Gawith, 1998, 25).

Of course, temperature is only one component of climate. Unfortunately, data on precipitation for the medieval and early modern period does not exist. This is a potential source of measurement error that biases downwards our coefficients on weather shocks. For example, periods of intense drought followed by intense rains such as occurred in the 1090s were associated with both subsistence crises and the massacres of Jews in Flanders, France, and Germany (Slavin, 2010, 177-178). If included in our dataset such episodes would appear as periods of warm weather and hence benign climatic condition. Thus measurement error strengthens our confidence that our regressions are picking up the effect of weather shocks on persecutions.

Agricultural Production and Prices

Our wheat prices series come from Allen and Unger (n.d.). This dataset contains grain prices series for 193 cities from the entire world. We use wheat prices from the 98 European cities. Figure 14 shows the location of these cities, though not all cities are in the panel for the entire period. The average price of wheat across all in-sample cities between 1100 and 1800 is shown in Figure 15. It clearly shows the effect of the Black Death in second half of the fourteenth century as well as the effect of silver imports from the New World during the sixteenth century.

Figure 14: Grain Price Cities. Source: Allen and Unger (n.d.).

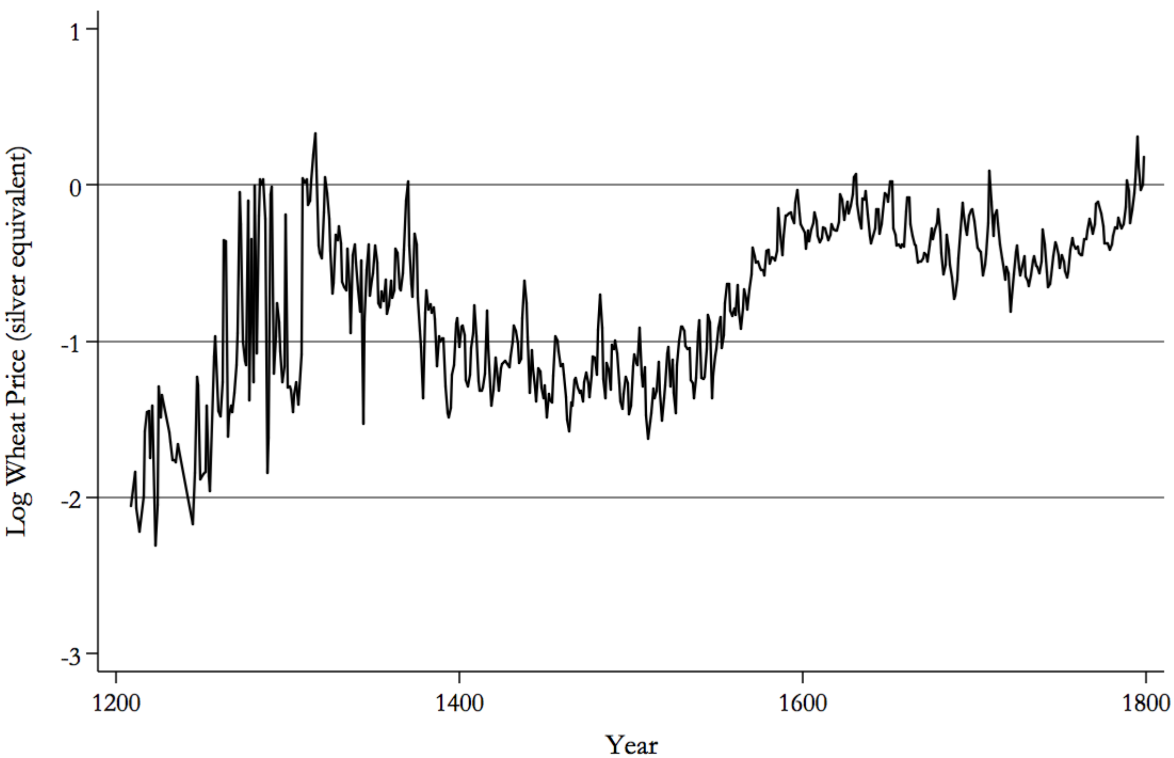


Figure 15: Grain Price Time Series. Source: Allen and Unger (n.d.).

D Additional Historical Evidence and Discussion

In the main text we provide an example of a negative weather shock leading to harvest failures and popular unrest and ultimately to violence against Jewish communities. Here we can provide more detail on several other examples that illustrate the causal mechanisms we identify in our model and in our empirical analysis.

The Black Death

A large number expulsions and persecutions accompanied the Black Death (1348-1350) (Cohn, 2007; Voigtländer and Voth, 2012). The fact that the Black Death triggered antisemitic violence is entirely consistent with our hypothesis and theoretical model.

The 1340s were in fact a period of warm summers. However, the years 1348-1350 saw 'three very rainy summer seasons. As a result, hunger was rife in Europe, and poverty spread extensively throughout the society. The frightful scenes of the "Black Death" were preceded by the phenomenon of drought and the distress of famine. There were places, in Breslau in Germany, for example where Jews were killed not by the plague, which had not yet reached there, but as a result of starvation, for hungry people in their distress turned upon the Jews' (Breuer, 1988, 140).

Jews were blamed for the plague across Germany. Both the Pope and the Holy Roman Emperor spoke against against this libel and the Emperor tried to protect Jews where and when he was able—less out of sentiment, but because he viewed them as an economic asset. Charles IV protected Jews in Prague and in other areas where his authority was strong, but elsewhere he was prepared to let his subjects burn Jews.

> 'When the plague was at its height and the bands of flagellants were sweeping across the country, he sold or transferred the holdings of the Jews, if and when they should be killed, to the cities and nobles who saw fit to support him. In exchange for all of these payments, the Jews could expect one thing: that the king, the nobles, and the city councils who had benefited from their monies would protect them. Undoubtedly, they were legally and morally obligated to do so and there is no reason to doubt that they would indeed have preferred to protect the lives of their Jews in order to continue to benefit from their money. However, under the circumstances we have described it appeared that they would not be successful, they decided to turn the destruction of the Jews to their best advantage' (Breuer, 1988, 146-147).[50]

The worst massacre was in Strasbourg where 2000 Jews were burned to death. In Brandenburg, where Louis I was faced with a rebellion, initial attempts to protect Jews from accusations of well-poisoning 'broke down under the frenzy of the populace, whose good will the embattled margrave could not afford to lose' and in 1351 Louis allowed Jews to be burnt in Königsberg (Baron, 1965*a*, 211). The massacres and expropriations more or less wiped out the Jewish communities in the Electorate.

The Armleder Massacres

One example comprises the series of persecutions that occurred in Alsace and Franconia between 1336 and 1339 and that are known to historians as the Armleder persecutions. They began when Arnold von Uissigheim, a knight turned highway robber, instigated an 'economically motivated social uprising' that turned against the Jews (Levenson, 2012, 188). He led a group of peasants with leather patches affixed to their arms and he became known as Rex Armleder. Uissigheim was arrested and executed by Count Gottfried of Hohenlohe. But other individuals took up the cause and the massacres continued across Bavaria and Alsace until 1338, destroying more than 100 Jewish communities (Rubin, 2004, 55-57).

Historians propose various explanations for the massacres. One contemporary explained that Uissigheim's brother had been killed by Jews. Others attributed it to resentment against usury. In some areas, antisemitism had been stirred up by prior allegations of host desecration. However, these events are also highly consistent with our theoretical framework.

[50] Charles IV subsequently forgave the perpetrators of the massacres, noting 'that the populace had been "animated by vulgar prejudice, bad advice, and reprobate feelings" when it attacked Jews and thus caused much damage to the royal Treasury, he nevertheless accepted the regrets and satisfaction offered him by the city elders' (Baron, 1965*a*, 158-159).

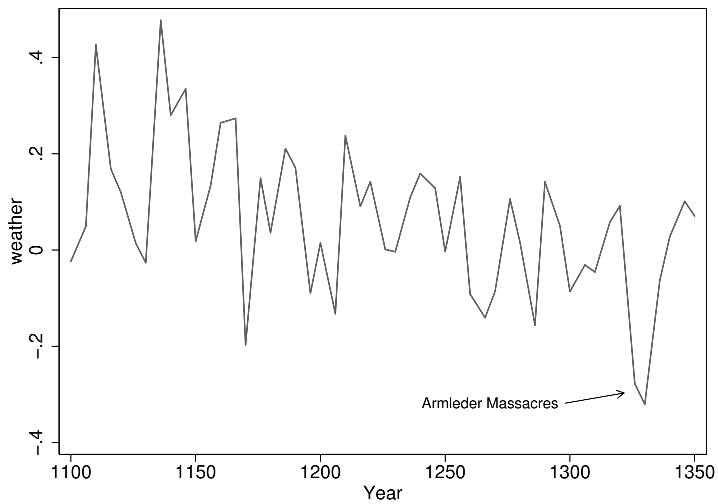


Figure 16: Temperature Deviations (Five-Year Averages) in Kitzingen 1100–1350. The Armleder pogroms (1336-1338) followed a period of extremely cold weather in Alsace and Franconia.

As Figure 16 illustrates, the Armleder massacres occurred during a period particularly cold weather. The town of Kitzingen saw its Jewish community massacred during this episode and is in our dataset. The average weather deviation in Kitzingen from 1100 to 1339 was 0.059 with a standard deviation of 0.16. The two coldest five year periods were between 1325 to 1335, which were two standard deviations below the mean. While weather from 1335 to 1339 improved, it was still three quarters of a standard deviation below average. In terms of the model, this represents a large negative realization of ω_{it}.

Political scientists have argued that a band of weak political authority created by the dismemberment of the Carolingian empire at the Treaty of Verdun in 843 shaped European history throughout the medieval and early modern period. In particular Stasavage (2011) argues that the lands known as Lotharingia which lie between the historical boundaries of France and Germany were areas of weak state authority and fragmentation. The Armleder massacres thus occurred in a region where γ_t was low.

The Haidamack Massacres

While persecutions and expulsions of Jews became less and less common in western Europe after 1600, they continued to take place in Eastern Europe where the Polish state remained weak (i.e. low γ_t). The Haidamack Massacres refers to a series of pogroms that occurred throughout the eighteenth century in Poland and Ukraine.

Figure 17 shows the temperature deviations for Zbarazh from 1100 to 1800. The figure depicts that a period of extremely cold weather occurred at the turn of the eighteenth century. The first massacres occurred in Belaya Tserkov and Satanov in 1703, and in Zbarazh and Izyaslav in 1708. The worst killings occurred in 1734, 1750, and 1768. Hence the timing and location of the Haidamack massacres is highly consistent with our theory and overall argument.

National Expulsions

There are five ‘national’ expulsions in our database:

1. England 1290
2. France 1306; 1394
3. Spain 1492
4. Portugal 1497

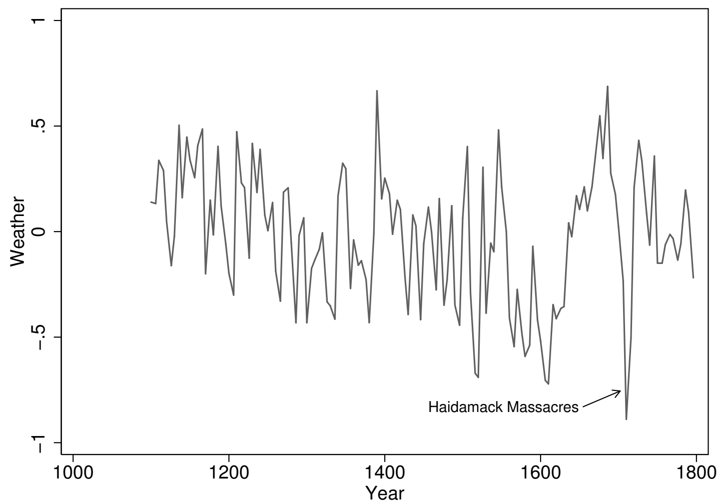


Figure 17: Temperature Deviations (Five-Year Averages) in Zbarazh, Ukraine 1100–1350. The Haidamack Massacres began in the early eighteenth century during a period of cold weather.

These national expulsions are consistent with the model developed in Section 3. Rulers conducted national level expulsions for a range of reasons including the need for immediate revenue.

The French king Philip IV (1285-1314) decided on a policy of expulsion as an expeditious way of getting his hands on as much Jewish wealth and property as possible.[51] He realized that

> '[i]t would take too many administrators and petty officials to organize the arrest of French Jews and confiscate all of their property, and most importantly, their loan records. At any point in the process, problems could arise which would translate to less revenue for the king. Local officials could quietly confiscate Jewish moveable property themselves, selling it off for their own profit. Or they might agree to accept bribes in return for allowing Jews to leave with at least some of their goods. Jews in close relationship with nobles, and government officials, might possibly hear of the plan and arrange to leave before it was carried out, or hide their valuables. Finally, the townspeople could discover that the Jews were being expelled and preempt the confiscation, taking for themselves Jewish property and the records that revealed their own indebtedness' (Taitz, 1994, 220-221).

In so doing he sacrificed a long-run revenue stream and therefore made the French crown permanently poorer (Jordan, 1989).[52]

[51]According to one historian: 'During the period 1301-1306, the king imposed similar taxes on the Jews of Normandy as elsewhere in France. The war against the Flemish was renewed in 1302 and resulted in the imposition of new taxes on the entire population . . . The seizure of Jewish goods, the detention of the Jews, and their expulsion from France in the summer of 1306 are events manifestly connected with this situation. On June 21, just two weeks after the statement on sound money, the king sent letters to his officials all over France secretly directly "the accomplishment of the mission the king charged them with *viva voce*". The following month was marked by detention and seizure. A contemporary chronicler writes that the confiscators left the Jews only the clothes they were wearing, that their apparel and furniture were sold for very little, and that cartloads of silver and gold from their houses were brought to the king day and night. On August 17, the king ordered that treasure found in Jewish houses belonged to him, threatening the usual penalties for those who ignored the order' (Golb, 1998, 536-537).

[52]Mechoulann (2004) demonstrates that at a discount factor equal to the prevailing 12% interest rate this decision may well have been the correct one for Philip IV given the political and fiscal situation he faced. Subsequent expulsions followed this pattern and involved some form of expropriation with minor variations. In 1492 the Jews of Spain were allowed to take their private possessions with them but forbidden from taking gold, silver, or minted coins while their communal property was distributed to local town councils (Beinart, 2002, 55-56).

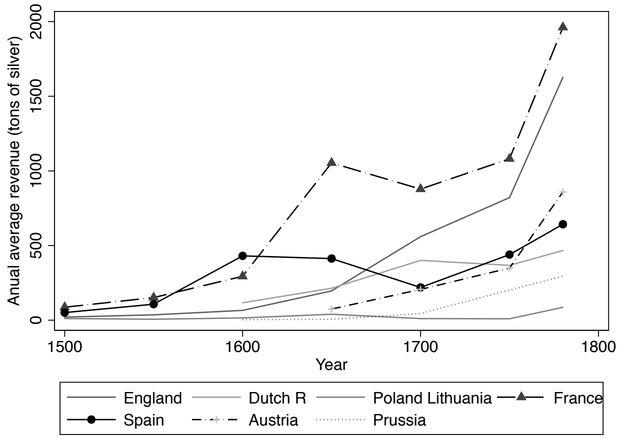


Figure 18: Karaman and Pamuk (2013) based on data from the European State Finance Database

State Capacity

Figure 18 depicts tax revenues per capita from Karaman and Pamuk (2013). It shows the dramatic rise in fiscal capacity that took place in the leading western European states from around 1600 onwards.

E Mathematical Appendix

To derive equation 7, we write out the ruler's objective function in full as follows:

$$U_t(\phi_t) = (1-\phi_t)\bar{T} + \phi_t\Phi_t + T^A - p_t(\phi_{t-1})\Lambda + \delta U_{t+1}(\phi_t) \ ,$$

where $U_{t+1}(\phi)$ is a continuation payoff that can take one of two values: $U_{t+1}(\phi^0)$ if the ruler chooses to protect the minority community in the previous period and $U_{t+1}(\phi^1)$ if the minority community has been expelled. The continuation payoff in period $t+1$ for the ruler if he does not expropriate the minority community: $U_{t+1}(\phi^0_t)$ is the same as the payoff he obtained in period t:

$$U_{t+1}(\phi^0_t) = T^A_{t+1} + (1-\phi_{t+1})\bar{T} + \phi_{t+1}\Phi - p_{t+1}(\phi^0_t)\Lambda + \delta U_{t+2}(\phi_{t+1}) \ .$$

The continuation payoff for the ruler in period $t+1$ if he does expropriate the minority community is:

$$U_{t+1}(\phi^1_t) = T^A_{it} - p_{t+1}(\phi^1_t)\Lambda + \delta U_{t+2}(\phi^1) \ .$$

Since the rebellion constraint does not bind, the ruler's maximization problem generates the following first order conditions:

$$-\bar{T} + \Phi + \delta U'_{t+1} = 0 \ , \tag{6}$$

where

$$\begin{aligned} U'_{t+1} = & - T^A_{t+1} - (1-\phi_{t+1})\bar{T} - \phi_{t+1}\Phi - \delta U_{t+2}(\phi_{t+1}) \\ & + (p_{t+1}(\phi^0) - p_t(\phi^1))\Lambda \\ & + T^A_{t+1} + \delta U_{t+2}(\phi^0_{t+1}) \end{aligned}$$

Rearranging, a ruler protects the minority if the following condition holds:

$$\delta\big(U_{t+1}(\phi^0) - U_{t+1}(\phi^1)\big) + \delta\big(p_{t+1}(\phi^1_t) - p_{t+1}(\phi^0_t))\Lambda\big) \geq \Phi - \bar{T} \ . \tag{7}$$

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