ELITES, WEATHER SHOCKS, AND WITCHCRAFT TRIALS IN SCOTLAND

CORNELIUS CHRISTIAN†

Abstract. I find that favourable temperatures predict more witchcraft trials in Early Modern Scotland (1563-1727), a largely agricultural economy. During this time, witchcraft was a secular crime, and it was incumbent on local elites to commit resources to trying witches. My main empirical specification is robust to different specifications, county-specific trends, and a placebo test using forward values of temperature. Turning to mechanisms, I find that positive price shocks to export-heavy, taxable goods like herring and wool predict more witch trials, while price shocks to Scotland's main subsistence commodity, oats, do not. This is consistent with the explanation that as elite income increased, more resources were devoted to witchcraft prosecutions.

†St. Francis Xavier University

E-mail address: `ccchristi@stfx.ca`.

Date: November 2015.

I am grateful to Robin Briggs, James Fenske, Julian Goodare, Christopher Roth, Stefan Saftescu, Raul Sanchez de la Sierra, James Wisson, and participants at Oxford's Gorman Workshop for help and suggestions. Any errors are my own.

Fair is foul, and foul is fair.

- William Shakespeare, Macbeth

1. Introduction

Persecution has deletrious consequences. Acemoglu et al. (2011) provide evidence that the Holocaust in Russia resulted in long-term harmful economic and political outcomes, while Voigtlander and Voth (2012) show that persecution is persistent, affecting persecuted minorities long after initial oppressions. This is especially significant in developing countries, where violence can impede economic growth (Blattman and Miguel, 2010; Abadie and Gardeazabal, 2003) and limit state capacity (Besley and Persson, 2010).

Understanding what causes persecution is therefore important. In particular, persecution often requires resources and organisation. Examining the Rwandan Genocide, Yanagizawa-Drott (2014) finds that access to Hutu-financed radio propaganda explains more killings, while Rogall (2014) discovers that military elites incited Hutu civilians to massacre Tutsis. Heldring (2013) in turn finds that greater state capacity in Rwanda facilitated more genocide atrocities in 1994. Planning and resources are crucial to carrying out persecutions.[1]

In this paper, I use data from Early Modern Scotland to examine a particular type of persecution: witch hunts, which were motivated by a genuine belief that witches are evil. Scottish law, which made witchcraft a secular crime in 1563, de facto required local elites to commit resources to trying witches. When these resources were more ample, witchcraft prosecutions increased. Consistent with this, and given that Scotland was an agricultural economy, I find that favourable (warmer) temperatures predict more trials. This is robust to county-specific time trends, different specifications, and placebo tests using forward lags.

Turning to mechanisms, I document secondary historical evidence that Scottish elites derived income from export-heavy, taxable commodities such as herring and wool. Using this as a guide, I find that positive price shocks to herring and wool predict more trials. As a falsification, I find that shocks to Scotland's main subsistence commodity, oats, do not

[1]The recently concluded Sri Lankan Civil War, planned and executed by Sinhalese leaders, led to the systematic murders of thousands of Tamil civilians (Weiss, 2012).

predict trials, since this crop was not a major source of elite income. I provide historical evidence that these patterns were not due to greed, since witchcraft suspects had little valuable property, and trials were costly.

I ground these observations in a simple model of witchcraft trials, where a local laird (Scottish lord) must decide whether or not to pursue a prosecution. The laird receives an income shock, and must then weigh the choices of funding witch trials, or non-trial activities. The laird gains benefit from both, but trials cost money. I find in my model that more income means more trials. This effect is amplified by a greater marginal benefit of trials, and is attenuated by a higher marginal cost - results that I indirectly test for my empirical section.

My paper proceeds as follows. In Section 2, I review related literature, and demonstrate my study's contribution. In Section 3, I provide historical background. I derive a model with testable implications in Section 4. In Section 5, I describe my empirical strategy and data in order to identify the causal impact of shocks on witch trials. Section 6 provides my results, along with robustness checks and mechanisms. In Section 7, I conclude.

2. Related Literature

My study investigates the idea that economic shocks cause violence, and thus follows an important literature in this vein (Hsiang et al., 2013; Collier and Hoeffler, 2004; Miguel et al., 2004). In particular, Bazzi and Blattman (2014) have stressed the need for case study evidence in order to disentangle underlying mechanisms. By examining witchcraft trials in Early Modern Scotland, I focus on a single case study, and am therefore able to uncover mechanisms that drive the link between temperature shocks and witch trials, while limiting confounding factors. This is an important contribution, since economic channels that drive conflict and violence are still ill understood, though recent research has made progress in this direction (Dell, forthcoming; Fetzer, 2014; Dube and Vargas, 2013).

The debate over these channels is long-lasting. Dube and Vargas (2013) use data on Colombian conflict in the 1990s and early 2000s to identify two widely-discussed mechanisms:

the opportunity cost effect, and the rapacity effect. The former effect states that when the *value* of being violent rises, relative to other activities, then violence itself increases (Besley and Persson, 2011; Dal Bo and Dal Bo, 2011; Angrist and Kugler, 2008). For example, if agricultural wages decline, then farm workers are more likely to join guerrilla squads. The rapacity effect, and its analogue the state prize effect, claims an opposite impact: higher income means that there is more to fight over (Hirshleifer, 1991; Grossman, 1999). If, say, oil prices rise, then paramilitaries are more likely to attack oil fields and kidnap oil executives. Although I find that positive environmental shocks predict more witch trials, this is not due to a rapacity effect. Rather, it is due to the ability of local elites to finance a trial.

The papers closest to mine in subject matter are Oster (2004), Miguel (2005), and Johnson and Koyoma (2014). Oster uses time series data to document a negative relationship between air temperatures and witch trials in Early Modern Europe, and argues that poor economic conditions prompt such trials. Unlike Oster, I focus on a single case study, Scotland, which had more centralised institutions than the rest of Europe for prosecuting witches. I uncover a completely different result: positive economic shocks predict *more* witchcraft trials. I also provide empirical evidence for an explicit mechanism driving this result.

Miguel's (2005) study of Tanzania suggests a similar story as Oster's: when rainfall is low, people kill unproductive members of society by blaming them for witchcraft. Tanzania, however, does not have the legal institutions that Scotland had for dealing with witchcraft accusations. Witch killings in Tanzania are much more decentralised, and are often carried out by family or community members without judicial restraint. In Scotland, sizable costs were incurred to ensure that legal procedure was carried out before a witch was executed.

Johnson and Koyama (2014) investigate witchcraft trials in France between 1550 and 1700, and argue that increases in fiscal capacity strengthened rule of law, reducing the number of witchcraft trials. Scottish trials were different from France's in this regard, since Scottish trials were more centralised, and followed rather strict judicial guidelines. At any rate, I am interested in an entirely different question: whether economic shocks caused witchcraft trials.

Because most Scottish witch suspects were women, I make a small contribution to the literature on violence against women.[2] Estimates find that intimate partner violence, and sexual violence against women, cost as much as $4.49 trillion per year, or 5.3% of world GDP (Fearon and Hoeffler, 2014). Causes of domestic violence, in particular, have been well-studied and include women's household bargaining power (Doss, 2013; Bloch and Rao, 2002) and emotional cues that prompt male spouses to act aggressively (Card and Dahl, 2011). In Early Modern Europe, women were viewed as inferior and corruptible beings, more naturally prone to witchcraft than men, which caused them to be hunted as witches (Rowlands, 2013). I find that weather shocks can precipitate these acts of violence.

I contribute to the literature on historical witchcraft trials by using a panel dataset to study the impact of temperature on Scottish trials. Historians have postulated a number of factors that contributed to witch trials, including changing religious values (Levack, 2006), state expansion (Larner, 1981), and patriarchy (Apps and Gow, 2003). I offer another explanation: the costs of financing a trial must be sufficient.

Finally, a growing literature in economics has examined persecutions (Jha, 2013; Voigtlander and Voth, 2012; Waldinger, 2010) . In addition to the Rwandan studies I mention in the introduction, a paper by Anderson et al. (2013) finds that bad weather shocks predict more Jewish expulsions from European cities between 1100 and 1800. The authors claim that these expulsions are driven by political economy concerns, as local rulers scapegoat Jews for economic woes. My story is also a political economy one, driven by the ability of local elites to finance a trial.

3. Historical Background

The Protestant Reformation consolidated itself in Scotland in 1560, when Edinburgh's Parliament formally rejected papal authority. Prior to the Reformation, witches were, at worst, seen as beings to be appeased, not persecuted. The Reformation changed this with its insistence on deliberate eradication of evil, thus making witchcraft a secular crime in 1563 with the Scottish Witchcraft Act (Cowan, 2008). The cultural reasons behind this are

[2]Roughly 85% of Scottish witch suspects were women.

beyond this study's scope, though other authors have covered this in detail (Goodare, 2013; Roper, 1994; Smout, 1973).

Historical evidence suggests that central authorities, especially the Privy Council in Edinburgh, were able to exert some influence over proceedings, so that no local trials occurred without first going through Edinburgh.[3] Local authorities were indeed content to have their trials sanctioned by central bureaucracy. According to a number of scholars, central control over witchcraft prosecutions was an important part of state building in Early Modern Scotland, a country that was otherwise difficult to govern (Dillinger, 2013; Larner, 1981).

There were five stages of witch hunts (Goodare, 2002):

(1) A witch is identified locally.
(2) Evidence is gathered through local kirks (churches) and elites.
(3) The Privy Council or parliament in Edinburgh reviews the evidence, and grants permission to local elites and witch hunters to set up a 'commission of judiciary' to try the accused.
(4) The commission tries the witch.
(5) The convicted witch is executed.

The bulk of expenses for the trial was incurred locally. The Privy Council was very interested in ensuring that proper judicial procedure was carried out, in order to prevent witch trials from descending into decentralised and unregulated killings.

The first stage, the identification of a witch, happened locally.[4] A triggering event, such as a death in the family, would incite Scottish people to accuse neighbours of witchcraft. It usually took years before a neighbour's accusation of witchcraft would result in a formal complaint, a pattern consistent with the rest of Europe (Briggs, 1998). Another way to identify a witch was for already accused witches to name their co-conspirators, although such evidence was given less weight.

[3]Treason was the only other crime to enjoy such a level of central oversight (Larner, 1981).
[4]An important exception, the 1590 North Berwick trials, started when King James accused witches of trying to sink his ship. However, even these trials relied on local identification of suspected witches.

In the second stage, a confession was sought, and this stage often involved torture. Sleep deprivation was commonly used, and was very effective in obtaining confessions, since it led to hallucinations (Dudley and Goodare, 2013). This stage might involve local kirk (church) officials, who otherwise had a very limited role in witchcraft prosecutions. Local officials and elites had to ensure that the evidence collected during this stage was suitable for Edinburgh's vetting.

The third stage involved acquiring Privy Council or parliament's permission to set up a commission of judiciary, composed of local elites (lairds, burgesses, justices, etc.) to try a witch. As Levack (2008) says,

> Most cases... were adjudicated by local authorities who petitioned the privy council or parliament for permission... These local commissioners then assembled an assize (jury) to determine innocence or guilt, which in most cases turned out to be the latter. (p. 4)

It was at this stage that the central government in Edinburgh got involved in local affairs. However, besides granting permission, the Privy Council and parliament usually did not intervene directly in local trials.

The trial itself, the fourth stage, relied on four types of evidence: confessions, neighbours' testimony, other witches' testimony, and The Devil's Mark. This last proof, either a visible blemish or insensitive spot on the body, was discovered by court examiners or professional witch-prickers. It was a sign of a witch having made a Satanic pact.[5]

To attain a more concrete analysis, I cite Paterson (2013), who uses case study evidence from Scottish witchcraft prosecutions to examine trial expenses. In 1596, when a day-labourer's wages were 40 pence per day (Gibson and Smout, 1994), it cost £20 to imprison a witch in Aberdeen.[6] This paid for the accused's sustenance, as well as the costs of extracting a confession. Elites paid the amount; as Paterson documents, the bill was laid upon a laird's estate, a burgh council composed of merchant elites, or a town council comprised of local elites and magistrates. Although a witch's property was sometimes seized to pay part of the

[5]The pact was sexual in nature, culminating in a witches' orgy.
[6]There were 240 pence in one Scottish pound.

trial costs, most witches had little valuable property, and the bulk of expenses were paid by local elites.

The last Scottish witchcraft trial was in 1727, and witchcraft was removed from secular criminal offenses in 1736. Historians investigating the decline and end of Scottish witch hunting have concluded that lawyers became less convinced about the validity of evidence in witchcraft cases: confessions under tortures were seen as questionable, and witch-pricking for the Devil's Mark was exposed as fraudulent (Wasser, 2008; Levack, 2008).

4. A Model of Witch Trials

I model witchcraft prosecutions as a game between Nature and a local laird. This stylised representation puts emphasis on local elites' role in carrying out witch prosecutions. Because Early Modern Scotland was largely agricultural, a laird's income is based on profits from export-heavy, taxable agriculture. Food that Scottish peasants grow for their own subsistence, like oats, has a negligible impact on elite income, and therefore on the elite's resources to carry out witch trials.

I assume that there is local demand for witch trials from the peasant population. This assumption is tenable, since case study evidence suggests that most witch accusations came from peasants and non-elites (Wasser, 2008; Larner, 1981). Accusations from nobles and elites were rare.

Nature moves first, determining y, the laird's income, at random. From this endowment, the laird can either spend y_w on witchcraft trials, giving him utility $u(y_w)$, or on non-trial consumption, c, to gain utility $v(c)$. For simplicity and exposition, I assume that this non-trial consumption is wholly spent on private goods. These functions have the following properties: $u', v' > 0$, while $v'', u'' \leq 0$. I justify this assumption based on the historical observation that even elites, like lairds, feared witches in their midsts, and therefore spending on trials was important to ease their minds (Cowan, 2008; Wasser, 2008).

Witch trials cost Ry_w. This includes the cost of travelling to Edinburgh to seek Privy Council or parliamentary permission to try a witch. The laird also has to spend his own resources gathering evidence and prosecuting the witchcraft suspect. The cost of private goods is pc.

The laird's overall optimisation problem, then, is:

$$u(y_w) + v(c)$$

$$s.t.$$

$$pc + \ Ry_w = y$$

To make this into an unconstrained optimisation problem is straightforward:

$$u(y_w) + v(\frac{y}{p} - \frac{R}{p}y_w)$$

The optimal spending on trials, y_w^*, is given by the First Order Condition:

$$\phi = \frac{\partial u}{\partial y_w^*} - \frac{\partial v}{\partial c}\frac{R}{p} = 0$$

Because R and p are constants, the above expression means that in equilibrium, the marginal utility and marginal disutility of witch trials must be equal, taking R and p into account. This result is rather standard. Similarly, the marginal rate of substitution between trials and non-trial consumptions is given by ratio between R and p.

The Second Order Condition is simply given as $\frac{\partial^2 u}{\partial y_w^2} + \frac{\partial^2 v}{\partial c^2}[\frac{R}{p}]^2$. Because $\frac{\partial^2 u}{\partial y_w^2} < 0$, and $\frac{\partial^2 v}{\partial c^2} < 0$, by assumption, this entire expression is negative, meaning that the solution is a maximum.

On a related note, spending on trials will increase if the marginal utility of trials, $u'(y_w^*)$, increases. To see this, note that if u' goes up, then v' must fall, which only happens if y_w rises. The marginal benefit of trials can increase if, for example, a national political crisis threatens the laird, making it more beneficial for him to invest in witch trials to quell discord.

Furthermore, as y increases, so does y_w^*. To show this, I differentiate the First Order Condition with respect to y to yield the following expression:

$$\frac{\partial^2 u}{\partial y_w^{*2}} \frac{\partial y_w^*}{\partial y} - \frac{\partial^2 v}{\partial c^2} \frac{R}{p^2} = 0$$

Rearranging the above expression,

$$\frac{\partial y_w^*}{\partial y} = \frac{\frac{\partial^2 v}{\partial c} \frac{R}{p^2}}{\frac{\partial^2 u}{\partial y_w^{*2}}} > 0$$

The fact that this is positive follows from $\frac{\partial^2 u}{\partial y_w^2} < 0$, and $\frac{\partial^2 v}{\partial c^2} < 0$, by assumption.

Thus, as the laird earns more income, he can afford to spend more on witch prosecutions. This is amplified by u', the marginal benefit of trials, and attenuated by R, the marginal cost of trials. I test this crucial prediction in my paper.

Using similar reasoning as above, I can show that:

$$\frac{\partial y_w^*}{\partial R} = \frac{\frac{\partial v}{\partial c} \frac{1}{p} - \frac{\partial^2 v}{\partial c} \frac{R y_w}{p^2}}{\frac{\partial^2 u}{\partial y_w^{*2}}} < 0$$

In other words, as R, the marginal cost of trials increases, then trials themselves will decrease.

I summarise these findings in the following proposition.

Proposition 1. *Witchcraft trials respond positively to economic shocks. The higher a laird's income, y, the more he can afford to spend on trials, y_w.*

These results are intuitive, and I shall test for evidence consistent with them in the rest of the paper.

5. Data and Empirical Strategy

5.1. **Empirical Strategy.** To test for the effects of temperature on witchcraft trials, I estimate the following specification:

$$Witch\ Trial_{i,t} = \beta Shock_{i,t} + \delta_i + \eta_t + \epsilon_{i,t}. \tag{1}$$

Here, $Witch\ Trial_{i,t}$ is either a dummy for whether or not a trial occurred, or a count for the number of witchcraft trials in county i in year t.

$Shock_{i,t}$ is simply a temperature shock, which is either a three-year, five-year, or ten-year moving average for temperature. The reason I use moving averages is because historians have documented that it took a long buildup for witchcraft suspicions to become full-blown accusations - sometimes as long as twenty years (Larner, 1981). To examine mechanisms related to agricultural commodities, I use $Suitability_i \times Price_t$ for the shock, where $Suitability$ is county i's suitability for the particular commodity, while $Price_t$ is its price on world markets in year t.

δ_i and η_t are county and year fixed effects, respectively. I use these to control for omitted heterogeneity at the level of counties and time periods. I also report county-specific trends for robustness. The equation is estimated using OLS, and I cluster standard errors by county.

My identification strategy is based on the fact that temperature and world commodity prices are exogenous from a single county's point of view. A negative coefficient on β implies that the shock negatively predicts unrest, while a positive coefficient β means that the shock positively predicts unrest. In northern Europe, unlike tropical zones such as Africa, higher temperature are better for agriculture.

5.2. **Data.** I acquire witchcraft trial data from the Survey of Scottish Witchcraft, which is available through the University of Edinburgh. The database was derived from previously existing printed data, and was enhanced through extensive archival research. Not all of those who were tried were executed: of the 305 cases we know the outcome for, 205 were executed, 52 were acquitted, and the rest were banished. However, while this sample gives an execution rate of 67%, the Survey's researchers believe that the actual execution rate was much higher, since this sample mostly comprises trials at Edinburgh's justiciary court, which followed judicial procedure more rigidly than the vast majority of courts. The Survey offers wide coverage of the year and county of witchcraft trials, for 3,098 witch suspects. For additional documentation, please see the Survey's website.[7]

[7]http://www.shca.ed.ac.uk/Research/witches/

Weather data for this period are scant, and the only panel data available for Europe are from Guiot and Corona (2010). These authors collect data from proxy sources, including ninety-five tree ring series, sixteen indexed climate series based on archives, ice-core series, and pollen series to construct grids of reconstructed growing-season (April to September) temperature for Europe from 900 AD to today. I use geospatial software to match counties with their nearest grid points. The measured temperatures are based on deviations from the 1961-1990 average.

There is substantial evidence that warmer temperatures in northern Europe are better for agriculture (Olesen and Bindi, 2002). Studies of Early Modern northern Europe have shown that warmer temperatures predict lower wheat prices (Waldinger, 2014) and greater grain yield (Holopainen and Helama, 2009). Parry (1975), in particular, examined cereal cultivation in south-east Scotland from the late Middle Ages to the the eighteenth century, and found that colder temperatures substantially reduce yields. It is therefore a sound assumption, for my analysis, that warmer temperatures improve agricultural conditions.

Scottish counties during this period look very different than they do today. Because no digital map of Early Modern Scottish counties is easily available, I constructed a map based on *The Atlas of Scottish History to 1707*. This gives me borders of counties that existed from 1563 to 1727, the years of my analysis.

In my specifications, I always control for population density, since this could impact trials. These data are from the History Database of the Global Environment (HYDE), and are available for the years 1500, 1600, 1700, 1710, 1720, and 1730.[8] HYDE data are based on historical sources of population numbers. Because there are gaps in my data, I linearly interpolate between years, within counties, to construct a balanced panel.

Price data, in real amounts, are from the Allen-Unger database. These data were collected by Robert C. Allen and Richard W. Unger based on various sources, and contains the price of commodities in grams of silver per litre. I examine three commodities in my analysis: wool, herring, and oats. None of the price data come from Scotland, but rather from important

[8]http://themasites.pbl.nl/tridion/en/themasites/hyde/

trading posts and cities from around the world, like Massachusetts, London, and Paris. Based on the *Atlas of Scottish History to 1707*, I located and mapped Scotland's eight trading ports: Leith, Glasgow, Bo'ness, Dundee, Ayr, Aberdeen, Burntisland, and Inverness. I then created a distance matrix between the locations from the Allen-Unger price data, and the closest Scottish port. I then applied an inverse-distance weighting to each price, to account for the fact, for example, that Copenhagen is farther than London. I therefore acquire the appropriate price for each commodity. To be concrete, suppose that the price of wool in Copenhagen is 1.3 silver units, while the price in London is 0.9 silver units. The distance from Copenhagen to the nearest Scottish port, Dundee, is 15.56 radial degrees, while the distance from London to the nearest port, Leith (Edinburgh), is 5.41. Thus the distance-weighted price index is: $1.3 \times \frac{1}{15.56} + 0.9 \times \frac{1}{5.41} = 0.25$.

Suitability for growing oats is from the *Food and Agriculture Organization*'s Global Agro-Ecological Zones (GAEZ) database. I use the values for rainfed, low input oats suitability, and merge this with my map of Scotland. Because oats suitability may not identify where oats were actually grown historically, I also use cropland usage data from the History Database of the Global Environment for the year 1500. For pasture land, I acquire data from Ramankutty and Foley (1999), which helps me to identify the suitability for herding sheep. Finally, for herring, I use information from Rorke's (2005) article on the Scottish herring trade from 1470 to 1600; instead of a continuous suitability measure, I use an indicator, since Rorke describes whether or not a region caught herring for export.

County-level fixed effects mean that I do not need to control for time-invariant county characteristics. However, I interact variables, such as distance from Edinburgh and justices of the peace, with my shock to test for heterogenous responses of trials to weather shocks. These are above-median indicators. For example, if distance from Edinburgh is greater than median, I code this as a 1, and as a 0 otherwise. I acquire justices of the peace data from the *Atlas of Scottish History to 1707*; this is the average number of justices over the period 1587 to 1663, when data is available.

Summary statistics for my dependent variables, shocks of interest, and county characteristics are shown in Table 1. I also provide a map of the total number of witchcraft trials over this period in Figure 1.[9] As can be seen, Edinburgh and East Lothian (Haddington) had the most intense witch-hunting. In Figure 2, I plot time series data for witch trials and temperature in Edinburgh county.

6. Results

6.1. **Main Results.** In Table 2, I report my main results for witch trials from 1563 to 1727, using three different moving averages for 3 years, 5 years, and 10 years. As can be seen, positive shocks to temperature predict more trials. For example, in column (2), a standard deviation increase in temperature causes a 0.06 standard deviation increase in trials. In column (5), a standard deviation increase in temperature causes a 0.14 standard deviation increase in the probably of a trial, or 4.06%. All regressions control for county-level population density, which might also predict trials.

These effects can be favourably compared to Hsiang et al's (2013) meta-analysis of the literature on climate and conflict, which finds that a standard deviation increase in temperature causes a 4% median increase in interpersonal violence, and a 14% increase in intergroup violence, across studies. Hsiang and his coauthors classify Tanzanian witch killings as "Personal Violence and Crime," and claim that these median figures are substantial, lending support to my results on Scottish witch trials.

6.2. **Robustness.** It is possible that I am not accounting for time-varying, county-specific factors that might affect witchcraft prosecutions. I thus repeat the analysis using county-specific time trends in Table 3. The results are still positive, large, and generally significant: for example, in column (6), a standard deviation increase in temperature (10 year MA) causes a 0.19 standard deviation increase in the probability of a trial, or 5.63%.

In Table 4, I conduct additional robustness checks by changing the empirical specification. In Columns (1)-(3), I run a logistic regression analysis, and in columns (4)-(6), I use

[9]The colour palette of my map was selected to reflect the particular chromatic characteristics of the external physiology of witches.

$ln(trials + 1)$ as my dependent variable. Results are still large and significant. Overall, warmer Scottish temperatures predict more trials.

As an additional check, I exclude trials prior to 1610. This is for two reasons. First, King James set off a national witch panic in 1590 when he accused witches of trying to kill him by sinking his ship. Thus, witch trials in 1590 were not due to local factors. Furthermore, Goodare (2002) claims that autonomous local trials, without central approval, occurred prior to 1610. These trials were conducted in regality courts, private courts that landlords held to settle disputes, and so were not as costly as establishing a commission of justiciary. Results are shown in Table 5. The results are significant, and larger than before, as I would expect. For example, in column (1) a standard deviation increase in temperature (3 year MA) causes a 0.11 standard deviation increase in trials. Favourable weather continues to cause more witchcraft trials.

My crucial identifying assumption is that weather is unrelated to unobservables that could bias my estimates. To determine if this is in fact the case, I perform a placebo test in Table 6, replacing current moving-average weather shocks with future moving-average weather shocks (one year forward). If my identification is sound, then there is no reason that future weather should predict current witch trials. As my results show, there is no significant relationship between witch trials and future weather, and the coefficient estimates are smaller than those for my main results. For example, in column (2), a standard deviation increase in the five-year moving average predicts only a 0.01 standard deviation increase in trials. Compare this to column (2) in Table 2, with a 0.06 standard deviation increase in trials predicted. This supports my identification strategy.

An alternate explanation for these patterns is greed: namely, witchcraft suspects had possessions that neighbours and the Crown wished to seize, and these possessions increased in value during beneficial years. There were a handfull of cases like this - notably, there were seven high-status women who were accused by heavily indebted men with property disputes (Yeoman, 2002). However, most such prosecutions failed, and the vast majority of witchcraft suspects were low-status women with no valuable property. Of the 316 witch suspects in my dataset whose socioeconomic status is known, only 9 are classified as either "Lairds/Baron" or "Nobility/Chiefs". Given the time and resources it took to try witches, historians do not believe that witchcraft trials were driven by greed (Goodare, 2010). Early Modern Scots, including educated elites, believed strongly in witchcraft, and were willing to take concrete measures to extirpate evil.

In Table 7, I briefly consider simple lagged temperature shocks, since my hypothesis depends crucially on the buildup of elite resources prior to a trial. In other words, elites need to accumulate resources over time in order for trials to occur, while there is unsatisfied demand. Although only column (4) in Table 4.7 is significant, all specifications yield positive and large coefficients. For example, column (2) shows that a standard deviation increase in temperature causes a 0.08 standard deviation increase in trials.

My hypothesis of a supply-side constraint is further demonstrated through a political incident: the 1660 end of Republican occupation of Scotland. After the English republicans left Scotland to its own devices, there was an outbreak of witchcraft trials. According to my data, only 2 trials were held in 1660. From 1661-1662, there were 612 witches prosecuted. Although this was a political event, it nonetheless supports my resource constraint theory of Scottish witch trials.

I have documented a robust relationship between beneficial temperatures and witchcraft prosecutions. This fits well with the observations that local elites required resources to conduct witchcraft prosecutions. It also supports my theoretical prediction that years of higher income should experience more trials.

6.3. **Compliers.** In Table 8, I interact the 5 year moving average weather shock with various compliers. First, I examine whether distance from Edinburgh had an impact. Those wishing to try a witch had to seek the Privy Council or parliament's permission in Edinburgh; in my model, this proxies for a higher R, the marginal cost of conducting a trial. Indeed, I find that a greater distance from Edinburgh (higher than median) attenuates the impact of the shock on trials. This lends support to my theoretical framework.

I then determine whether having more justices of the peace has an impact. Data on justices of the peace is available for every county except Cromarty, and therefore my sample size is slightly smaller. More justices of the peace implies a lower R, since there is some legal state capacity available to try a witch. Indeed, this amplifies the impact of the shock, as my model would predict.

To get a sense of u', the marginal benefit of prosecuting a witch, I use the intuition that during times of national political crisis, u' increases - it is dangerous to let witches roam during these times. I use Levack (2008) to identify five periods of political instability: In 1590-91, James I was fending off a series of rebellions; In 1597, there was a large-scale quarrel between church and the state; In 1643-44, a radical group of presbyterians, the covenanters, consolidated political power in Scotland; In 1649-50, some covenanters fought English military efforts to occupy Scotland; Finally, in 1661-1662, the covenanters were displaced by royal power. I code each of these years as a '1', and a zero otherwise, and then interact this with the weather shock. Clearly, times of crisis exacerbate the impact of this shock on trials. This corresponds to an increase in u' leading to more witch trials.

Finally, I examine distance from the nearest trade port. Counties further from trading ports have less access to alternate sources of income. If this is greater than median, I indicate this as a '1', with a zero otherwise. This is intended to capture y, the value of income. According to my model, the smaller this income is, the less likely a trial is to occur. Indeed, a higher distance from a port attenuates the impact of the shock on witch trials, lending support to my hypothesis.

6.4. **Mechanisms.** Because local elites, such as lairds and burgesses, were responsible for the time and money involved in carrying out witch trials, I expect that positive shocks to their income would lead to more witchcraft trials. Specifically, shocks to export-heavy, taxable commodities like herring and wool should have an impact on trials, while shocks to Scotland's main subsistence commodity, oats, should have no effect.

Historical evidence states that local elites derived income not only from peasant rents, but also from exports. Customs duties were levelled on goods exiting Scotland, helping to fill the coffers of burgesses and lairds through customs farming. Evidence from the regions of Gowrie and Aberdeen also suggests that tenants paid landlords rents in the form of surplus agricultural produce, which landlords then sold to merchants to buttress their income (Young, 2007; Whyte, 1986). Furthermore, many elites (burgesses) of royal burghs and burghs of barony were themselves merchants, who relied on export income to exert local political and economic power (Brown, 1992; Smout, 1973). Based on data from the *Atlas of Scottish History to 1707*, I was able to identify two of the most common exports: wool, and herring. Based on a 1614 survey of exports from the *Atlas*, wools and wool products comprised about 15% of total exports, while herring comprised 13% of total exports. Fells (timber) is the only commodity that comprises a larger percentage of exports (21%), but based on customs receipts from 1595 to 1599, wool and herring were taxed at a higher rate than fells. I therefore focus on wool and herring as examples of export-heavy, taxable commodities.

Scotland's main subsistence commodity, oats, was not exported much at all. Oats comprise 0.4% of total exports, based on the 1614 survey. Oats' short growing season combined with their nutritious content made them a staple diet among Scots (Smout, 1973). Therefore, although it was an important crop, oats do not contribute significantly to elite income, and therefore should not impact witch trials.

My reduced form relationship between weather and witch trials requires some discussion here. Warm temperatures in Scotland were important for growing oats, but also for producing wool and catching herring. Veterinary studies show that sheep shear better when temperatures are warm, and they can die or fall ill under inclement conditions (Glass and Jacob, 1991; Torell et al., 1969). With regards to herring, a common method of storage at the time was salting (Rorke, 2005), which works better under warmer temperatures.

In Table 9, I show the regressions for wool/herring price shocks and witch trials. Total witch trials is the outcome variable. Clearly, higher prices of both commodities lead to more trials. For example, in column (1), a standard deviation increase in the wool price shock (3 year MA) increases trials by 0.15 standard deviations. In column (4), a standard deviation increase in the herring price shock (3 year MA) increases trials by 0.10 standard deviations.

In Table 10, I regress witch trials on oat price shocks. In columns (1)-(3), I interact the world oats price with the FAO data for oats suitability. There is no significant effect, and the coefficient estimates are much smaller than those for herring and wool. In column (3), a standard deviation increase in the oat price shock reduces trials by 0.0001 standard deviations. The coefficient estimates are negative, which could suggest the following story: peasants who grow and sell oats blame witches when oat prices are low. Although this is plausible, there is no historical evidence to support it, and at any rate, the coefficients are insignificant: even if peasants complain about witches, elites need the resources to prosecute. In columns (4)-(6), I interact the world oats price with HYDE data for cropland usage, and again find an insignificant impact, although it is now positive, further indicating that the oats price does not robustly predict trials. The effect is larger - for instance, in column (4), a standard deviation increase in the oats shock predicts a 0.10 standard deviation increase in witchcraft trials - however, given the overall insignificance, and the fact that this insignificance is robust across specifications, I can conclude that oats shocks do not predict witch trials.

There is, additionally, anecdotal evidence that spending on other public goods increased following favourable weather. The town of Aberdeen, for example, was unique in its retention of a large Justice of the Peace Court, which tried crimes like fornication and adultery. Running the court was fairly expensive and, according to DesBrisay (1986),

> The forces of nature could clearly influence the court's work: in 1697, when... poor weather and serious food shortages led to disease and high mortality, the justice court sat only thirteen times... it seems likely that backlogs of cases occasionally built up. (p. 81)

It therefore makes sense that witch trials would increase following favourable temperature.

7. Conclusion

Persecution of populations is not always a disorganised, unruly affair. Events like the Khmer Rouge killings, East Timorese massacres, and Rwandan genocide were all planned and organised by elites. Even the frequent persecution of political dissidents by Saudi Arabia and China requires resources. Similarly, Early Modern Scottish witchcraft trials required local elites' time and material resources.

In this paper, I have shown that positive weather shocks caused more witchcraft trials in Early Modern Scotland. During such good times, local elites had more resources to devote to witch prosecutions. Consistent with this, I find that positive price shocks to export-heavy, taxable commodities, herring and wool, caused more trials, while shocks to oats, Scotland's main subsistence commodity, did not.

A further question raised by this paper is that of policy: namely, how can we prevent persecution, when elites finance it? Based on my findings, the answer might be to target the export of goods that elites derive wealth and power from.[10] Indeed, such sanctions are used against states like North Korea and Iran ostensibly for this purpose (Elliot, 1998; Marinov, 2005). An Early Modern 'omnipotent economic planner' wishing to limit witchcraft trials would therefore sanction the export of wool and herring from Scotland. Although such a thought exercise risks overgeneralising, especially since actors may react unexpectedly to sanctions, the policy implications are worthy of future research.

[10]This abstracts from general equilibrium concerns. Sanctions can, after all, harm even persecuted populations by denying them of food, medicine, and income.

References

Abadie, Alberto, and Javier Gardeazabal. "The Economic Costs of Conflict." *American Economic Review*, March 2003, *93*(1), pp. 113-132.

Acemoglu, Daron, Tarek Hassan, and James Robinson. "Social Structure and Development: A Legacy of the Holocaust in Russia." *Quarterly Journal of Economics*, June 2011, *126*(2), pp. 895-946.

Anderson, Robert Warren, Noel D. Johnson, and Mark Koyama. "Jewish Persecutions and Weather Shocks: 1100-1800." *2013 Working Paper*.

Angrist, Joshua D., and Adriana D. Kugler. "Rural Windfall or a New Resource Curse? Coca, Income, and Civil Conflict in Colombia." *Review of Economics and Statistics*, May 2008, *90*(2), pp. 191-215.

Apps, Lara, and Andrew Gow. *Male Witches in Early Modern Europe*, Manchester University Press, 2003.

Bazzi, Samuel, and Christopher Blattman. "Economic Shocks and Conflict: Evidence from Commodity Prices." *American Economic Journal: Macroeconomics*, October 2014, *6*(4), pp. 1-38.

Besley, Timothy, and Torsten Persson. "State Capacity, Conflict, and Development." *Econometrica*, January 2010, *78*(1), pp. 1-34.

Besley, Timothy, and Torsten Persson. "The Logic of Political Violence." *Quarterly Journal of Economics*, August 2011, *126*(3), pp. 1411-1445.

Blattman, Christopher, and Edward Miguel. "Civil War." *Journal of Economic Literature*, March 2010, *48*(1), pp. 3-57.

Bloch, Francis, and Vijayendra Rao. "Terror as a Bargaining Instrument: A Case Study of Dowry Violence In Rural India." *American Economic Review*, September 2002, *92*(4), pp. 1029-1043.

Briggs, Robin. *Witches and Neighbours*. Penguin Books Ltd., New York, 1998.

Brown, Keith M. *Kingdom or Province? Scotland and the Regal Union, 1603-1715*. MacMillan Press, London, 1992.

Card, David, and Gordon B. Dahl. "Family Violence and Football: The Effect of Unexpected Emotional Cues on Violent Behavior." *Quarterly Journal of Economics*, February 2011, *126*(1), pp. 103-143.

Collier, Paul and Anke Hoeffler. "Greed and grievance in civil war." *Oxford Economic Papers*, August 2004, *54*(4), pp. 563-595.

Cowan, Edward J. "Witch Persecution and Folk Belief in Lowland Scotland: The Devil's Decade." *Julian Goodare (ed.) Witchcraft and Belief in Early Modern Scotland*, Palgrave Macmillan, London, 2008.

Dal Bo, Ernesto, and Pedro Dal Bo. "Workers, Warriors, and Criminals: Social Conflict in General Equilibrium." *Journal of the European Economic Association*, August 2011, *9*(4), pp. 646-677.

Dell, Melissa. "Trafficking Networks and the Mexican Drug War." *American Economic Review*, forthcoming.

DesBrisnay, Gordon. "Menacing Their Persons and Exacting Their Purses: The Aberdeen Justice Court, 1600-1800." *David Stevenson (ed.) From Lairds to Louns: County and Burgh Life in Aberdeen, 1600-1800.* Aberdeen University Press, Aberdeen, 1986.

Dillinger, Johannes. "Politics, State-Building, and Witch-Hunting." *Brian Levack (ed.) The Oxford Handbook of Witchcraft in Early Modern Europe and Colonial America.* Oxford University Press, 2013, pp. 528-547.

Doss, Cheryl. "Intrahousehold Bargaining and Resource Allocation in Developing Countries." *World Bank Research Observer*, January 2013, *28*(1), pp. 52-78.

Dube, Oeindrilla and Juan F. Vargas. "Commodity Price Shocks and Civil Conflict: Evidence from Colombia." *Review of Economic Studies*, October 2013, *80*(4), pp.1384-1421.

Dudley, Margaret, and Julian Goodare. "Outside In or Inside Out: Sleep Paralysis and Scottish Witchcraft." *Julian Goodare (ed.) Scottish Witches and Witch-Hunters.* Palgrave Macmillan, London, 2013.

Elliot, Kimberly Ann. "The Sanctions Glass: Half Full or Completely Empty?" *International Security*, Summer 1998, *23*(1), pp. 50-65.

Fearon, James, and Anke Hoeffler. "Benefits and Costs of the Conflict and Violence Targets for the Post-2015 Development Agenda." 2014, *Copenhagen Consensus Working Paper.*

Fetzer, Thiemo. "Social Insurance and Conflict: Evidence from India." *2014 Working Paper.*

Goodare, Julian. "Witchcraft in Scotland." *Brian Levack (ed.) The Oxford Handbook of Witchcraft in Early Modern Europe and Colonial America.* Oxford University Press, 2013, pp. 300-317.

Goodare, Julian. "The truth about witches and witch-hunters." *The Guardian*, 2010, *http://www.theguardian.com/commentisfree/belief/2010/oct/30/halloween-witches-history.*

Goodare, Julian. "Witch-hunting and the Scottish state." *Julian Goodare (ed.) The Scottish witch-hunt in context.* Manchester University Press, 2002, pp. 122-145.

Green, M Holm, and RH Jacob. "Losses of sheep following adverse weather after shearing." *Australian Veterinary Journal*, June 1991, *69*(6), pp. 142-143.

Grossman, Herschel. "Kleptocracy and Revolutions." *Oxford Economic Papers*, April 1999, *51*(2), pp. 267-283.

Guiot, Joel, and Christophe Corona. "Growing Season Temperatures in Europe and Climate Forcings Over the Past 1400 Years." *PLoS One*, April 2010, *5*(4), pp. 1-15.

Heldring, Leander. "State Capacity and Violence: Evidence from the Rwandan genocide." *2013 Working Paper.*

Hirshleifer, Jack. "The Technology of Conflict as an Economic Activity." *American Economic Review Papers and Proceedings*, May 1991, *81*(2), pp. 130-134.

Holopainen, Jari, and Samuli Helama. "Little Ice Age Farming in Finland: Preindustrial Agriculture on the Edge of the Grim Reaper's Scythe." *Human Ecology*, April 2009, *37*(2), pp. 213-225.

Hsiang, Solomon M., Marshall Burke, and Edward Miguel. "Quantifying the Influence of Climate on Human Conflict." *Science*, September 2013, *312*(6151).

Johnson, Noel D., and Mark Koyoma. "Taxes, Lawyers, and the Decline of Witch Trials in France." *Journal of Law and Economics*, February 2014, *57*(1), pp. 77-112.

Jha, Saumitra. "Trade, Institutions, and Ethnic Tolerance: Evidence from South Asia." *American Political Science Review*, November 2013, *107*(4), pp. 806-832.

Larner, Christina. *Enemies of God: The Witch-hunt in Scotland*. Chatto & Windus Ltd., London, 1981.

Levack, Brian. *The Witch-Hunt in Early Modern Europe (3rd edition)*. Pearson Education, United Kingdom, 2006.

Levack, Brian. *Witchcraft in Scotland: Law, Politics, and Religion*. Routledge, New York, 2008.

Marinov, Nikolay. "Do Economic Sanctions Destabilize Country Leaders?" *American Journal of Political Science*. July 2005, *49*(3), pp. 564-576.

Miguel, Edward. "Poverty and Witch Killing." *Review of Economic Studies*, October 2005, *72*(4), pp. 1153-1172.

Miguel, Edward, Shanker Satyanath, and Ernest Sergenti. "Economic Shocks and Civil Conflict: An Instrumental Variables Approach." *Journal of Political Economy.*, August 2004, *112*(4), pp.725-753.

Olesen, Jorgen E., and Marco Bindi. "Consequences of climate change for European agricultural productivity, land use and policy." *European Journal of Agronomy*, June 2002, *16*(2), pp. 239-262.

Oster, Emily. "Witchcraft, Weather and Economic Growth in Renaissance Europe." *Journal of Economic Perspectives*, Winter 2004, *18*(1), pp. 215-228.

Parry, M. L. "Secular climatic change and marginal agriculture." *Transactions of the Institute of British Geographers*, March 1975, *64*, pp. 1-13.

Paterson, Laura. "Executing Scottish Witches." *Julian Goodare (ed.) Scottish Witches and Witch-Hunters*, Palgrave Macmillan, London, 2013.

Ramankutty, Navin and Jonathan A. Foley. "Estimating historical changes in global land cover: Croplands from 1700 to 1992." *Global Biogeochemical Cycles*, December 1999, *13*(4), pp. 997-1027.

Rogall, Thorsten. "Mobilizing the Masses for Genocide." *2014 Working Paper.*

Roper, Lyndal. *Oedipus and the Devil: Witchcraft, Religion and Sexuality in Early Modern Europe.* Routledge, London, 1994.

Rorke, Martin. "The Scottish Herring Trade, 1470-1600." *The Scottish Historical Review*, October 2005, *84*(2), pp.149-165.

Rowlands, Alison. "Witchcraft and Gender in Early Modern Europe." *Brian Levack (ed.) The Oxford Handbook of Witchcraft in Early Modern Europe and Colonial America.* Oxford University Press, 2013, pp. 449-467.

Smout, T.C. *A History of the Scottish People, 1560-1830.* The Chaucer Press Ltd., UK, 1973.

Torell, D.T., W.C. Weir, G.E. Bradford, and G.M. Spurlock. "Effects of time of shearing on wool and lamb production." *California Agriculture*, November 1969, *23*(11), pp. 16-18.

Voigtlander, Nico and Hans-Joachim Voth. "Persecution Perpetuated: The Medieval Origins of Anti-Semitic Violence in Nazi Germany." *Quarterly Journal of Economics*, May 2012, *128*(2), pp. 469-530.

Waldinger, Fabian. "Quality Matters: The Expulsion of Professors and the Consequences for PhD Student Outcomes in Nazi Germany." *Journal of Political Economy*, August 2010, *188*(4), pp. 787-831.

Waldinger, Maria. "The Economic Effects of Long-Term Climate Change: Evidence from the Little Ice Age, 1500-1750." 2014, *Working Paper.*

Wasser, Michael. "The Mechanical World-View and the Decline of Witch Beliefs in Scotland." *Julian Goodare (ed.) Witchcraft and Belief in Early Modern Scotland*, Palgrave Macmillan, London, 2008.

Weiss, Gordon. *The Cage: The fight for Sri Lanka & the Last Days of the Tamil Tigers.* Bellevue Literary Press, New York, 2012.

Whyte, Ian. "Agriculture in Aberdeenshire in the Seventeenth and Early Eighteenth Centuries: Continuity and Change." *David Stevenson (ed.) From Lairds to Louns: Country and Burgh Life in Aberdeen, 1600-1800.* Aberdeen University Press, 1986.

Yanagizawa-Drott, David. "Propaganda and Conflict: Evidence from the Rwandan Genocide." *Quarterly Journal of Economics*, August 2014, *129*(4), pp. 1947-1994.

Yeoman, Louise. "Hunting the rich witch in Scotland: high-status witchcraft suspects and their persecutors, 1590-1650." *Julian Goodare (ed.) The Scottish witch-hunt in context*. Manchester University Press, 2002, pp. 106-121.

Young, Mary. "Scottish crop yields in the second half of the seventeenth century: evidence from the Mains of Castle Lyon in the Carse of Gowrie." *Agricultural History Review*, 2007, *55*(1), pp. 51-74.

TABLE 1. Summary Statistics

Variable	N	Mean	Std. Dev.	Min	Max
Main Results					
Witch Trials Count	5,610	0.55	4.16	0	116
Witch Trials Dummy	5,610	0.10	0.30	0	1
Temperature (3 year MA)	5,610	0.16	0.42	-1.11	1.83
Temperature (5 year MA)	5,610	0.16	0.35	-0.81	1.73
Temperature (10 year MA)	5,610	0.16	0.29	-0.55	1.30
Population Density	5,610	4,008	11,028	18.36	93,331
Commodity Price Shocks					
Suitability × Price Wool (3 year MA)	5,610	8.78	3.25	0.78	16.74
Suitability × Price Wool (5 year MA)	5,610	8.78	3.17	0.81	15.98
Suitability × Price Wool (10 year MA)	5,610	8.77	3.05	0.88	15.26
Suitability × Price Herring (3 year MA)	5,610	0.64	1.01	0	3.96
Suitability × Price Herring (5 year MA)	5,610	0.63	1.01	0	3.90
Suitability × Price Herring (10 year MA)	5,610	0.62	0.99	0	3.68
Suitability × Price Oats (3 year MA)	5,610	0.02	0.005	0.009	0.04
Suitability × Price Oats (5 year MA)	5,610	0.02	0.005	0.01	0.04
Suitability × Price Oats (10 year MA)	5,610	0.02	0.005	0.01	0.03
Compliers					
Distance from Edinburgh: above median	34	0.5	0.5	0	1
Times of crisis: indicator	5,610	0.05	0.23	0	1
Justices of the Peace: above median	33	0.48	0.5	0	1
Distance from a Port: above median	34	0.5	0.5	0	1

Figure 1. Total Number of Witchcraft Trials, 1563-1727

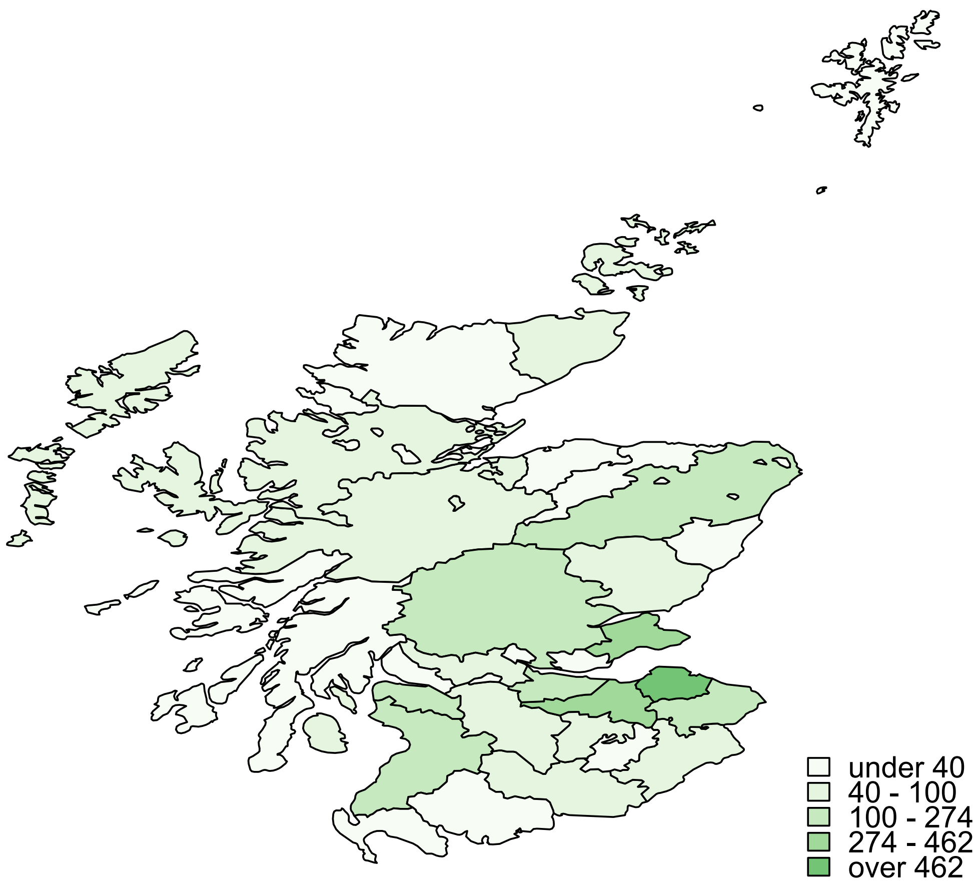

FIGURE 2. Witch Trials and Temperature (5-year MA) in Edinburgh, 1563-1727

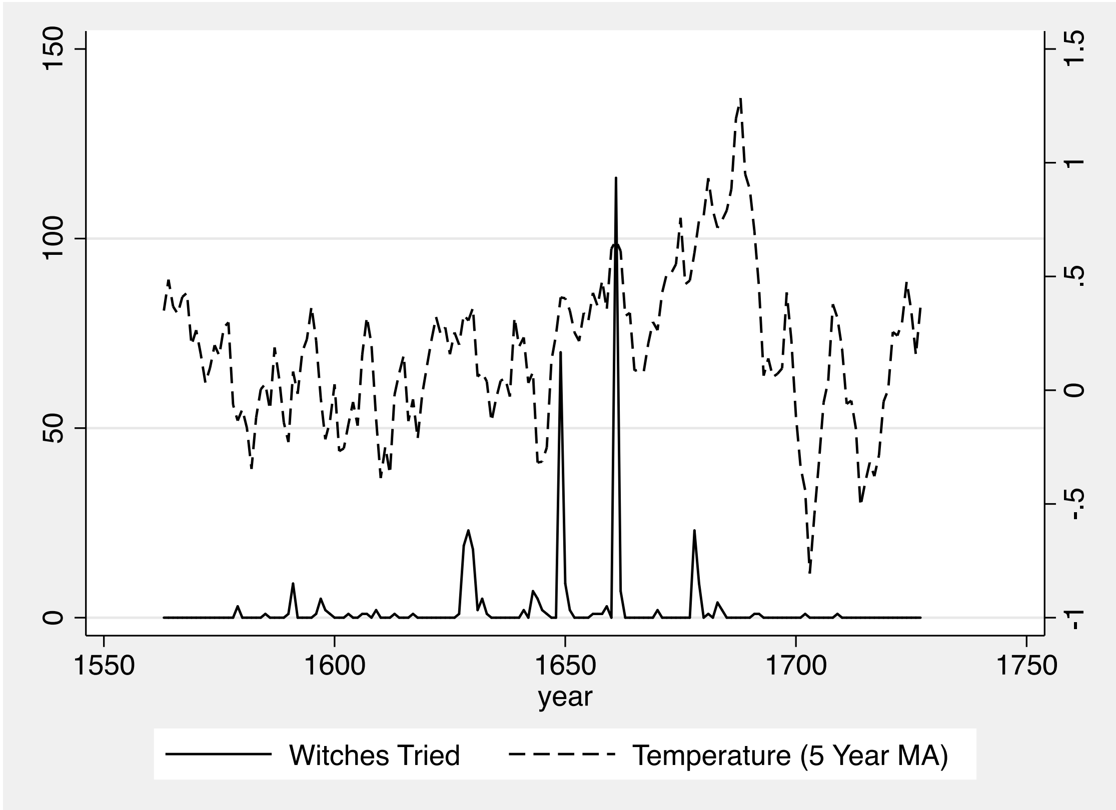

Table 2. Effect of Temperature Shocks on Witchcraft Trials

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	Count	Count	Count	Dummy	Dummy	Dummy
Temperature (3 year MA)	.548			.104**		
	(.504)			(.046)		
Temperature (5 year MA)		.711**			.116***	
		(.341)			(.040)	
Temperature (10 year MA)			.805			.161**
			(.499)			(.071)
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Counties	34	34	34	34	34	34
No. of observations	5,610	5,610	5,610	5,610	5,610	5,610

Standard errors, clustered at the county level, are reported in parentheses.
Significance levels are ***< 0.01, **< 0.05, and *< 0.1.
All regressions control for population density.

Table 3. Main Results with County-Specific Trends

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	Count	Count	Count	Dummy	Dummy	Dummy
Temperature (3 year MA)	.619			.110**		
	(.571)			(.049)		
Temperature (5 year MA)	.	.850**			.126***	
		(.374)			(.036)	
Temperature (10 year MA)	.		.962			.194**
			(.601)			(.084)
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
County-Specific Trends	Yes	Yes	Yes	Yes	Yes	Yes
Counties	34	34	34	34	34	34
No. of observations	5,610	5,610	5,610	5,610	5,610	5,610

Standard errors, clustered at the county level, are reported in parentheses.
Significance levels are ***$<$ 0.01, **$<$ 0.05, and *$<$ 0.1.
All regressions control for population density.

Table 4. Main Results: Different Specifications

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	Dummy	Dummy	Dummy	*ln*	*ln*	*ln*
Temperature (3 year MA)	.012*			.149*		
	(.008)			(.076)		
Temperature (5 year MA)	.	.024***			.176***	
		(.009)			(.061)	
Temperature (10 year MA)	.		.004			.220**
			(.011)			(.101)
Robustness Check:	Logit	Logit	Logit	Dep Var	Dep Var	Dep Var
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Counties	34	34	34	34	34	34
No. of observations	5,610	5,610	5,610	5,610	5,610	5,610

Standard errors, clustered at the county level, are reported in parentheses.
Significance levels are *** < 0.01, ** < 0.05, and * < 0.1.
All regressions control for population density.

TABLE 5. Excluding Years Prior to 1610

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	Count	Count	Count	Dummy	Dummy	Dummy
Temperature (3 year MA)	1.12**			.196***		
	(.545)			(.059)		
Temperature (5 year MA)	.	1.30***			.228***	
		(.413)			(.059)	
Temperature (10 year MA)	.		1.50***			.290***
			(.526)			(.095)
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
County-Specific Trends	Yes	Yes	Yes	Yes	Yes	Yes
Counties	34	34	34	34	34	34
No. of observations	4,012	4,012	4,012	4,012	4,012	4,012

Standard errors, clustered at the county level, are reported in parentheses.
Significance levels are ***< 0.01, **< 0.05, and *< 0.1.
All regressions control for population density.

Table 6. Future Weather Shocks (One Year Forward) and Current Witch Trials

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	Count	Count	Count	Dummy	Dummy	Dummy
Temperature (3 year MA)	-.277			.048		
	(.297)			(.068)		
Temperature (5 year MA)	.	.158			.085	
		(.415)			(.061)	
Temperature (10 year MA)	.		.417			.120
			(.404)			(.071)
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
County-Specific Trends	Yes	Yes	Yes	Yes	Yes	Yes
Counties	34	34	34	34	34	34
No. of observations	5,610	5,610	5,610	5,610	5,610	5,610

Standard errors, clustered at the county level, are reported in parentheses.
Significance levels are ***< 0.01, **< 0.05, and *< 0.1.
All regressions control for population density.

Table 7. Effect of Temperature Shocks on Witchcraft Trials: One Year Lags

	(1)	(2)	(3)	(4)
Dependent variable:	Count	Count	Dummy	Dummy
Temperature	.093	.524	.067	.123**
	(.372)	(.367)	(.055)	(.060)
County FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Counties	34	34	34	34
No. of observations	5,610	4,012	5,610	4,012

Standard errors, clustered at the county level, are reported in parentheses.
Significance levels are ***< 0.01, **< 0.05, and *< 0.1.
All regressions control for population density.

Table 8. Compliers

Dependent variable: witch trials	(1)	(2)	(3)	(4)
Temperature (5 year MA)	.194***	.198	.270	2.045**
	(.052)	(.539)	(.216)	(.804)
Temperature × interaction	-.060***	.813*	10.09*	-1.043**
	(.021)	(.472)	(5.42)	(.482)
Interacted variable:	*Distance from Edinburgh*	*Justices of the Peace*	*Political Crises*	*Distance from a Port*
County FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
County-Specific Trends	Yes	Yes	Yes	Yes
Counties	34	33	34	34
No. of observations	5,610	5,445	5,610	5,610

Standard errors, clustered at the county level, are reported in parentheses.
Significance levels are ***< 0.01, **< 0.05, and *< 0.1.
All regressions control for population density.

Table 9. Effect of Wool and Herring Shocks on Witch Trials

	(1)	(2)	(3)	(4)	(5)	(6)
Price Shock:	Wool	Wool	Wool	Herring	Herring	Herring
3 year MA	.198**			.431**		
	(.092)			(.202)		
5 year MA	.	.186**			.400**	
		(.087)			(.184)	
10 year MA	.		.236**			.359**
			(.103)			(.160)
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Counties	34	34	34	34	34	34
No. of observations	5,610	5,610	5,610	5,610	5,610	5,610

Standard errors, clustered at the county level, are reported in parentheses.
Significance levels are ***< 0.01, **< 0.05, and *< 0.1.
All regressions control for population density.

Table 10. Effect of Oats Shocks on Witch Trials

	(1)	(2)	(3)	(4)	(5)	(6)
3 year MA shock	-.097			.113		
	(.100)			(.104)		
5 year MA shock	.	-.094			.133	
		(.123)			(.143)	
10 year MA shock	.		-.113			.221
			(.175)			(.224)
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Counties	34	34	34	34	34	34
No. of observations	5,610	5,610	5,610	5,610	5,610	5,610

Standard errors, clustered at the county level, are reported in parentheses.
Significance levels are ***< 0.01, **< 0.05, and *< 0.1.
All regressions control for population density.