Grain Price Fluctuations and Witch Hunting in Bavaria

(preliminary version)

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Abstract

Based on the data set of Behringer (1997), we develop and test competing models of the determinants of witch hunting in Bavaria in the period 1345-1750, which explain the cyclicity as well as the variation over time from the 14th to the 18th century. Our main focus is on economic factors and their influence on the intensity of prosecution. We analyse this issue by quantifying the importance of grain price fluctuations for the frequency of witch trials/accusations, taking into account other possible explanations like the impact of confession and regional characteristics.

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1 Introduction

Witch burning or the social process leading to it is one of the unresolved puzzles of pre-industrial human history. Why do people kill their neighbours - mostly without any economic advantage? Although it has been argued in the older literature that direct economic incentives might have played a role for local governments, Rummel (1991, pp. 161-3) and Tschaikner (1992, p. 72-75) have shown that the costs of the trial by far exceeded the revenues from confiscated property.

Most theories aimed at explaining the strong increase in persecution in Germany during the late 16th century. Witch hunting has been put in context with the confessional bifurcation in Germany that took place in the 16th century, especially with the catholic reaction to the spread of Protestantism. However, a direct link of persecuting Protestants in catholic areas has been rejected or constrained to a few exceptional cases (Volk 1882, Renczes 1990).

Trevor-Roper (1990) argued convincingly that the increased hostility between confessions led to a more hostile climate against other 'religious' abnormalities, and this had the additional effect that critics of witch burning were quickly accused of being Protestants. This explains to a certain extent the intensification of persecution in the late 16th and early 17th century, but not the variation throughout the period and the smaller panic trials from the 14th through the 18th century. It has even been argued by Thomas (1971) and Macfarlance (1970) that the rise of the protestant idea that personal charity should be abolished and governmental charity be introduced instead might explain this intensification. The influence of religious beliefs has been mainly considered in regional cross-sections. We will consider the finding of Midelfort (1972) that catholic areas in Germany displayed a higher probability of accusations than protestant territories. Other possible explanations of this intensification include the use of witch hunting as a disciplinary tool (Schwerhoff 1991), especially for the female part of population (Becker et al. 1983).

Behringer (1993, 1997) developed a list of additional factors:

- Changing mentality after the climatic and agrarian crisis of 1560-1590.
- Increasing inequality between farmer owning large plots, clergymen, parts of the nobility and merchants on the one side and the majority of modernization losers on the

other side. This inequality led to a more hierarchical society and an ideological homogenization i.e. elimination of oppositional groups.

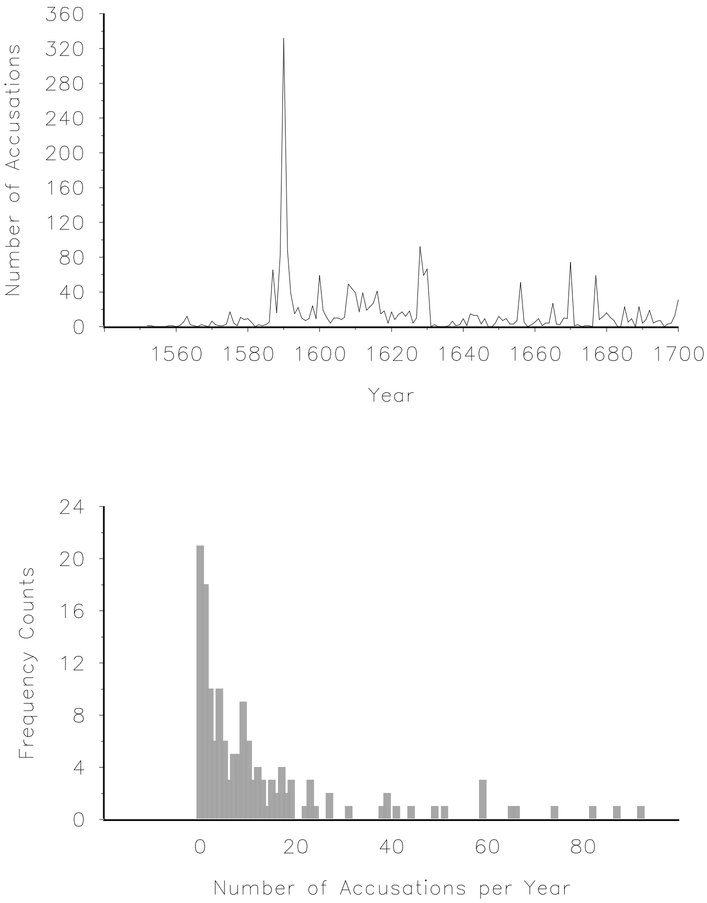
- It has been argued that the Swedish occupants prevented further accusations, and that the war itself kept the people from accusing so that "*peace-time pursuits like witch-hunting simply stopped*" (Monter 1976).

In contrast to these theories focussing on the long-term trend and regional differences, very few authors were interested in a systematic study which also takes into account the short-term variations of witch hunting propensity. Behringer argued that hunger crisis years were important for increasing the propensity of people to persecute witches. However, he did not test this relationship statistically, but just provided examples for years in which the chronology fitted.

In the following, we will develop and test competing models of the determinants of witch hunting in the long-run that might explain the short-term variation. A number of models with differing timing appear to be plausible. First of all, we have to describe the social group that might be affected by our proxy for "worsening situation" and that might be inclined to search for scapegoats. Grain price shocks clearly affected the live of day-laborers, handicrafts, the urban population in general, and farmers who were specialized in non-grain activities. The urban upper classes were - due to their higher income - probably less affected by modest price increases. This changed, however, when prices continued to be high for a number of years or if the price shock was extreme. Another problem arises because there is no theory suggesting the lag between people realising a significant deterioration in the overall economic situation, and the response to it, i.e. the increase in witch hunting propensity. To deal with this problem, we will test several models: A moving average, a model focusing on the price level of the previous year, and a price shock model which depends on the past fluctuations of grain prices. The latter assumes that people tend to adjust to gradually deteriorating situations (for example, by lowering fertility), but they were unable to cope with unexpected, sudden shocks.

2 Data Description

Figure 1: Witch Hunting in Bavaria, 1550-1700



The data on witch hunting are from Wolfgang Behringer who collected all evidence on witch trials in the Southern part of today's Bavaria. Since witch activities were considered to be capital crimes, their prosecution was in the responsibility of the states (that is for this area, the Bavarian principality, the archbishopries (*Hochstifte*) of Freising, Salzburg, and Augsburg, the *Reichsstädte* of Augsburg, Höchstädt, Regensburg and several smaller territories).

Visual analysis of the series shows that the number of accusations increased over the 16th century (Figure 1). In 1562/63 the first large persecutions took place (N=5 and 10), a smaller one in 1570 and a larger one in 1575 (N=17), almost immediately followed by the 1578-81 hunt. The “large panic trial” started in 1568/7, with the absolute peak in 1590. Between

1587 and 1630, there were almost never less than 10 women accused in the territories under analysis. This high persecution period can be characterised by enormous peaks at the beginning (1590) and end (1628-30), a smaller peak in 1598 and a high plateau in 1608-18. During the Swedish invasions persecutions declined. Afterwards, we find some blocks of ca. 10 accusations per year in 1642-4 and 1649-51. The period from 1650 to 1700 is characterised by strong one-year peaks in 1673, 1680 and 1694 (60-80 accusations) and smaller peaks in 1650, 1558, 1561, 1665 and 1785.

The evidence on grain prices reports annual levels on the Augsburg and Munich grain markets.[1] Grain prices tend to be closely correlated, even if the markets were several hundreds of kilometers apart. Hence, these two cities can be regarded as more or less representative for the region under analysis.

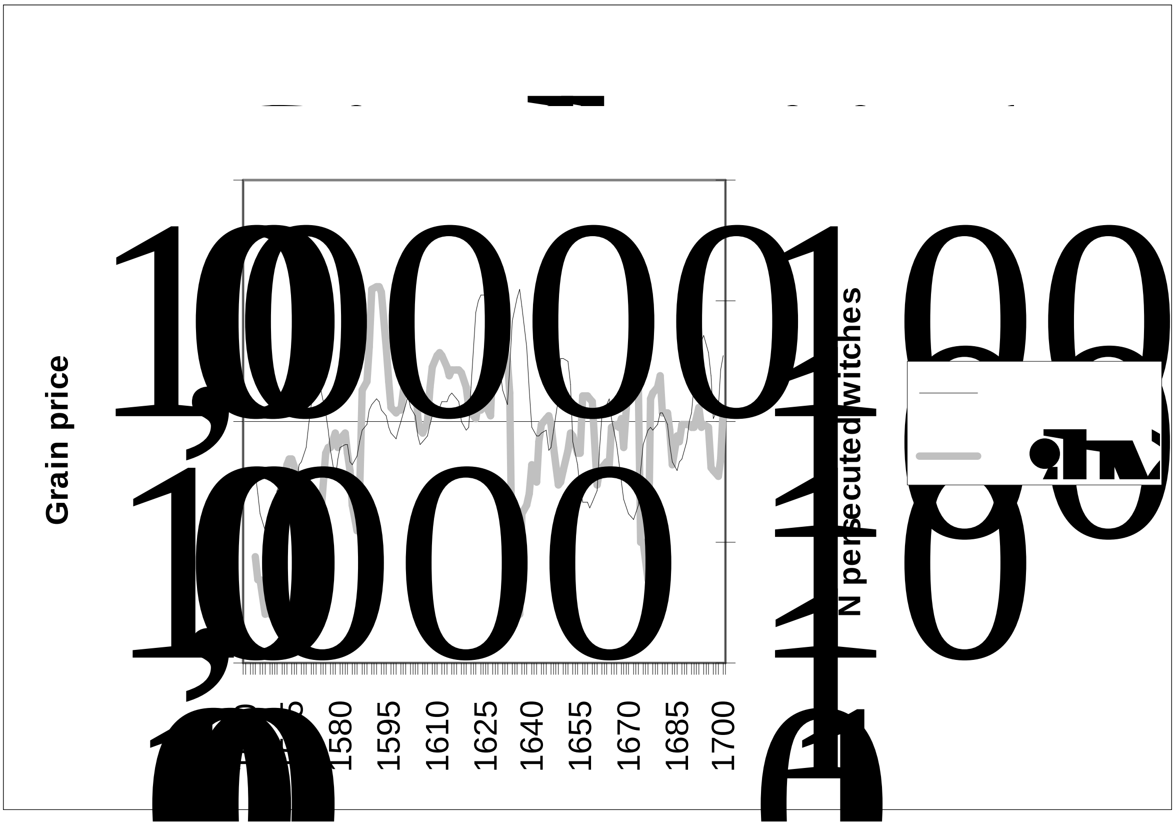
3 Witch Hunting and Grain Price Fluctuations

3.1 Visual Inspection of Moving Averages

We start with a visual analysis a simple moving average of four years for the prices and accusation series. It is obvious that they are relatively close correlated in the latter third of the 16th century and the first decades of the 17th century. Before that date, little correlation is visible. The *Kipper und Wipper* inflation and the Thirty Years War distort the picture for the time period 1620-1660. Between 1660 and 1680, there is no correlation. In the very last decades of the 17th century, the correlation appears again. Note that living standards during this time period were lower than immediately after the war, because population growth had filled up the gaps again that the war had produced. Arable land for free was not available any more, as it often was directly after the war. Therefore, simple visual analysis suggests that during time periods of higher population pressure and lower living standards in general the correlation between the grain price and propensity for pogroms might be closer. However, interpretation does not take into account the annual fluctuation of accusations. It is also impossible to adjust for inflation during this period. To perform this analysis, we have to employ more specialized statistical methods.

[1] Documented in Elsas (1936/40). See also the description in Bauernfeind and Woitek (1996a, b).

Figure 2



3.2 Methodology

We want to assess the influence of grain prices p_t on the number of accusations per year acc_t . This can be done by estimating a model of the form acc_t=f(p_t), where we have to take into account that the data on accusations are typical of count data, and that the assumption of a normal distribution would certainly be wrong. What we use instead as a starting point of our analysis is a Poisson regression model.[2] The main equation of the model is given by

$$\text{Prob}(ACC_t = acc_t) = \frac{e^{-\lambda_t}\lambda_t^{acc_t}}{acc_t!}; \quad acc_t = 0,1,2,\ldots, \tag{1}$$

where we assume that λ_t is given by

$$\lambda_t = e^{\beta p_t} . \tag{2}$$

[2] For the following , see Greene (1993), p. 676 ff. Figure 1 shows that the empirical distribution of the accusation data has indeed a Poisson shape.

Looking at the moments of the Poisson distribution, we see that

$$\mathrm{E}[acc_t | p_t] = \mathrm{Var}[acc_t | p_t] = \lambda_t \,. \tag{3}$$

This allows an intuitive interpretation of the result: suppose that we are interested in the influence of a marginal change in the grain price at time *t* on the expected number of accusations in this year. Using the above equation, the resulting expression is

$$\frac{\partial \, \mathrm{E}\left[acc_t | p_t\right]}{\partial p_t} = \lambda_t \beta \,. \tag{4}$$

The model can be estimated with maximum likelihood techniques. The log-likelihood function is given by

$$\ln L = \sum_{t=1}^{T} \left(-\lambda_t + acc_t \beta p_t - \ln acc_t! \right). \tag{5}$$

The Poisson regression model has been criticised for the model to be valid, the hypothesis that the first two moments of the distribution have to be equal must hold. Cameron and Trivedi (1990) offer several tests for overdispersion, based on the structure

$$\begin{aligned} &\mathrm{H0} : \mathrm{Var}\left[acc_t\right] = \lambda_t \\ &\mathrm{H1} : \mathrm{Var}\left[acc_t\right] = \lambda_t + \alpha \, \mathrm{f}\left(\lambda_t\right) \end{aligned} . \tag{6}$$

We use the simple procedure suggested in Greene (1993), p. 679. In case the null hypothesis is rejected, we will use the Negative Binomial Regression Model (NEGBIN) instead. This model allows the variance of the process to differ from the mean.

In addition to the grain prices in log levels, we also test for the influence of unexpected price shocks on the number of accusations per year. To get a time series of price shocks for our observation period, we fitted a structural time series model to the data by using the Kalman filter approach (Harvey 1992, p. 100ff). The model has two equations: the measurement equation

$$p_t = \begin{pmatrix} 1 & 0 & 1 & 0 \end{pmatrix} \alpha_t + \varepsilon_t, \quad \varepsilon_t \xrightarrow{d} NID(0, h), \tag{7}$$

and the transition equation

$$\alpha_t = \begin{pmatrix} \mu_t \\ \beta_t \\ \psi_t \\ \psi_t^* \end{pmatrix} = \begin{pmatrix} 1 & 1 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & \cos\omega & \sin\omega \\ 0 & 0 & -\sin\omega & \cos\omega \end{pmatrix} \begin{pmatrix} \mu_{t-1} \\ \beta_{t-1} \\ \psi_{t-1} \\ \psi_{t-1}^* \end{pmatrix} + \underbrace{\begin{pmatrix} \eta_t \\ \xi_t \\ \kappa_t \\ \kappa_t^* \end{pmatrix}}_{\eta_t}; \quad \eta_t \xrightarrow{d} NID(\mathbf{0}, \mathbf{Q}) \quad . \qquad (8)$$

The first two elements of the state vector**,** α_t, are the level (μ_t) and the slope (β_t) of a local linear trend. In addition, we assume that the grain prices have a cyclical component with period $2\pi/\omega$. The basic principle of the Kalman filter is the following: in each period t, we calculate forecasts of p_t based on the state vector of the previous period α_{t-1}. The forecast error will be used to update the state vector for the next forecasting step. What we are interested in is the forecast error: people know that prices will fluctuate according to the above model. As long as the forecast error is not unusually high, they will not change their behaviour. Dependent on the size and direction of the error, the "tolerance" towards witches might change.

3.3 Results

To control for price changes which contemporaries saw as clearly not attributable to the influence of witches, we added dummies to the model to account for the *Kipper und Wipper* inflations in 1618-1623, 1659-1667, and 1676-90. We also took into account the influence of the Thirty Years War (1625-26 and 1632-37) by introducing a dummy for the period. In addition, we added a dummy for the extreme year 1590.

We start by looking at the Poisson model for prices in log levels. The vector of independent variables is given by

$$\mathbf{x}_t = \begin{pmatrix} 1 \\ AUG_t \\ D_t^{KW} \\ D_t^{WAR} \\ D_t^{1590} \end{pmatrix};$$

where AUG_t is the log price level in Augsburg, D_t^{KW} is a dummy which takes the value 1 during *Kipper und Wipper* inflation periods, D_t^{WAR} is a dummy taking into account the war years, and D_t^{1590} corrects for the extreme witch hunt in 1590. The result of the exercise are displayed in Table 1.

Table 1: Results for the Poisson Model, Price Levels

Parameter	Estimate	Standard Error
CONS	-1.0409	0.3036
AUG	0.5243	0.0438
D^{KW}	-0.2774	0.0630
D^{WAR}	-1.7341	0.1868
D^{1590}	2.3936	0.0537
Log-Likelihood = 31.26		n = 149

All parameters are significant on conventional levels, and show the expected sign: during the *Kipper und Wipper* inflation period, people were aware of the fact that the observed price increase is not due to changes in supply, but was a consequence of debasement. The Thirty Years War and the Swedish occupation had obviously a negative influence. As we cited above, "peace-time pursuits like witch-hunting simply stopped". In addition, the estimated parameter for the 1590-dummy shows that we have to control for the outlier.

The interesting parameter, however, is *AUG*. It is significantly positive, i.e. a price increase leads to an increase in the number of accusations. The Poisson model allows to calculate two interesting measures which help to interpret the outcome. The first one is the expected value of accusations, given a certain vector of independent variables. For the price variable we chose the sample mean; the rest of the variables was set to zero (i.e. assuming a "normal" year), with the exception of the constant. As result, we obtain E[ACC]=12.79 over the sample period.

The other measure is the change in the expected value of witch accusations, dependent on the change in the price. In our case, we obtain $\frac{\partial E[ACC]}{\partial AUG} = \overline{ACC}\beta_2 = 7.77$, where $\overline{ACC}$ is the sample mean of the accusations and β_2 is the estimated parameter for *AUG*.

As stated above, the Poisson model has been criticised for not taking into account the possibility of overdispersion, i.e. the possibility that the actual distribution of the data might not fulfil the requirement E[*ACC*]=Var[*ACC*]. In fact, testing for overdispersion following the procedure proposed by Cameron and Trivedi (1990) shows that we have reject the hypothesis E[*ACC*]=Var[*ACC*].[3] Reestimating the relationship using the NEGBIN model leads to the results displayed in Table 2.[4]

Table 2: Results for the NEGBIN Model, Price Levels

Parameter	Estimate	Standard Error
CONS	-0.6239	0.5535
AUG	0.4619	0.0824
D^{KW}	-0.0456	0.1238
D^{WAR}	-1.3050	0.4659
D^{1590}	2.2798	0.2386
γ	2.9499	0.1583
Log-Likelihood = 37.82		n = 149

Obviously, there is no dramatic change in the parameters, all have the same sign as before and about the same size. The partial derivative of E[*ACC*] with respect to *AUG* is given by $\frac{\partial E[ACC]}{\partial AUG} = \overline{ACC}\beta_2 = 6.85$, and the expected value is E[*ACC*]=12.66.

Maybe more interesting is the analysis of the influence of price shocks, which we obtain as output (standardised residuals) from the Kalman filter procedure described above. The vector of independent variables is now given as

[3] The same is true for all the other models presented here (results are available on request).

[4] We follow King (1989) and use the following specification for the variance:

$$\mathrm{Var}[acc_t] = \lambda_t\left(1 + \exp(\gamma)\right)$$

$$\mathbf{x}_t = \begin{pmatrix} 1 \\ SHOCK_{t-1} \\ D_t^{KW} \\ D_t^{WAR} \\ D_t^{1590} \end{pmatrix};$$

Where $SHOCK_{t-1}$ denotes the price shock in the previous period;[5] all other variables have the same definition as in the models for the price level. The results for the Poisson model are displayed in Table 3.

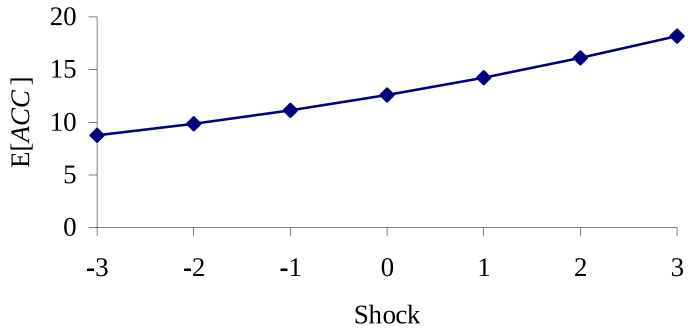
Table 3: Results for the Poisson Model, Price Shocks

Parameter	Estimate	Standard Error
CONS	2.5336	0.0272
SHOCK	0.1224	0.0216
D^{KW}	-0.2415	0.0633
D^{WAR}	-1.2631	0.1823
D^{1590}	2.5117	0.0535
Log-Likelihood =30.90		n = 149

The sign of the parameter for the SHOCK variable is positive; for the other parameters, there is no major difference to the price level model. Since we use standardised residuals now, we can construct comparable graphics were we plot E[*ACC*], dependent on the size and the sign of the shock. We choose the shock variable to be *SHOCK*=-3,-2,-1,0,1,2,3. The result for the Poisson model is displayed in Figure 3.

[5] We also tried the price shock in period *t*, but the result was not significant, not only in statistical terms, but also in terms of influence on the number of accusations. To understand this, we have to consider that the winter price - that did put the hardest pressure on the population - is determined mainly by the harvest months of the preceding year.

Figure 3: Accusations Dependent on Price Shocks, Poisson Model



Obviously, the higher the price shock in the previous period, the higher the expected value of witch accusations in the current period. The reaction of the expected value with respect to a change in the shock is given by $\frac{\partial E[ACC]}{\partial SHOCK} = 1.81$, i.e. lower than the reaction towards an increase in the overall price level.

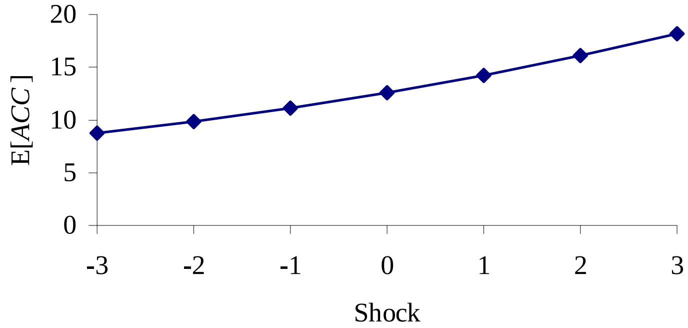
As already stated, there is evidence for overdispersion in the data. Hence, we also look at the results for the NEGBIN model, which are displayed in Table 4.

Table 4: Results for the NEGBIN Model, Price Shocks

Parameter	Estimate	Standard Error
CONS	2.5027	0.1165
SHOCK	0.1094	0.0790
D^{KW}	0.0227	0.1577
D^{WAR}	-0.8149	0.4560
D^{1590}	2.4415	0.2374
γ	3.0007	0.1607
Log-Likelihood = 37.78		n = 149

This time, the results change slightly: the *Kipper and Wipper* dummy is no longer significant, and the SHOCK parameter is less precisely estimated than before. However, the reaction of the expected value of accusations to a shock increase is not very different from the above result: $\frac{\partial E[ACC]}{\partial SHOCK} = 1.62$. In addition, the expected value shows a similar pattern dependent on the size and sign of the shock as above (see Figure 4).

Figure 4: Accusations Dependent on Price Shocks, NEGBIN Model



4 Regional Patterns of Witch Hunting

4.1 Constructing a Data Set of Regional Accusation Intensity

A considerable attention of witch hunting research has been devoted to cross-sectional patterns of persecution intensity. However, the absolute figures that are normally considered tend to be misleading, because in a more densely populated region the expected value of accusations is also higher. An obvious alternative would be to look at per capita accusations. However, population figures on Southern Germany are not available on a regional basis. We therefore use the oldest population figures with the required coverage, which are based on the Montgelas census of 1809/1810. To use such a late set of figures, we have to assume that the population was growing at more or less the same pace in all regions, because population in the time period around 1800 can be considered as maximum value compared with the other pre-industrial time periods between 1550 and 1700. Until around 1600, population was increasing, catching up after the large demographic loss of the 14th century. During the Thirty Years War, population declined dramatically (around one third) and started thereafter its long recovery from the middle of the 17th to the late 18th century. During the time period when most accusations took place, the late 16th and early 17th century, population was at a climax point. It is not unreasonable to assume similar mechanisms during this maximum compared with the climax around 1800: Probably the most fertile, grain or cash crop producing regions allowed the highest population density. The presence of proto-industrial activities also increased the potential population per unit of arable land, for example, in the region south of Augsburg. If there would be bias created from the unavailability of contemporary population figures, it would most probably relate to those regions with a high population potential, because those regions tend to lose the highest share of population during crisis periods.[6] In our example, this would produce a too large denominator for the regions along the Danube river, causing the accusation per population figure to be too low there - this possibility is, however, not very realistic given that it is already quite high in those regions.

[6] Baten (1993), describes using a local example how relatively remote regions suffer less in relative terms.

4.2 Hypotheses about Regional Persecution Intensity

A number of - sometimes heavily contested - hypotheses have been put forward in witch hunting research. These include a higher intensity

(0) in catholic regions (Midelfort 1972)

(1) in Alpine (Trevor-Roper 1990) or *Mittelgebirge* regions (Schormann 1981).

(2) when the counter reformation was intensified (over time). Transformed into a regional cross-section, this could imply that catholic regions adjacent to protestant territories could display a larger propensity to persecute.

(3) in smaller territories. Behringer (1997) argued that in larger territories, a system of "checks and balances" might have kept the number of trials and burnings down, because many institutions were involved. In most small territories there was a single authority responsible for with trials.

(4) in densely settled, heavily urbanized territories, or regions which were connected by navigable waterways. In those regions, both the accusations itself and the staff of witch trials (the professional persecutors) could have moved more easily from one place to the next. We will call this an "epidemiological" spread of witch persecution (Behringer 1997).

(5) a combination of (3) and (4): regions of larger territories that were on the border of the smaller territories might have experience some spread of the epidemics across the border.

4.3 Looking at the Map

A simple glance at the map reveals that the largest regional clustering of regions with accusation intensity is in the Western Danube area, between Abensberg and Donauwörth. Note that no data is available on the "white spots" on the map (*Hochstift* Eichstädt and

Passau, Ansberg, Upper Palatinate and the whole Northern region). The Eastern, densely settled part of the Bavarian duchy stands out as having a relatively low accusation intensity, only somewhat higher in the regions adjacent to Werdenfels (that belonged to *Hochstift* Freising, with an extremely high propensity to persecute), and to Neuburg and Augsburg (for example, Rain and Ingolstadt). The *Reichsstadt* Augsburg is not shown on the map (in the centre of the rural district of Göggingen) had a modest persecution intensity.

What distinguishes regions with high accusation intensity from those of lower intensity? Using the Bavarian data set, we can say little about religion: Apart from a few *Reichsstädte*, all of our territories were catholic. Proximity to protestant territories could be factor, because some Northern districts had a higher persecution intensity than the Southern districts. But there are a lot of exceptions from this rule (Werdenfels, Traunstein). The same consideration applies to urbanisation and an "epidemiological" model of witch hunts, which would suggest spreading accusations along large rivers and main roads. There is some evidence in the urbanized Danubian regions, but many counter-examples (the East of the Danube valley between Kelheim and Passau has only average persecution intensity).

A common factor to many territories with high accusation intensity is their small size. However, the only large territory in our sample is the Bavarian duchy; and the fact that there is just one case reported might bias the result. Moreover, the Neuburg duchy as the second largest territory displayed a relatively strong persecution intensity. The very small *Reichstädte* (not shown in the figure) rank at the lower scale of accusation intensity.

To test this formally, we performed a set of cross-sectional regressions.[7] We coded those territories that had a substantial share of a “smaller” territory as “SM_TER”. We considered the Duchy of Neuburg as “large territory” (it had a larger counterpart in the Palatinate).

As a result, the population density variable was in fact negative, somewhat contrary to our initial expectations. Multicollinearity did not play a major role in this context. The dummy variable for smaller territories was not far from being significant at the 10% level. Adjacent regions of Bavaria and Neuburg that bordered the small principalities exhibited a higher persecution intensity. Hypotheses about mountainous region exhibiting stronger persecution propensity are clearly rejected, at least with our data set, and other variables were also not influential. The relatively low R^2 of 0.16 (adjusted 0.07) indicates that for regional cross-sections, little explanation is possible on the basis of the existing hypotheses that we have chosen for examination.

[7] This can also be called analyses of variance, because all exogenous variables are coded as dummies.

Table 5: Results for the Regional Analysis

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,393[a]	,155	,070	1,2270

a. Predictors: (Constant), HLANDPPL, MOUNT, BORDPROT, ADJSMT, HNONAGR, SM_TER, HPOPDENS, HINFRA

b. Dependent Variable: LGVPPOP

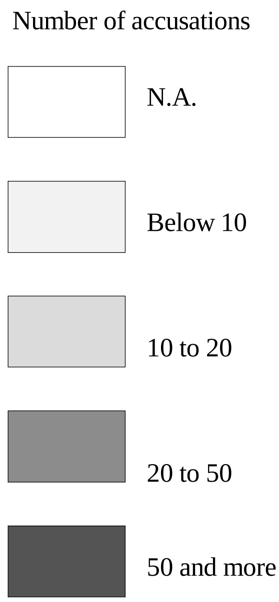
Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	2,582	,382		6,752	,000		
	BORDPROT	-,259	,499	-,062	-,519	,605	,749	1,336
	MOUNT	-,217	,306	-,080	-,711	,479	,838	1,193
	ADJSMT	,720	,316	,249	2,282	,025	,886	1,129
	SM_TER	,494	,300	,187	1,645	,104	,816	1,226
	HPOPDENS	-,773	,313	-,297	-2,470	,016	,731	1,368
	HNONAGR	-2,17E-02	,301	-,008	-,072	,943	,884	1,132
	HINFRA	-1,85E-02	,350	-,007	-,053	,958	,593	1,687
	HLANDPPL	4,483E-02	,301	,018	,149	,882	,750	1,333

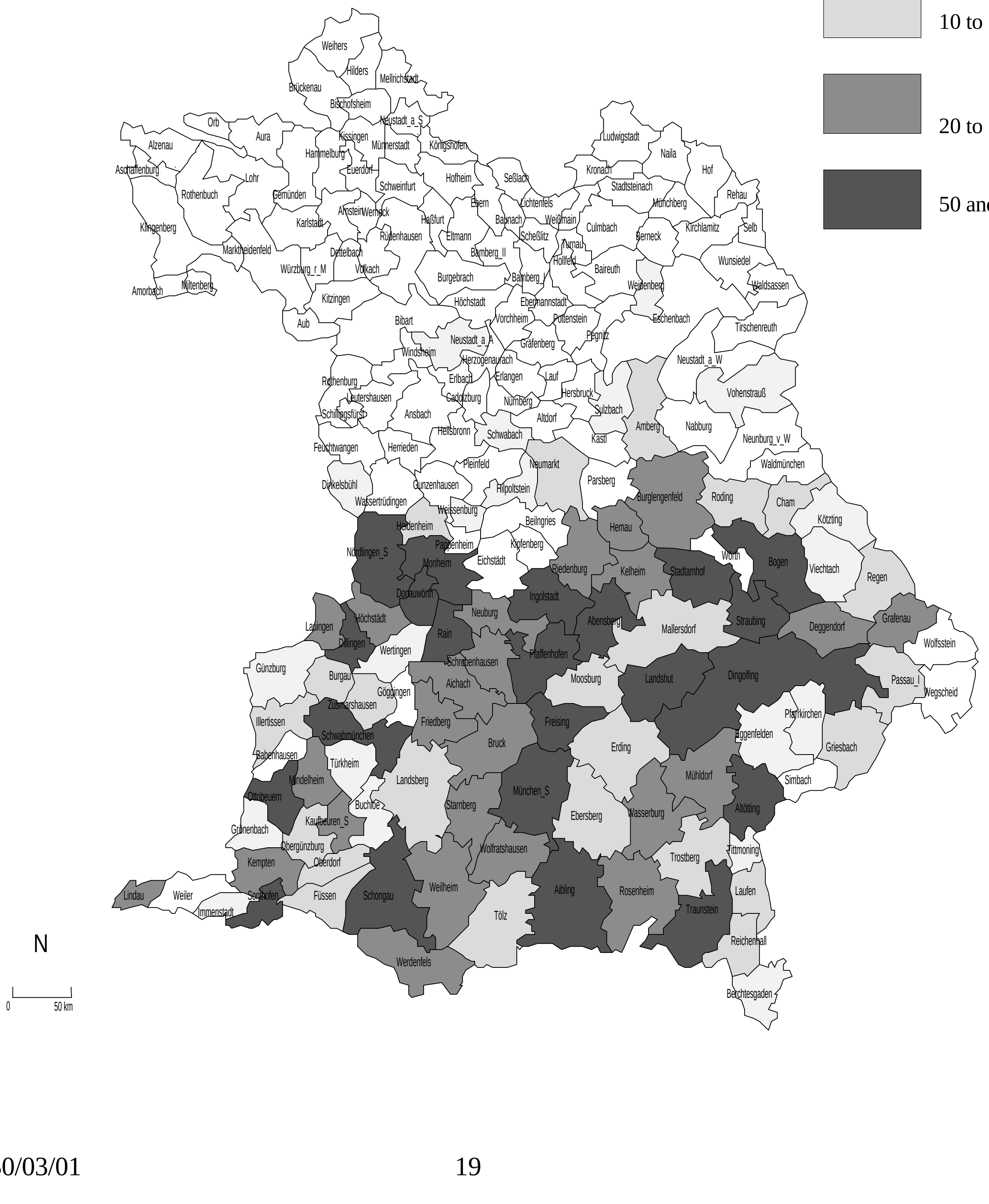
a. Dependent Variable: LGVPPOP

Variables:
ADJSMT = 1, if district is adjacent to one of the small territories, else 0
BORDPROT = 1, if territory is adjacent to one of the protestant territories, else 0
HLANDPPL = 1, if the average size of agricultural holdings was above average, else 0
HPOPDENS = 1, if population density in 1809/10 was above average, else 0
MOUNT = 1, if district was mostly above 700 m, else 0
PROT = 1, if district had at least 33% protestants in 1852, , else 0
SM_TER = 1, if territory is smaller than Neuburg, , else 0

Source of measurement variables: Munich Database on Bavarian Living Standards



Map 1: Absolute number of accusations



A. per 10000 Inhab.:

N.A.

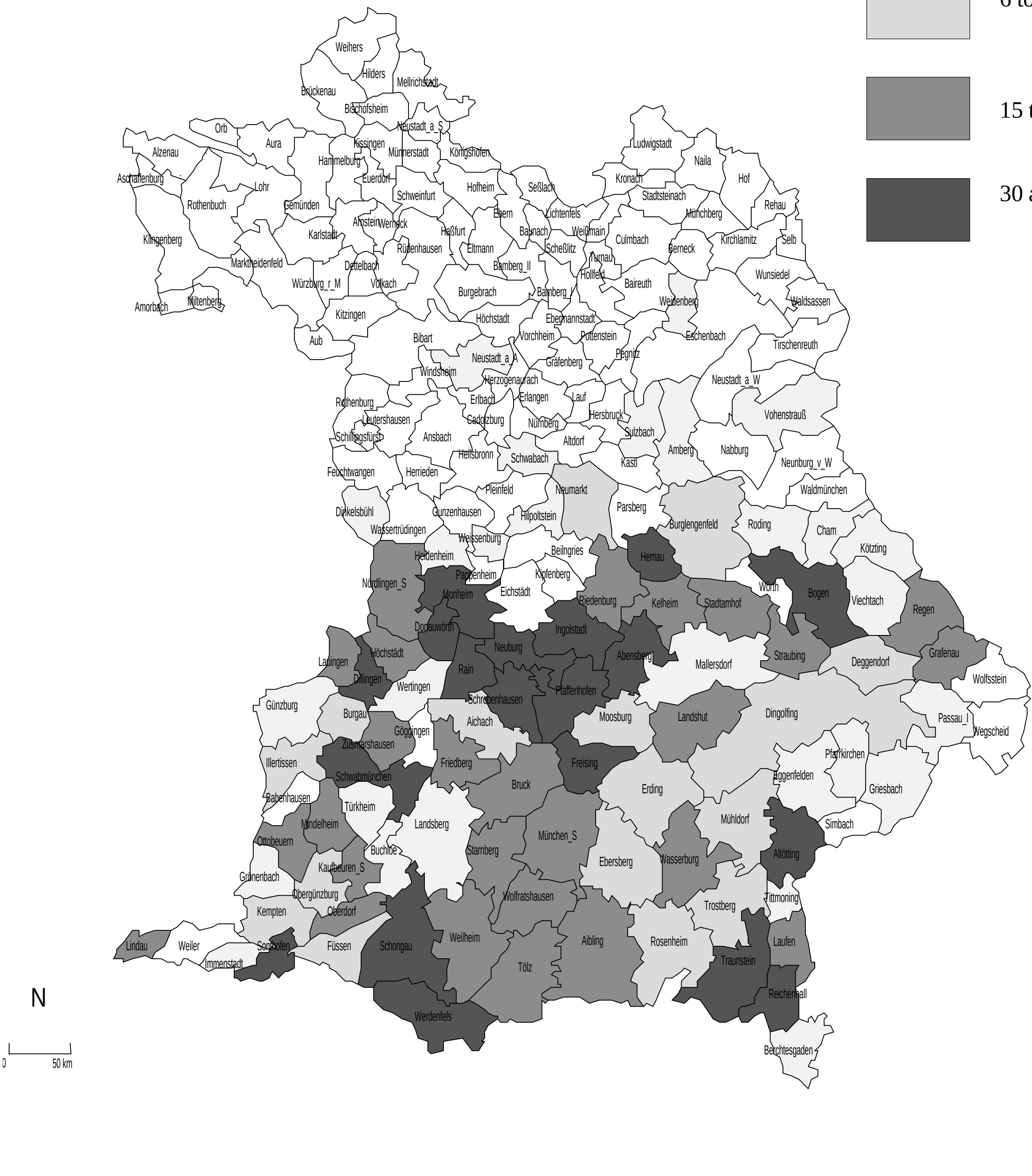
Below 6

6 to 15

15 to 30

30 and more

Map 2: Accusations per 10000 Inhab



5 Conclusions

This exploratory study considered potential determinants of witch accusation intensity over time and across regions. Over time, special attention was devoted to short- and medium term variations in the willingness of people to persecute their neighbours as witches. We found that the moving average of grain price was correlated to the number of accusations in the late decades of the 16th and the earliest and latest decades of the 17th centuries. Considering the long run, those periods were times of population maxima and high grain price levels, so the more difficult general situation might have strengthened the correlation between short-term economic hardship and the propensity to look for scapegoats.

However, the short term variation of prices is only an approximate indicator, because it is difficult to adjust for inflation during this early period. We therefore estimated the impact of shocks that were defined as sudden increases of grain prices that stand out clearly even if the price variation of the years before shock are considered. These shocks lead to a considerable increase in witch-hunting activity in the following year.

In a cross-sectional analysis, a number of hypotheses were tested. We were able to reject Trevor-Roper's and Schormann's ideas that people living in mountainous regions are more prone to accuse women as witches. In contrast, Behringer's qualitative judgement that small territories display more persecution activity could not be rejected, but turned out to be only weakly significant. We found empirical evidence for our additional hypothesis that the intensity in the adjacent regions of larger territories was higher. Other variables, such as population density or neighbourhood to navigable waterways, turned out to have no effect.

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