A Game Theoretic Analysis for Witch Killing and Human Sacrifice

Ding Fengming, 119020147
Yu Qinyang, 120020054
Wu Yiqiu, 120020173

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1 Introduction and motivation

Witch killing, or witch hunting, was originally a moral panic and political purge of women who had been labeled as witches. This phenomenon derives from medieval Europe and reached its peak at the 16^{th} century. Official legislation against witch killing has been established to prevent social turbulence in most modern societies. However, the cruel custom has survived until today in some African and Indian villages. Stripped of the Christian context and strengthened by local religious attributes, the practice of witch killing evolved into a manifestation of human sacrifice, while its essence of mass hysteria and religious persecution remains unchanged. Extensively documented in Kenya, Mozambique, Uganda, and Zimbabwe (EWD, 2002), witch killing is still prevalent in most rural areas. Over 400 witches have been killed since 1985 in poor northern provinces of South Africa (Niehaus, 2001).

To bystanders, the cause of the formation and cultural inertia of witch killing are perplexing. Underlying factors involve poverty, lack of infrastructure and public facilities, blocked information in remote areas, illiteracy and ignorance, superstition, personal enmity, and rural religious power dynamics (Nath, 2016). To generalize, the witch-killing phenomenon occurs mainly through cultural and economic channels. Witchcraft belief, as the cultural channel, is widespread throughout Sub-Saharan Africa and India. The religious belief misleads people to regard their misfortunes caused by random events as human-induced and pin the blame on a particular witch (Evans-Pritchard, 1937). Miguel (2005) creatively proposed another economic channel in his empirical research and verified that there exists a strong negative relationship between income shock and the witch murder rate. Copious literature also supports the view that poverty and violence always go hand in hand since a slumping economic situation leaves desperate people with nothing to lose and makes crimes a means of grabbing resources.

As a violation of humanitarianism, witch killing seriously damages women's human rights and reflects gender inequality. So far, many strategies have been invented and implemented by the local government to abolish this barbaric practice but with little success. Our study aims to employ a game theoretic model to capture key influencing factors, investigate the rationale of decision-making behind witch killing, and explore possible preventive solutions. Such policy implications are of great significance in protecting women and promoting the supremacy of human rights.

2 Game theoretic framework

2.1 Model specification

Consider a two-player game between the religious leader (denoted as L) and people living in the village (denoted as P). Assume that a disaster (i.e. flood, drought, or plague) hits the village in period j. As a superstitious tradition, both the leader and villagers need to jointly decide whether to sacrifice a living person in their native religious ritual to invoke religious salvation. The person to be killed may have committed serious crimes to endanger the interests of the community but may also be just a sinless scapegoat (mostly an old woman) who is accused of witchcraft. The randomness of the sacrificer's humanity is common knowledge for everyone. We assume the villagers hold the prior belief that the sacrificer's nature is innocent with probability p and guilty with probability $1-p$.

In this game, there is an information asymmetry between the leader and the villagers. The leader, as the religious authority, has the power to determine who should become the next sacrificer in the village. He may purge evildoers to promote justice for the community (assume this action to be relatively legitimate in the murdering setting) but may also take revenge on his enemies for his own gain or incriminate someone innocent to consolidate religious power over the village. In this sense, the leader gains an information advantage from his position. However, the sacrificer is a stranger to most villagers, and they cannot observe the sacrificer's true state. Thus, the sacrificer's nature is private information for the leader. This situation is captured by the incomplete information framework. According to different private information the leader possesses, we divide his role into an "innocent type" leader and a "guilty type" leader, referring to when he faces an innocent sacrificer and a guilty sacrificer. The villagers then hold a posterior belief that they may encounter an "innocent type" leader with probability q and $1-q$ otherwise. Here the villager's belief should follow the Bayesian update rule given the leader's action profile.

The game is represented as a tree diagram (Figure 1) and interpreted as follows. Nature moves first and decides the sacrificer's state. The leader observes the sacrificer's nature and decides whether to issue the order to kill him. If the leader decides not to kill, the game ends immediately and everyone gets 0 payoffs. If the leader decides to kill, then the villagers have the option to accept or reject the impending witch killing. If the villagers accept, the murder happens with a probability of 1. The leader gains a reputational benefit (denoted as R) from the killing ritual but at the same time faces a potential defamation loss (denoted as D) when he deliberately kills an innocent sacrificer. The villagers gain a utility from killing (denoted as U_p), which is a function of multiple factors and varies by different leader types.

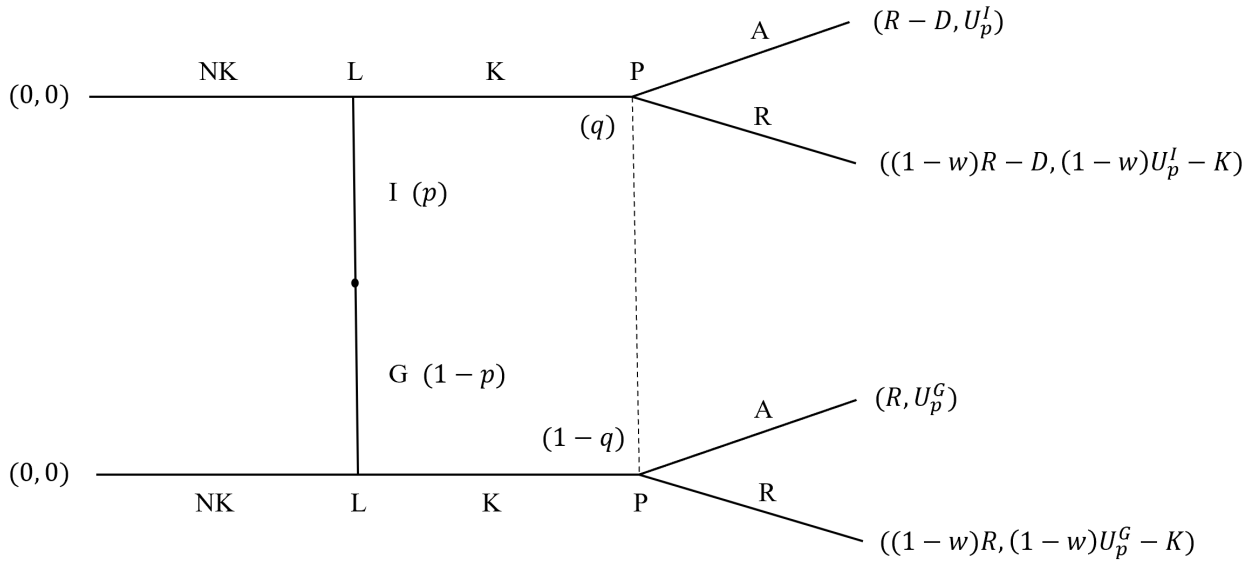

Figure 1: the game tree under incomplete information

If the villagers reject, they have a chance of w to stop the murder but also face the price of antagonizing the leader (denoted as K) since the disobedience would arouse grudge from the leader and make them more likely to be the next victim. The magnitude of w depends on the relative discourse power of villagers against the leader in the religious context.

A villager i's utility function from killing contains four main factors and is specified as follows:

$$u_i(t_i, y_j, e_i, c_j) = -\frac{(1-\delta)t_i}{y_j} - e_i - c_j$$

where t_i denotes the subjective threat that a witch poses to a villager, which brings a negative payoff. This variable measures the degree to which the religion penetrates villagers' minds. y_j is the harvest or income of the community in period j, which reflects an individual's economic status in those poor and agricultural-based areas. With these two variables, we derive the disutility of a witch's threat to be $-\frac{t_i}{y_j}$, which is identical to the utility of not killing a witch. This formula contains both cultural and economic channels to explain the hatred towards witchcraft. y_j, as the denominator, measures the extent of economic influences on cultural factors. Mathematically, it represents the sensitivity of religious fear toward witches based on different income levels. The derivative of the witch threat utility function is $\frac{\partial u}{\partial t_i} = -\frac{1}{y_j}$. This property implies if the villagers have a lower income, a unit increase in the religious trust will bring a stronger hostility and a more negative payoff, indicating the mechanism that poverty reinforces religious beliefs. δ measures the extent of religious relief from witch killing. We assume $0 < \delta < 1$ to denote the limited effectiveness of the relief. After witch killing, villagers' payoff increases by $\frac{\delta t_i}{y_j}$. e_i measures the evaluation of villager i toward the sacrificer. We assume the evaluation toward an innocent sacrificer $e_{iI} > 0$ and the evaluation toward a guilty sacrificer $e_{iG} < 0$. Thus, killing an innocent person reduces the villagers' payoff, and killing a guilty person increases the villagers' payoff. c_j denotes the generalized potential cost of murder, which is an increasing function of round j. It includes

the higher risk of being the next victim since the headcount declines and the probability of being identified by the leader as a witch is higher as the game proceeds. It also includes punishment and regularization from the local government and the police, the intensity of which gradually increases in j.

To better understand the practical meaning of this utility design, we derive the condition that villagers are willing to accept witch killing:

$$E[u_i(witch\ killing)] \geq E[u_i(witch\ threat)]$$

$$-\frac{(1-\delta)t_i}{y_j} - e_i - c_j \geq -\frac{t_i}{y_j}$$

$$\frac{\delta t_i}{y_j} \geq e_i + c_j$$

The left-hand side of the inequality involves factors that encourage witch killing while the right-hand side of the inequality involves factors that restrain witch killing. With a larger relief effect, greater witch threat, or lower income level, villagers are more likely to accept the legitimacy of witch killing. With higher evaluation or murder costs, villagers will prefer to consider witch killing as illegitimate. Eventually, we denote villagers' net utility from killing as U_p, where $U_p = \frac{\delta t_i}{y_j} - (e_i + c_j)$. Villagers choose to accept if $U_p > 0$, reject if $U_p < 0$, and be indifferent if $U_p = 0$.

To make the model conform to reality and to rule out some boring or extreme cases, the following three assumptions are made:

$$(1-w)R < D < R \tag{1}$$

$$wU_p^I + K < 0 \tag{2}$$

$$Normally, U_p^G > 0, U_p^I < 0\ ; \quad (1-p)|U_p^G| \geq p|U_p^I| \tag{3}$$

Assumption (1) claims that the leader's defamation loss would be less than his reputational gain if villagers accept his order but would be greater if villagers reject his order. Assumption (2) claims the return for saving an innocent person would be greater than the cost, justifying the villager's resistance motivation. Assumption (3) firstly made an intuitive statement that a positive e_i^I leads to a negative U_p^I while a negative e_i^G leads to a positive U_p^G. Furthermore, it reveals a conservative estimation of humanity. The positive evaluation of an innocent stranger would be moderate, but the negative evaluation of a guilty stranger would be tremendous. Thereby the positive payoff from killing a guilty sacrificer would be sufficiently higher than the negative payoff from killing an innocent sacrificer, weighted by the prior probability. Here, the term "normally" averages the effects of variables other than e_i. For example, extremely low income in a blank year or radical religious fanaticism in some villages may lead to a positive U_p^I, which are considered special cases beyond the scope of our study focus.

2.2 Baseline SPNE with complete information

Firstly, let us simplify the game as a sequential game with complete information, where both the leader and villagers realize the sacrificer's nature. The equilibrium is characterized as a baseline comparison. Using Assumptions (2) and (3), we know $U_p^I < (1-w)U_p^I - K$ and $U_p^G > (1-w)U_p^G - K$. Based on backward induction, villagers will reject given that the leader chooses to kill an innocent sacrificer and will accept given that the leader chooses to kill a guilty sacrificer. Knowing this, the leader compares his payoffs between killing and not killing. Using Assumption (1), when facing an innocent sacrificer, he gets 0 payoffs from not killing and gets a negative payoff of $(1-w)R - D$ from killing. When facing a guilty sacrificer, he gets 0 payoffs from not killing and gets a positive payoff of $(1-w)R$ from killing. Thus, his best response is not to kill an innocent sacrificer and kill a guilty sacrificer.

To conclude, the SPNE of this game is $(NK|I, K|G, R|IK, A|GK)$. This benchmark equilibrium can be interpreted as social optimum in terms of efficiency, since all guilty people face the penalties they deserve while no innocent people are unjustly accused and sacrificed in this system.

2.3 PBE with incomplete information

Now consider the case with incomplete information. When the leader faces a guilty sacrificer, killing is his dominant strategy regardless of the villagers' choice. This leaves us two candidates for PBE.

Consider the separating strategy set where the leader chooses to kill a guilty sacrificer and not kill an innocent sacrificer first. Given this strategy profile, the villagers believe that the sacrificer is innocent with 0 probability according to the Bayesian update rule ($q = 0$). Thus they know if they are at their decision node, they must face a "guilty type" leader, and their best response is to accept. However, since villagers' acceptance will also bring a positive payoff when the leader kills an innocent sacrificer, the leader will deviate by choosing to kill. Hence, the separating PBE, $(K|G, NK|I, A)$ *with* $q = 0$, is invalid.

Lastly, we consider the pooling strategy set where the leader chooses to kill the sacrificer regardless of his nature. Given this strategy profile, the villagers believe that the sacrificer is innocent with probability p according to the Bayesian update rule ($q = p$). The villagers' expected utility of accepting is $E[U_p(A, K)] = pU_p^I + (1-p)U_p^G$, while the villagers' expected utility of rejecting is $E[U_p(R, K)] = p[(1-w)U_p^I - K] + (1-p)[(1-w)U_p^G - K]$. By assumption (3), we obtain the following:

$$\begin{aligned} &E[U_p(A, K)] - E[U_p(R, K)] \\ = pU_p^I + (1-p)U_p^G - p[(1-w)U_p^I - K] - (1-p)[(1-w)U_p^G - K] \\ &= pwU_p^I + (1-p)wU_p^G + K \\ &= w[pU_p^I + (1-p)U_p^G] + K \\ &= w[(1-p)|U_p^G| - p|U_p^I|] + K > 0 \end{aligned}$$

Thus, $E[U_p(A, K)] > E[U_p(R, K)]$, so the villagers' best response is to accept. Given the villagers' choice, we check the leader's incentive again and confirm that $K|I, K|G$ is indeed his best response since both scenarios bring a positive payoff.

In short, the unique PBE for this incomplete information game is the pooling PBE $(K|I, K|G, A)$ *with* $q = p$. This PBE illustrates the reason why witch killing is mutely accepted by the community and the inhumanity behind is permitted in a legitimate way. Even though the villain may be only a small minority, religious incitement demonizes innocent witches as a hideous image and confuses the benighted public who are uncertain about humanity. As the equilibrium deviates from the efficiency, the collective verdict fails to enforce its fair judgment power and gradually turns into collective violence in such a religious system.

3 Model implication and preventive approaches

In this section, we propose five dimensions of potential solutions to witch killing. Each approach has its own advantage or limitation, together bringing certain policy implications or mechanism improvements. Some approaches aim primarily to minimize the sacrifice of innocent people, while most approaches work to reduce the overall event rate of collective sentencing regardless of the sacrificer's nature according to the norms of modern law-based society. Relevant parameters in the model are adjusted as an indication.

3.1 Income: y_j

Recall the condition for villagers to accept witch killing is $U_p = \frac{\delta t_i}{y_j} - (e_i + c_j) > 0$. Thus, a larger y_j partials out the impacts of religious threat, reduces the utility of witch killing, and makes $(1-p)|U_p^G|$ smaller than $p|U_p^I|$ after weighting, eventually increasing the expected utility of rejecting.

This approach works through the economic channel, where enough wealth alleviates the shortage of living resources and reduces the poor's criminal motives. In reality, elderly women and baby girls are most likely to be the victim because they have the least labor productivity. These witches contribute little to the local economy and are seen as economic burdens, especially in bad years. Miguel (2005) proves that extreme rainfall brings income shock and further leads to a higher witch murder rate in rural Tanzania.

Through this channel, public economic policies can play a positive role in eliminating witch killing. According to Miguel, the local government can improve the system of formal insurance against extreme weather to help households smooth their consumption across bad years or provide elderly women with regular pension schemes to transform a net household liability into an asset. Poverty relief and employment programs can also be implemented in rural areas.

However, these measures often fail in reality. Financial aid comes with high costs and calls for strong government intervention. Unfortunately, most governments in these areas are too poor to afford such a large transfer payment, which therefore is not a sustainable solution. Besides, poverty relief and employment programs are hard to carry out due to the single and inflexible agricultural-oriented economic structure in these areas. As a result, solutions through the income channel are fundamental but hard to reach in practice.

3.2 Witch's threat: t_i and δ

The witch-killing phenomenon is deeply rooted in the extent of religious belief in witchcraft, denoted as the threat of a witch t_i in the model. If t_i is reduced to some degree, then the declining utility of witch killing will increase the expected payoff of rejecting through the same way as y_j does. Alternatively, if the relief effectiveness δ of a witch's threat becomes smaller, the ritual loses its magic and becomes redundant for villagers. To differentiate, t_i and δ represent the long-run static and short-run dynamic influences of religion on thoughts, respectively.

To reduce religious penetration, the most effective way is through educational guidance and scientific popularization. Even though this measure is straightforward, it may not have immediate effects and require long-term efforts since such religious beliefs are inveterate, intergenerationally inherited, and difficult to disprove. For example, the mitigation of a disaster, which can be explained by a natural fluctuation, may be wrongly interpreted as the impact of witch killing and further reinforce villagers' religious identification. For low-educated villagers, the mystical worldview of religion is more attractive compared to science and hard to transform in a short term.

3.3 Family bonds: e_i

Under the setting of incomplete information, the nature of the sacrificer is decisive. In the previous model, we only assume there are two states of the sacrificer (i.e., innocent and guilty). However, if we take villagers' relatives or someone they care about into consideration, the equilibrium and villagers' choice may completely differ. To simplify, we use F to denote the family attribute. Now three types of sacrificer's nature are specified, including innocent (I), guilty (G), and familial (F).

We mainly focus on areas where people are presumed to attach great importance to family and examine how the involvement of relatives will change the equilibrium outcome. Assume the accusation and death of relatives bring an enormous disutility to the villagers (denoted by $U_p^F << 0$) through an incomparably high evaluation e_i^F. We further denote that the potential sacrificer is a relative with probability m, an innocent strange person with probability n, and a guilty strange person with probability $1-m-n$. Based on the above assumptions, the following relationship is easily achieved due to an extremely negative U_p^F:

$$E[U_p(A,K)] - E[U_p(R,K)]$$

$$= mU_p^F + nU_p^I + (1-m-n)U_p^G - m[(1-w)U_p^F - K] - n[(1-w)U_p^I - K] - (1-m-n)[(1-w)U_p^G - K]$$

$$= w[mU_p^F + nU_p^I + (1-m-n)U_p^G] + K < 0$$

In this case, since the incomplete information disenables villagers from distinguishing the witch's true identity before making decisions, villagers are motivated to exclude the possibility of losing a close family member. Thus, they prefer R to refuse out of fear that their relative will be killed. Besides, it is obvious that m can be written as a function of round j, as the probability of family members being selected will increase in the upcoming round, multiplying the negative effects of U_p^F. As a consequence, villagers will have a much stronger motivation to reject killing.

Family values and the closeness of family ties vary from place to place and are largely rooted in regional cultural traditions. However, the government or anti-witch-hunting organizations can use education and advertising to cultivate villagers' sense of family and enhance family bonds as enlightenment for villagers' realization of life autonomy.

3.4 Murder cost: c_j

In the model, c_j denotes all the potential external costs of witch killing. A higher murder cost leads to a higher threshold for witch killing and a higher probability of villagers choosing to reject. In the model specification, we argue that c_j contains the risk of becoming the next victim and the pressure from the government or the police. Here, we further subdivide the latter's intervention policies into two parts, including the regulatory punishment system and the social welfare system. Then c_j can be decomposed into three parts:

$$c_j = (risk\ of\ being\ the\ next\ sacrificer) + (regularatory\ punishment) + (loss\ of\ social\ welfare)$$

The first part of c_j automatically increases as the stage number accumulates. Thus, no manipulation is needed, and a rational villager will be more likely to reject as j increases.

The second part of c_j prompts the government to conduct inspections of villages with witch-killing customs and impose severe legal punishment on villages that are found to have committed murders. The utility takes a form of a product of the punishment degree and the probability of being inspected. For villages where the frequency of witch killing is higher in the previous inspection, the government will pay higher attention to them and raise the inspection intensity for the next round, increasing the value of c_j and discouraging villagers to accept killing.

The third part of c_j functions similarly to the income channel. The government curbs the incidence of witch killing by establishing a social welfare system for the elderly, for example, granting subsidies to those unable to work. Suppose villagers choose to kill an old woman, then the whole village will face the loss of subsidy, forming a tradeoff between killing and its opportunity cost. The increasing c_j, together with the income relief from resource scarcity, thus reduces the incentive to murder.

3.5 Democratic power: w, K, and D

In addition to factors in the utility function, the discourse power of the public in religious affairs (w), the potential cost brought by resisting the religious authority (K), and the defamation loss of unjust treatment D can also affect the total payoffs of the leader and villagers. These three parameters denote the democratic power within the religion.

The discourse power w and the deformation loss D can be increased by education or political advertising. With stronger democratic awareness, villagers tend to be more proactive to fight for rights, stop the occurrence of witch killing with a higher probability, and play a more prominent role in rejecting killing under the condition $(1-p)|U_p^G| - p|U_p^I| < 0$. For the defamation loss, once the magnitude of D exceeds that of R, a separating PBE, $(K|G, NK|I, A)$ *with* $q = 0$, would then be valid. By intensifying the public negative response to leaders' injustice, the sacrifice of the innocent is minimized.

Reducing the potential cost K of rebelling against religious leaders, such as being ostracized or persecuted, would also give people courage to reject killing. The government can build an effective social security system to provide adequate assistance and protection for people bearing the cost and restrict the activity sphere of religious forces. The decreasing K will increase villagers' payoff of rejecting.

4 Conclusions

Motivated by the persistence of witch-killing phenomenon and the significance of prevention, our study presents a model that incorporates a sequential game and incomplete information. The model describes the mechanism behind witch-killing decisions in African and Indian villages, and explains why in most cases villagers tend to comply with the decision of religious leaders to kill the "witch" and accept the inhumane mass murder under incomplete information.

Our model implies by guaranteeing households' income, reducing religious penetration, strengthening family concept, increasing external murder costs, and enhancing democratic power in religious affairs, the local government can effectively influence villagers' choice and refrain the occurrence of witch killings. These approaches provide practical policy implications for local governments in countries where witch-killing events are rampant, advocating principles of modern societies (i.e., paramountcy of human rights). Moreover, our findings can further raise insights for addressing similar social issues and unethical behaviors, such as business irregularities and domestic violence.

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