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Max Krauskopf April 10, 2020

Trial by Ordeal: A Model of Trial Choices and Policy Restrictions

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Abstract

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Ordeals were a common trial method around the world, and particularly in western Europe, for hundreds of years. Despite this prevalence, ordeals as a trial method are often dismissed or ridiculed. This thesis explores the backgrounds and effects of 13th century legal systems that incorporated trials by ordeal. I hypothesize that the use of trials by ordeal enhances the efficiency of these legal systems. I use a game theoretical model to demonstrate how rational actors navigate a legal system containing ordeals. I expand on this model by further demonstrating how policymakers can use these rational responses to ordeals to maximize their utility, which I align with societal benefits. The outcomes and insights on behavioral effects from my model are applicable in informing policy recommendations on judicial reforms around the globe.

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Introduction

Burning coal, hot iron, and boiling water: seemingly unrelated, these three punishments were all used in trials by ordeal, a practice that dominated the legal system of medieval Europe for hundreds of years. It is easy to dismiss this practice as barbaric, a relic of the past. Such a dismissal is ignorant, the result of evaluating ordeals in the context of modern social norms and technology instead of those of the 13th century. Ordeals were commonly sought after by rational, utility-maximizing, actors and effectively ascertained guilt or innocence.

This paper presents a foundational game-theoretical model that provides the tools to examine relevant policy implications. I use this model to determine the effects that the presence of ordeals had on rational actors navigating the medieval legal system and to demonstrate how ordeals could be used by policymakers. Under ordeals, faith often led the guilty and innocent to opt for different trial methods. Policymakers can use this knowledge to enhance efficiency by limiting trial options, potentially forcing the guilty to plead. Such a plea saves societal effort and reduces the chance of the legal system making an error.

Ordeals represent the starkest differences in the societal roles of religion and technology between the 13th century and today. Without surveillance recordings or DNA evidence, it was often expensive, if not impossible, for a medieval court to come up with enough evidence for a confident conviction.

The secret behind ordeals' success is that they induce a separating equilibrium in which accused actors who are innocent and guilty opt for different trial methods (Leeson 2012). This equilibrium is maintained through the religiousness of medieval society. The prevailing belief, know as "Iudicium Dei", was that God was omniscient and performed miracles to save the innocent from ordeals (Ho 2003; Leeson 2012; Baker 2019). This belief was perpetuated through the fact that the outcomes of ordeals were secretly rigged by the clergy (Baker 2019).

The truth is, very few people suffered the cruel methods that ordeals seemingly promised. This misunderstanding is what causes so many to dismiss them today.

In fact, ordeals are still relevant in today's society. They are still used in different forms in some countries to this day, and they share commonalities with modern technologies, such as lie detectors, that could someday reinvent our legal landscape. While my model is tailored to best fit medieval European society, it remains useful in understanding the history of western legal systems, other countries that use ordeals, and new technologies with similar behavioral mechanisms.

In the following sections, I first review the background of ordeals in medieval European society and previous literature that proves helpful in constructing my model. Second, I present my methodology and mathematical model. Third, I report on the results of my analyses. Finally, I discuss my findings and present opportunities for future studies.

Background and Literature Review

Before the thirteenth century, the most serious legal trials were not resolved by judges or juries; they were resolved by making God the arbiter. Only through a miracle could a court ascertain guilt or innocence when evidence was otherwise lacking. To use God as the arbiter, one method the court turned to was trial by ordeal. Other common trial types in this time period included compurgation,[1] jury trials, bench trials, and ordeals better-known cousin, trial by combat (Baker 2019; McAuley 2006).

There were a few different types of common ordeals, generally separated into the categories of hot and cold ordeals. Some of the most common included plunging one's hand

[1]Compurgation is a public exclamation of one's innocence and character by unrelated witnesses. Trial by compurgation generally resulted in much lower conviction rates than other trial types.

into a bucket of boiling water, grasping a hot iron poker, walking across a bed of burning coals, and seeing if one floats or drowns when submerged in freezing or boiling water. With all of these ordeals, if the accused survived and was unharmed, they were considered innocent of all wrongdoing; otherwise, they were guilty and to be sentenced to the punishment associated with the crime for which they were accused (Leeson 2012).[2]

This system is familiar to many due to its depiction in movies such as *Monty Python and the Holy Grail*. However, even then, it is not taken seriously, usually relegated as a comedic device resulting from a perceived absurdity. Perhaps this criticism is fair. At first glance, some may consider this system barbaric or backward when compared to the evidence-based jury trials used today. This gut reaction against an ordeal system is a large part of why an ordeal system must be sought out, investigated and qualified.

Many people associate ordeals with witch trials or the Spanish inquisition. However, ordeals in the medieval period do not deserve this reputation. While it might seem as if everyone sentenced to an ordeal was set up to fail, as they were in the aforementioned examples, there is one crucial twist; the clergy rigged medieval ordeals. One study of ordeals in England has those undergoing them passing 62.5% of the time (Leeson 2012, p. 706).

Ordeals were highly structured at an institutional level. Importantly, they were only available to those who believed in them. Known nonbelievers and members of other religions

[2]The punishment could be decided by the government or the clergy depending on whether the crime was heard in a royal or ecclesiastical court. Ecclesiastical courts are those that are run by the church. They are comprised of "judges" who are priests that are appointed by the local bishop. It is essential to understand when the church tried crimes instead of the crown. The exact jurisdiction which church courts possessed is a debated topic with blurred lines when considering the 13th century. While rare, records indicate that the church did hear some fully secular and serious criminal crimes during the period in question. Ecclesiastical courts often had more lenient punishments and lower conviction rates (Helmholz 1983).

were forbidden from undergoing an ordeal. Furthermore, priests worked to determine the guilt of the accused prior to deciding whether or not they should rig the ordeal. Defendants were required to be interviewed by the priest and to engage in substantial prayer sessions, often in excess of 12 hours or over multiple days. On top of this, people who were known liars or had poor reputations were also barred from undergoing an ordeal. These restrictions were meant to enhance the clergy's ability to ascertain one's guilt or innocence and determine if they should rig the ordeal (Peters and Bartlett 1989; Baker 2019).

Despite the above structure, there still was some randomness to the clergy's decision. Following the work of Peter Leeson (2012), who strives to prove that this system of ordeals induces a separating equilibrium whereby only the innocent opt for a trial by ordeal, the clergy consciously work to maintain separation. Separation occurs due to the belief in "Iudicium Dei" that God is the arbiter and there is no room for error. It is unlikely that this belief would hold in scenarios were the majority, or all, of people who underwent ordeals passed (Fudenberg and Levine 2006; Leeson 2012). Accordingly, in situations where the clergy do not find enough defendants guilty they must consciously condemn those they know to be innocent.

Ordeals were also structured with a degree of secrecy. This secrecy was implemented to make it easier for the clergy to rig and prevent repeated observations and learning that could dissuade rational actors from believing in the ordeal (Fudenberg and Levine 2006). For example, most of the preparation for an ordeal was done in private, people attending the ordeal were required to stay back a significant distance, and the priest had sole authority over the length of time different aspects of the ordeal lasted (such as elongated prayer) and the quantities of items used, such as holy water or oil. This structure made it relatively straightforward for a priest to coat the accused in protective water or oil, conduct prayer until the iron rod cooled to a safe temperature, or even swap a hot iron for a cool one while out of sight (Baker 2019).

Whereas previous economic studies have focused on the mechanisms that allow for separation to occur (Leeson 2012), in this paper I focus on how ordeals, and the separation they induce, effect the medieval legal system and any resulting policy decisions. A proper understanding of when ordeals are useful provides a few crucial benefits: Firstly, it provides a better understanding of any effects that came as a result of changes in legal systems and the modernized jury system. Secondly, it helps inform modern policy changes surrounding countries that still undergo trials by ordeal.

It is a common misconception that ordeals are strictly a medieval institution. This is not true as the practice is still quite common in many African nations. In these countries, ordeals exist either as a formal legal institution or as an illegal service that citizens turn to instead of the formalized court system (Leeson and Coyne 2012). These secondary court systems arise from corruption, distrust in the government, or a lack of infrastructure. An understanding of how modern policy changes would affect these countries can help determine the appropriate amount of international resources that should be devoted to these causes. Perhaps we may find that applying modern western legal values to other societies is not as universally beneficial as many currently think.

Lastly, knowing how ordeals affect the legal system is informative about other types of separating equilibrium that may arise in our legal system as technology changes. An excellent example of this type of separating equilibrium arising in modern legal systems is the lie detector. Given this, it is reasonable to assume new devices, with similar economic and behavioral effects, will emerge in our society's future.

Methodology [3]

Game Theory

To study the unique effects of the ordeal system in medieval society, I turn to game theory. Game theory is the use of mathematical models to study the decisions and interactions between rational-decision makers. For the purposes of this paper, a game consists of (1) rational actors,[4] (2) potential strategy profiles for those actors, and (3) utility functions that measure the outcomes for each actor as a function of the strategies that they use. The standard solution concept for such models is the subgame perfect Nash equilibrium. This concept is a notion of stability, requiring that all decisions that the actors make be optimal given the decisions of the other actors. Following this standard application, I will use backward induction[5] to solve for the subgame perfect Nash equilibrium of the game (Nash 1950).[6] These solutions serve as a prediction for the actual decisions made by real actors in the 13th century.

[3]This section discusses the theoretical methods I used in order to support my research question. I believe that the theoretical methods chosen are the most accurate given the available information and objectives. For a discussion on alternative empirical methods and their associated benefits, challenges, and next steps please see Appendices A and B.

[4]Rational actors always work to maximize their utility and minimize any costs that they may incur. This assumption is the basis of Rational Choice Theory. Following (Fudenberg and Levine 2006), my model adheres to Rational Choice Theory. Superstitious or religious decisions are not inherently irrational and can be on a subgame perfect Nash equilibrium path. In order for superstitions to achieve this rationality, there must not be an unlimited ability to experiment. Ordeals adhere to these experimentation restrictions through designed exclusivity.

[5]A backward induction algorithm is used to solve for the final decisions in the game that are optimal, then fixing those as the decisions being made, determining the optimal decisions that would be made immediately prior. This is repeated until all decisions are computed. This approach allows the agents to anticipate that other agents will make optimal choices following their own choices.

[6]The timing in this model arises from the fact that policy regarding the trial options offered to the accused is set prior to the accused choosing a trial.

Game theory is commonly used by economists to study the effects of policy changes when empirical methods are infeasible. It has been the primary form of analysis in the field of law and economics since its inception (Coase 1960; Becker 1968). The usage of ordeals as a policy has received some theoretical attention (Leeson 2012), but little empirical attention due to the inability to experiment and difficulties in collecting appropriate data.[7] This is demonstrated by the rate at which the innocence of those who are actually innocent is discovered when undergoing an ordeal, a parameter that is difficult to measure empirically but can be incorporated into a theoretical model. There is significant evidence that policymakers in the 13th century believed that they could accurately discover this innocence. This belief was apparent in their actions. For example, as discussed in the background, priests typically required that any accused person undergoing an ordeal spend significant time with them before they would conduct an ordeal ceremony (Peters and Bartlett 1989; Baker 2019). Policymakers seemed to believe that elongated interactions and prayer with the accused could help the clergy make a more educated decision regarding the accused's guilt or innocence. While there do not appear to be records specifying the exact qualities that were looked for or the rates at which these qualities and innocence occurred, it would be logical to assume that qualities such as the innocent being less nervous, more honest, and less hesitant when interacting with the clergy filled this role.[8] Factors such as this are highly relevant to the effects of ordeals as a form of policy but are unobservable. While this makes empirical estimation problematic, theory provides value in that it still allows broad conclusions in the face of these issues.

[7] See Appendices A and B for a further breakdown of these difficulties.

[8] It is also worth considering that the priests may have been studying the level of repentance the accused had, in addition to innocence, when deciding if they should rig an ordeal. This possibility would fit into Catholic ideals of confession. However, this possibility is not included in the model due to its complexity and lack of empirical evidence.

Model

Consider a world with two actors - the policymaker and the accused, a person currently going through the legal system in question.[9] The accused can be innocent or guilty. The accused knows whether he is innocent or guilty but the policymaker does not not. The probability that the accused is guilty is p and thus the probability of innocence is 1-p.[10] [11]

The actors interact in a 2-stage sequential game. First, the policymaker offers one of three menus of trial options.[12] The presence of a menu reduces the number of total choices available to the accused. Second, the accused chooses and undergoes one of the trial options offered to him on the given menu.

Pleading guilty, trial by ordeal, and trial by jury are the only potential trial options that may be available to the accused. Medieval courts had significant variation between countries, and even within countries, when it came to trial types and choices.[13] There are numerous alternative trial methods, such as compurgation and trial by combat, that do not appear in this model. These

[9]While there can be many actors that are accused in reality, it is sufficient to model one actor as the policymaker's inability to distinguish between the accused makes a singular actor representative of all actors.

[10]These probabilities are not relevant to the accused as guilt is the result of choices made outside the model. These probabilities likely correspond with aggregate crime rates in the population being analyzed. These rates are observable by the policymaker.

[11]All accused actors know whether they are innocent or guilty because this status is assumed to be exogenous. However, endogenous guilt would have no effect on my model because any crime would have occurred prior to the decisions I examine. The policymaker's choices can influence the overall crime rate. I will discuss that possible implication later. Additionally, it is worth considering that there could be rare circumstances where legal definitions are unclear and the accused legitimately does not know whether they are innocent or guilty. I do not examine this scenario as it is unlikely to occur and would unnecessarily complicate the model.

[12]I will be discussing the policymaker's choice of punishment for those found guilty later on in this section.

[13]There was also significant variation between countries regarding whether the accused even had a say in choosing the trial options. However, even a society that does not offer this choice can still benefit from the consideration of policy recommendations that entail allowing the accused to choose between trial options.

alternatives are not included in the model for a few reasons. Ordeals and jury trials were the predominant methods in the period we are examining (Baker 2019). The exclusion of these rarer trial forms allows for a simpler model that better reflects incentives and decisions, allowing for an easier interpretation. Additionally, the variables representing the jury trial component of my model can be used as a proxy to understand other trial types.[14]

Regardless of the choice of trial, the accused suffers a cost G<0 as punishment if found guilty. [15] [16] This cost can be monetary if a fine is involved. It can also include the opportunity costs of imprisonment or even death. The exact value of G is fixed across cases and trial types, but dependent on the alleged crime. This consistency of G ensures the importance of trial variations as G should not be the cause of separation.[17]

[14]The methods that allow the substitution of other trial types into the model will be discussed later in the discussion section.

[15]One could make the counterargument that there were some benefits to imprisonment in the medieval period. For example, charitable giving to criminals was quite common (Scarborough and Classen 2012). However, I believe that it is unlikely that any small benefit outweighs the loss of freedom or reputation that would occur.

[16]There is a chance that no punishment occurs at all. This is not ideal because if it were easy to avoid the penalty for punishment, the choice of trial type and its associated accuracy would be trivial. The accused would simply plead guilty as the cost of pleading guilty if the punishment is avoidable could be 0, which would be preferable to the higher expected costs of c or θ. From a modern perspective, this scenario may seem unlikely. However, in some medieval European countries, the government did not guarantee punishment the way it does in our modern legal system. An example of this is Iceland from the 12th to 13th centuries. During this period, Iceland was unique in that all crime, including murder, was punished by fines. Furthermore, while the actual judgment of guilt was public, the government did not assist in the collection of these fines. Instead, the collection was privatized and thus not guaranteed to occur (Friedman 1979). While this was a fairly isolated practice that is unlikely to occur, my model already accounts for this possibility through expected utilities.

[17]I will expand on a variable or optimal G in the discussion section.

The preferences of the accused depend on the structure of each trial choice. Among the three trial choices, the simplest to model is the decision to plead guilty. If the accused pleads guilty, he will suffer the punishment for being guilty, G.

If the accused were to undergo an ordeal, he might incur a cost θ associated with failing an ordeal, in addition to the punishment G. While not monetary, θ represents the significant consequences that many of the different types of ordeals have for failing. This includes the physical pain one could suffer, such as in ordeals involving burns, as well as the mental trauma an ordeal could cause. Unlike jury trials, these costs are only incurred if one fails the ordeal. This is reasonable because, as mentioned earlier, if one passes the ordeal then it must have been rigged by the clergy in a way that ensures no serious pain should occur. The probability that the ordeal finds the accused guilty depends on their guilt: α for the guilty and $\alpha(1\text{-}\gamma)$ for the innocent. γ captures the likelihood that an actor's innocence is actually revealed, discounting the overall probability of conviction by this likelihood.

Lastly, if the accused were to undergo a jury trial, he will incur a cost c in addition to the punishment G if found guilty. c includes any potential court costs, opportunity costs, as well as any costs caused by hiring an attorney or other advisor.[18] Importantly, this cost is incurred regardless of the accused being found innocent or guilty. The probability that the trial finds the accused guilty also depends on their actual guilt: β for the guilty and $\beta(1\text{-}\delta)$ for the innocent.[19]

[18]Note that it was not common, or potentially forbidden, for accused persons to hire attorneys to defend them in national courts during this time (Pound 1944). However, the inclusion of this fee reflects that it remained possible in some jurisdictions and allows for easier comparison to other modern legal systems.

[19]The perceived probability of conviction in α and β also takes into account the probability of an appeal. This is an important distinction between a jury trial and a trial by ordeal. While there existed limited means for which someone could appeal a court decision they believed had been made in error, it was not permitted at all in cases using a trial by ordeal (Caenegem et al. 1982). This makes sense in a religious context, if God is infallible and

δ functions similarly to γ, discounting the overall probability of conviction by the likelihood an innocent actor's innocence is revealed.

Assumption 1: $0 < \gamma, \delta < 1$; There is a positive probability that an innocent actor's innocence is revealed in a jury trial or ordeal.

γ and δ capture the increased chance that one is found innocent if they are actually innocent. There is no evidence, nor does it make logical sense, that being innocent would actually make one more likely to be convicted or less likely to be able to produce evidence in their favor. To the contrary, there is significant evidence that policymakers of the time period likely believed in the existence of positive discount factors (Baker 2019).

Having specified the components of each trial method, I can now combine them to form the second stage model. Let us begin by building a game tree in a world without any menu options or policymakers.[20] In this model, the accused has a choice between a trial by ordeal, jury trial, or choosing to plead guilty. Each of these three choices is represented by their perceived expected costs.

While this model of trial choices is insightful by allowing the prediction of the trial preferences of a medieval society with any given set of characteristics, its greater contribution is for the insight it provides on how policies can change these preferences and outcomes in a way that is beneficial for society. To understand this benefit, I must introduce the second player, the policymaker, into the game.[21] The policymaker has the ability to change the available trial options. For example, in the second stage model, the accused would have the ability to plead, undergo an ordeal, or choose a jury trial. Under this full model, if the policymaker decides to

acting as the arbiter, there would never be a need for a system of appeals. This difference could have a potentially significant effect on perceived utility, particularly in a highly inaccurate legal system.

[20] Please refer to Figure 1 for this game tree

[21] Please refer to Figure 2 for this game tree

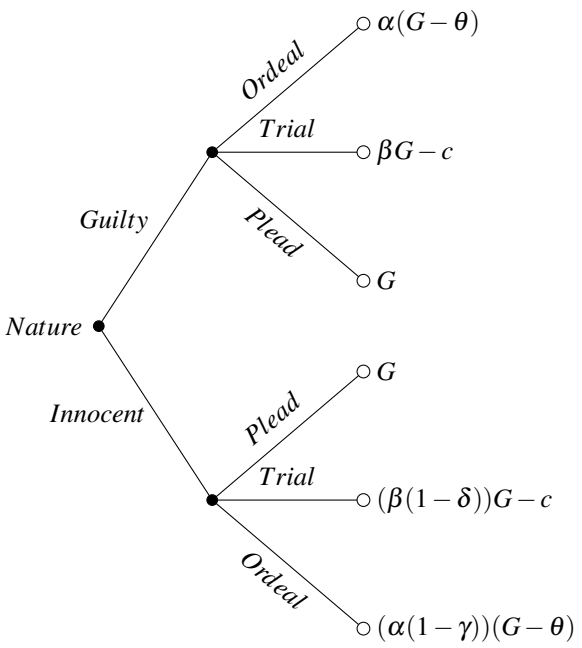


Figure 1: Stage 2 Game Tree

implement a menu restriction, they will only have the option to either plead or choose a jury trial (Menu 1) or the option to either plead or choose an ordeal (Menu 2).[22] Alternatively, the policymaker could implement no restrictions (Menu 3).

It is important to determine which menu is most appropriate to enact. This determination depends on how one defines the utility function of the policymaker. A simple utility function to implement is one with binary payoffs.[23] In this utility function, the policymaker receives a

[22]One important design consideration when creating the model was to never take away the option to plead. As a result, there is not an additional menu that allows one to choose only between an ordeal or jury trial. While plea bargains were not commonly utilized in this time period, the actual ability to plead was a constant option (Langbein 1978). I believe that it would be unrealistic to model a society without the option to plead. Furthermore, guilty pleas are potentially the cheapest option to society as they have no expenses related to conducting an ordeal or trial and no opportunity costs related to a judge or jury. Due to this, I think it is unlikely a policymaker would ever find a menu without pleading as beneficial to their utility.

[23]A binary utility function is beneficial as the use of 0 as a potential payoff allows the utility function to be simplified.

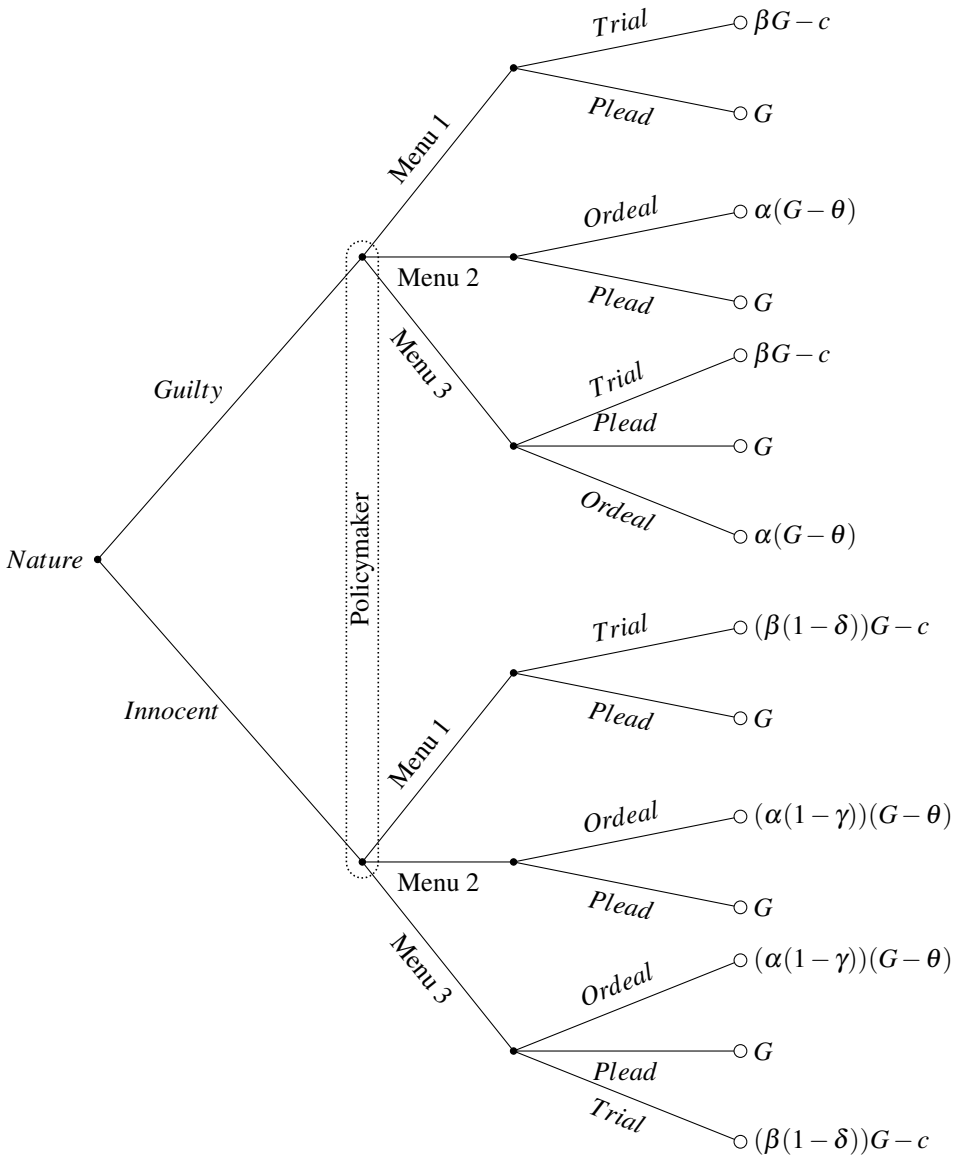


Figure 2: Full Game Tree

utility equal to 1 if a guilty person is punished or an innocent person is acquitted and 0 if a guilty person is acquitted or an innocent person is punished. This is then used to determine the utility of each menu using the expected utility:[24]

$$U(menu) = Pr(Convict|Guilty) * Pr(Guilty) * U(Convict|Guilty) + Pr(Acquit|Innocent)$$
$$* Pr(Innocent) * U(Acquit|Innocent) + Pr(Acquit|Guilty) * Pr(Guilty) * U(Acquit|Guilty)$$
$$+ Pr(Convict|Innocent) * Pr(Innocent) * U(Convict|Innocent).$$

Simplified for the model this becomes:

$$P(1, \beta, \text{or } \alpha + (1-P)(0, 1-(\alpha(1-\gamma), \text{or } 1-(\beta(1-\delta))$$

Each strategy profile will have its own utility in accordance with the given menu restriction and expected utility. Consider the case of the strategy profile (Plead, Ordeal) where (x,y) represents the strategy profile in which the accused chooses x if he is guilty, and y, if he is innocent. Under menus 2 and 3 its utility is:

$$P + (1-P)(1-(\alpha(1-\gamma))$$

This would vary only slightly under menu 1 where multiple cases would be calculated due to the uncertainty of what the new strategy and parameters will be.

Despite its simplicity, a binary utility function can be considered an accurate representation of societal expectations for a legal system. This type of utility implies that a legal system should prioritize and be rewarded for accuracy above all other considerations. If one believes that the sole purpose of the legal system is to find the truth and determine guilt or innocence, than this is an accurate and interpretable representation of how a policymaker would act. However, it is worth noting that some may criticize this utility function as too simplistic. They may argue

[24] In the expressed utility function, Pr is short for probability and | implies a conditional probability.

that society cares about more than accuracy. For example, they may believe that the avoidance of type 1 errors, wrongfully convicting the innocent, is more important than correctly punishing the guilty. Alternatively, they may believe that the severity of the punishment is more important than just ensuring a punishment occurs.[25]

Equilibrium Trial Choices

The accused actor will choose whichever of the three trial options imposes the smallest expected cost on them. The accused's trial option preferences can be modeled by a system of inequalities representing the relative cost of each trial. For example, an innocent person will plead guilty if doing so returns a higher expected utility than undergoing an ordeal or going to trial. Mathematically, this means that (-G) > $(\beta(1-\delta))$(-G) - c and (-G) > $(\alpha(1-\gamma))$((-G)-θ). The choices of the accused will be discussed below, and the full characterization can be found in tables 4, 5, 6, and 7 in Appendix C.[26] [27]

[25]To address some of these concerns, I have also modeled a more complicated quadratic utility function where the policymaker's utility equals $(\hat{G}-\tilde{G})^2$ if a guilty person is punished or an innocent person is acquitted and $\hat{G}^2$ if a guilty person is acquitted or an innocent person is punished. $\hat{G}$ represents the actual punishment received in any given case. $\tilde{G}$ represents the punishment that society sees as ideal for someone guilty of the crime in question. Unlike the first utility function, no parts of this utility function cancel out or form standardized parameter ranges. This second utility function better fits more nuanced ideals of how a legal system should function. It not only captures the emphasis on accuracy from our first utility function, but also appeals to ideas of justice by accounting for if the severity of the punishment fits the crime.

[26]Strategy profiles are displayed in four separate cases. Due to the theoretical nature of this paper, we do not know whether $\alpha > \beta$ or $\alpha < \beta$ and if (α (1 - γ)) > (β(1 - δ)) or (α(1 - γ)) < (β (1 - δ)). As a result of this uncertainty, we must consider all four cases. The characterization of the accused's choices is displayed by menu.

[27]I will be classifying the accused's choices when the parameters allow a strict ranking of preferences between trial options. If the parameters are such that the accused is indifferent between two of these options, then he could make either choice. This indifference has no qualitative impact on the results of this paper, and the set of

		Innocent		
		Plead	*Trial*	*Ordeal*
Guilty	*Plead*	Cost of guilt is low. Trial and ordeal have high costs and a high conviction rate; Low accuracy in discovering innocence	Cost of guilt is low. Ordeal and trial have high conviction rates; Trial is most accurate in discovering innocence	Cost of guilt is low. Ordeal and trial have high conviction rates; Ordeal is most accurate in discovering innocence
	Trial	Trial has lowest conviction rates; Innocent more likely to plead than guilty	Trial has lowest conviction rates and costs; Trial most accurate in discovering innocence	Trial has lowest conviction rates. Moderate cost of guilt; Ordeal is most accurate in discovering innocence
	Ordeal	Ordeal has lowest conviction rates; Innocent more likely to plead than guilty	Ordeal has lowest conviction rates. Moderate cost of guilt; Trial most accurate in discovering innocence	Ordeal has lowest conviction rates. Moderate cost of guilt; Ordeals are most accurate in discovering innocence

Table 1: Trial Choice Characterization

Within this model, the accused generally go for the trial option that has the lowest chance of convicting them. For the guilty, this means the option with low conviction rates (low α or β).[28] Innocent actors also consider the accuracy of the trial type in determining their innocence (high γ or δ). Importantly, this initial tendency can be overshadowed for both actors when substantial costs or punishments exist. These equilibrium tendencies are described qualitatively for each strategy in table 1 above.

Using table 1, it is clear that pleading is attractive in societies with a low cost of punishment (G), a high conviction rate, and a poor accuracy in correctly identifying innocence. As G increases, the likelihood of pleading decreases, and actors are pushed towards trials or ordeals. The guilty are pushed towards ordeals when they have a lower conviction rate than trials (α is low compared to β) and are pushed towards trials when they have a lower conviction rate than ordeals (β is low compared to α).

In the context of practical institutions, the guilty plead when punishments are low and they are confident that the church and courts will convict them. The guilty turn to the courts when they have high faith and turn to the church when they have low faith. On the other hand, the innocent plead when they believe that neither the courts nor church will see their innocence. As the innocent become less faithful, they move towards the courts and as they become more faithful they move towards ordeals.

A particularly interesting prediction of this model is the identification of societies where there is a separating equilibrium involving ordeals in which the guilty and innocent

parameters for which this indifference occurs is negligible within the set of all possible parameter values. Later in the discussion, I consider G as an endogenous choice of the policymaker. This permits choosing a G that allows indifference, however, it will not affect the conclusions described in this section.

[28]While α and β do not correspond directly to historical conviction rates, they work similarly to conviction rates and it is useful to think of α or β in this terminology.

select different trial choices. This type of society uses the strategy (Trial, Ordeal) or (Plead, Ordeal). Therefore, trials must have a low conviction rate and ordeals must be fairly accurate in recognizing innocence. This could happen in a society that is not very technologically advanced but that has high religious beliefs. The lack of technology causes evidence to be more challenging to collect and thus trials to be less likely to convict. On the other hand, the religiousness of society allows for an ordeal to be perceived as highly accurate. This type of society is of particular interest as it has the most relevant policy implications due to its similarities with medieval Europe.

Some strategy profiles are clearly infeasible or unrealistic. These strategies must be identified so that later analysis can avoid them, instead considering parameter regions that are reasonable.

Given the conditions in tables 4, 5, 6, and 7 in Appendix C, the strategies (Trial, Plead) and (Ordeal, Plead) are ruled out by assumption 1. Both conditions involve an innocent person pleading guilty while a guilty person does not plead. In order for this to be mathematically feasible, γ and δ would have to be negative [29]

The strategy (Ordeal, Trial) should also be considered unreasonable given real world expectations. Despite being mathematically valid, it does not work in the context of a medieval society that would potentially use ordeals. This strategy implies that innocent people go to trial while guilty people undergo an ordeal. Such a case would generally imply high trust in the accuracy of the legal system (high δ with a somewhat high β) and low faith in the ordeal system (low γ with a moderate α). However, given what we know about medieval Europe, we know that β was not high and δ was likely not very high either (Baker 2019). We also know that α was most likely high due to the prevailing religious culture in the time period (Ho 2003). For these

[29] An edge case of 0 is also unrealistic. It is invalid as the innocent and guilty are choosing different strategies and would have the same preferences if γ and δ were both 0.

reasons, this strategy is unlikely to have been chosen and thus I make the following assumption to rule out this possibility.

Assumption 2: The Guilty party never prefers a trial by ordeal unless the innocent party also prefers a trial by ordeal.

C1: $\alpha > \beta$

C2: $(\alpha(1-\gamma)) > (\beta(1-\delta))$

$$\begin{cases} G \geq max\{\frac{\alpha\theta}{(1-\alpha)}, \frac{c-(\alpha\theta)}{(\alpha-\beta)}\} & \text{if } C1 \text{ and } \sim C2 \\ \frac{c-(\alpha\theta)}{(\alpha-\beta)} > G \text{ or } G > \frac{(\alpha\theta)}{(1-\alpha)} & \text{if } C1 \text{ and } C2 \\ G \leq min\{\frac{c}{(1-(\beta(1-\delta)))}, \frac{c-(\alpha(1-\gamma))\theta}{(\alpha(1-\gamma))-(\beta(1-\delta))}\} & \text{if } \sim C1 \text{ and } \sim C2 \\ (1-(\beta(1-\delta))) > G \text{ or } G > \frac{c-(\alpha(1-\gamma))\theta}{(\alpha(1-\gamma))-(\beta(1-\delta))} & \text{if } \sim C1 \text{ and } C2 \end{cases}$$

Having analyzed the trial choices of the accused, we can turn to an analysis of the policymaker's decisions.

Equilibrium Menu Choices

In this section I analyze the optimal menu choice for the policymaker. The restrictions of the menus cause deviations from the strategies discussed in the previous section. If the menu that the policymaker chooses permits the accused's previous strategy, he will continue to follow it. However, if the chosen menu removes a trial option from the strategy used without menu restrictions, the accused's choice can now be pushed to either of the other two trial options depending on the specific parameter regions of their given society. The characterization of the policymaker's choices is located in Appendix C in tables 8 and 9, while an intuitive description of the choices under each menu is located in tables 2 and 3. [30]

[30] Options where the innocent actor pleads are not included as they violate the assumption mentioned in the previous section. An orange X indicates an unrealistic parameter that violates assumptions.

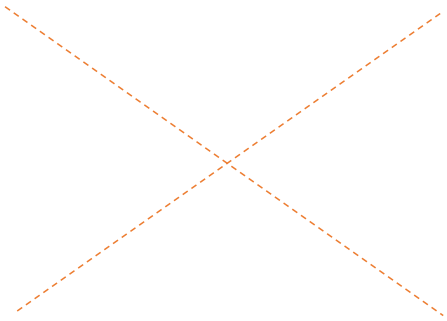
		Innocent	
		Trial	*Ordeal*
Guilty	*Plead*	No Changes	Guilty: No Change Innocent: Trial or Plead
	Trial	No Changes	Guilty: No Change Innocent: Trial or Plead
	Ordeal		Guilty: Trial or Plead Innocent: Trial or Plead

Table 2: Menu 1 - Plead or Trial Strategy Descriptions

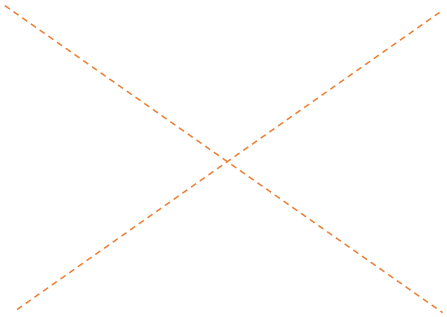
		Innocent	
		Trial	*Ordeal*
Guilty	*Plead*	Guilty: No Change Innocent: Ordeal or Plead	No Changes
	Trial	Guilty: Ordeal or Plead Innocent: Ordeal or Plead	Guilty: Ordeal or Plead Innocent: No Change
	Ordeal		No Changes

Table 3: Menu 2 - Plead or Ordeal Strategy Descriptions

Whereas the conviction rate and the accuracy of ascertaining guilt of the trial options was of primary importance for determining the accused's optimal choice with a full menu of options, the parameters measuring the outcomes (G, c , and θ) are significantly more impactful when the menu is restricted. However, as a general rule, if neither actor had pled before a menu implementation, an innocent actor will always switch to the other trial method rather than plead when a new menu is implemented. Furthermore, a guilty actor will generally only switch to pleading if the other trial method has an extremely high γ or δ.

The policymaker now has the ability to induce different equilibrium allowing movement between the different types of pooling equilibrium, types of separating equilibrium, or movement from a pooling equilibrium to a separating equilibrium.

A policymaker will seek to use menu restrictions to induce movement from one type of separating equilibrium to another type or one type of pooling equilibrium to another type only if the new trial method results in the innocent being more likely to be acquitted and the guilty being more likely to be found guilty. Unlike the accused, the policymaker's decision is not affected by the value of c or θ, even if either figure is extreme. As a result, menu restrictions can be beneficial when these costs cause the accused's strategy to deviate from the trial method that best ascertains guilt and assigns punishments. Moreover, it is also possible that as technology changes, the policymaker may know about changes regarding the accuracy or efficiency of different trial methods before the general populace. In this scenario, it could be beneficial to use menu restrictions to reduce inefficiency resulting from a lag in the transmission of information.

A policymaker will seek to use menu restrictions to induce movement from a separating equilibrium to a pooling equilibrium when the pooling equilibrium is more accurate in ascertaining guilt and assigning punishments. This could be to counteract extreme costs and ensure that accused actors are choosing the most accurate trial type. However, the policymaker's decision is

also greatly influenced by the quantity of guilty or innocent actors captured through P. If there is an extremely low chance of guilt or innocence, utility can be gained from using a slightly less accurate pooling equilibrium or even acquitting or convicting almost all actors regardless of their true type. In this case, the low quantity of either type of actor could make it costly to societal utility to maintain the separating equilibrium.

A policymaker will seek to use menu restrictions to induce movement from a pooling equilibrium to a separating equilibrium when the signaling that results from separation increases the accuracy with which society can ascertain guilt and assign punishments. This is particularly useful when G varies across trial types and can help ensure that $\hat{G}$ is close to $\tilde{G}$.

Consider a restriction of the full menu to one in which only one trial option is given in addition to pleading. In conjunction with the strategies and parameter regions that have already been identified as violating model assumptions, the strategy (Plead, Plead) must also be considered unrealistic in the context of this model. If (Plead, Plead) is the optimal strategy given a full menu, it is impossible to influence this strategy through any sort of menu restrictions as the policymaker will never remove the right to plead. There are situations where a policymaker may want to induce both types of accused actors to plead. [31] On the other hand, if both types of accused actors begin by pleading, it indicates that more systemic issues are at hand. For example, the punishment for the crime (G) may be significantly higher than the socially optimal punishment, the conviction rates for ordeals and trials (α and β) may be indiscriminately high with a low accuracy in ascertaining innocence. The cost of going to trial (c) or of failing an ordeal (θ) could also be prohibitively high. These types of structural issues cannot be influenced using menus, but this equilibrium could serve as an indicator that the efforts of the policymaker are best spent influencing these other factors.

[31] This can occur at extreme values of P where it is costly to maintain a separating equilibrium.

Discussion

This paper develops a model that can predict the effects that the presence of ordeals had on rational actors navigating the medieval legal system and demonstrates how ordeals could be used by policymakers to increase societal utility. This model contributes to the existing literature by creating a foundational framework that can capture the complexities of the various forms of trial by ordeal. I will now demonstrate how this model can be used to evaluate policies in 13th century England and modern-day Liberia, societies that have used trials by ordeal.

Ordeals in 13th Century England

England is a good representation of the general medieval society used to create the model assumptions. Most people in England during this time period were religious, with little separation between church and state (Helmholz 1983). English clergy followed the ordeal practices previously described in the background section. They limited whom they provided ordeals to, required time in prayer with the accused, and rigged outcomes. This means that English society had a high α and a high γ. Additionally, England in this period was not very technologically advanced. This likely affected the availability of evidence and, thus the ability of the courts to effectively ascertain guilt. As a result, β and δ were low. Due to these values, this society would best fit the parameters for a separating equilibrium strategy of (Trial, Ordeal) or (Plead, Ordeal). The choice between these two strategies would be dependent on the exact parameter values as well as the potential impact of preexisting menu restrictions. This outcome corresponds with the limited trial data available from English plea roles which emphasize the presence of the separating equilibrium and the aforementioned parameter values (Leeson 2012).

While the historical record can validate the predictions of the accused's behavior, the model allows me to dive deeper in my analysis and predict whether improvements could be

made to society through the introduction of menus that restrict the accused's trial options. The model demonstrates that it is possible that the policymakers could benefit from restricting the ability to go to trial, as pleading has a higher rate of conviction than going to trial. Indeed, such restrictions were implemented in some English jurisdictions (Baker 2019; Leeson 2012; McAuley 2006).[32] Furthermore, the model predicts that it is unlikely to be beneficial to restrict the option to undergo an ordeal given the religiousness and technological capabilities of medieval English society.

Despite the model indicating that it is not necessary to restrict ordeals, England suspended the practice in 1219 C.E (Leeson 2012). The model allows us to predict the effects this policy decision may have had. According to the model, the elimination of the option to undergo a trial by ordeal would be beneficial for the policymaker if there was a significant change in technology, faith, or other parameter values. However, it does not appear that this decision was made for economic or efficiency reasons. There does not appear to have been a major shift in technology or other parameters such as the crime rate. While society was trending to be more secular, belief in the ordeal was likely still maintained at this time. As a result, the model predicts that this transition to jury trials led to less efficient trial outcomes, at least initially.

Ordeals In Present Day Liberia

While this model was constructed to represent societies common in medieval Europe, it can still provide insight into societies that are modern, non-European, non- Christian, or all of the above. One such society where the model can provide insight is present-day Liberia.

[32] Also note that it could be worth restricting the ability to plead if G was variable and trials better ensured $\hat{G}$ is close to $\tilde{G}$. However, this goes beyond the scope of the model and does not appear to have been frequently implemented historically.

The most prevalent ordeal in Liberia is called Sassywood. It involves drinking a poison made from the bark of the Erythrophleum suaveolens, aptly nicknamed The Ordeal Tree. The majority of Liberians, regardless of their animist or Christian faith, believe that a spirit inhabits the tree the poison is made from. They believe that the spirit flows into one's body from the drink saving the accused and causing them to expel the poison from their body if it deems them innocent or leaving them to suffer and die if it finds them guilty. Like medieval ordeals, village elders rig Sassywood by manipulating the components of the drink or by giving the accused additional substances to ensure they expel the liquid (Leeson and Coyne 2012).

Ordeals have been banned numerous times by the Liberian government. However, despite this ban, Liberia maintained two separate legal systems until 2008. One system used jury trials and government courts and the other system involved tribal leaders using ordeals. However, due to international pressure, they officially stopping supporting ordeals under the customary legal system in 2008. Despite this, many villages still use Sassywood in defiance of the national government. Some polls even suggest that a majority of citizens do not even know the practice was outlawed (Leeson and Coyne 2012; International Crisis Group 2006). While we can only speculate, perhaps the reason that many villages defy the government's ban on ordeals is that they recognize the inefficiency and loss of utility associated with the restriction of ordeals.

In order to test the implications of the model for Liberia, I will use the general characteristics of the country to roughly infer the appropriate parameter ranges. Liberia appears to have modern technology, such as fingerprints and DNA evidence in their criminal justice system. This would both suggest a high rate of conviction and accuracy in ascertaining guilt (high β and δ). However, this is counteracted by allegations of incompetence and corruption. Less than 5% of magistrates hold law degrees and 50% - 75% of judges are illiterate (International Crisis

Group 2006). Further, many of these judges are known to be corrupt and bribable.[33] This would suggest lower values of β and δ. While these counteracting effects make the overall level of β and δ ambiguous, I will use a low level for the remainder of this analysis. We also know that c is high due to the low number of courts and the distance of courts from rural areas. For ordeals, we know that α should also be relatively high. Liberia's population is spiritual and trusting of their village elders and chiefs. Ordeals should not be as affected by any corruption as their local ties to the community would make their cost of being found corrupt much higher. One important difference between Liberian and medieval ordeals is that cost of failing the ordeal (θ) is significantly higher for Sassywood due to the higher chance of death (Leeson and Coyne 2012).

Based on the inferences above, the parameters for Liberia are likely similar to that of medieval Europe. As a result, the model would predict that the full menu of trial options results in a separating equilibrium in which the guilty choose to either go to trial or plead, and the innocent opt for an ordeal. This result suggests that it is likely unnecessary to restrict ordeals in Liberia. Despite this, Liberia fully suspended the practice for political reasons in 2008, rather than due to a change in parameters. The model predicts that, like medieval England, this transition to jury trials led to less efficient trial outcomes, at least initially.

Furthermore, in interviews, Liberians argue that criminal activity has increased notably since the government banned Sassywood and related judicial ordeals (Leeson and Coyne 2012). While a prediction on crime rates is beyond the scope of this model, it represents an exciting potential to expand the model going forward.

[33] I will discuss how corruption is modeled later in this section.

Corruption

The previous analysis of ordeals in Liberia introduced the need to understand how corruption may affect my model. Corruption is not unique to Liberia and is also a concern in analyzing medieval Europe. Corruption in medieval Europe took on a few different forms. The most obvious form of corruption was bribery. This could occur before a trial if it involved the police.[34] It could also occur during the trial if it involved the judge, jury, or clergy. Outside of bribery, some scholars also argue that corruption existed along class lines. Specifically, this arises when comparing ordeals to related trial options such as judicial oaths and trials by combat. They argue that these other trial options were typically only available to the wealthy (Caenegem et al. 1982). This is problematic as these alternative trial options all had lower conviction rates.

While the model could certainly be expanded to allow alternative trial choices and individual characteristics such as wealth and class, the more typical forms of corruption can already be captured within the model's parameters. This can be accomplished through the variables of β and c. If one believed that a judge or jury was susceptible to bribery than their β would be lower as this belief would decrease their perceived chance of conviction. However, the cost of this bribe would also be reflected in a higher c.[35] Whether or not there is an incentive for an actor to engage in bribery depends on the change in c relative to β. Since bribery is not mandatory and an actor could elect to stick with their original values of c and β, it is likely that

[34] As our model only considers the decisions of those accused of a crime, this type of bribery falls outside its scope.

[35] Corruption in ordeals could result in a lower α but would also need an additional variable added to represent the additional cost. This was not included in the initial model as corruption at the ordeal level is improbable. Corruption did occur among the clergy, but it generally manifested during ecclesiastical trials. Priests who gave ordeals were members of their local community and had much to lose if caught (Helmholz 1983; McAuley 2006; Leeson and Coyne 2012).

the change in c is smaller than the net expected change in punishment (β). Moreover, bribery is more likely to move the guilty towards the trial as their change in expected punishment is greater than that of the innocent. This is due to the innocent's increased chance of being found innocent (1-δ) as the chance for the guilty is (β' - β)G but only (β' - β)(1-δ)G for the innocent. This result demonstrates that the innocent gain less from engaging in corruption but have the same cost of doing so as the guilty.

Conclusion

Few economic studies have examined trials by ordeal as a potentially efficient legal system. My model corroborates the findings of Leeson (2012) that the presence of an option for a trial by ordeal may result in a more efficient outcome for society by inducing a separating equilibrium where the guilty and innocent tend toward different trial types. The model this paper presents serves as a foundation for understanding the trial preferences of accused medieval actors. The model predicts that the innocent move towards ordeals when they have high faith and believe that God, working through the church, will identify their innocence. Conversely, the model predicts the tendencies of guilty actors to seek the trial type with the lowest conviction rate, moving away from the church as their faith increases. It also predicts how preferences react in the face of policy changes, providing parameter ranges that apply to past and present societies. The model has demonstrated that it can be in a policymaker's best interest to restrict trial types through menu choices. These restrictions can result in increased utility and efficiency when moving the equilibrium to or away from ordeals.

Furthermore, the model has the potential to be further extended to study the implications of trial options. In particular, two extensions seem of particular value. First, one could allow for the punishment from being convicted to be endogenously determined by the policymaker. In

such a framework, the policymaker would have to weigh the potential benefits against the costs of a type 1 error, wrongly punishing the innocent. This choice would be particularly interesting if the punishment varied by trial choice. This occurs regularly in modern society, with plea bargains offering reduced sentences. In this context, the incentive would be very different: by inducing a separating equilibrium, the policymaker could determine guilt more conclusively and thus, offer harsher punishments to the guilty (higher values of G) with less fear of a type 1 error. Alternatively, the model could be changed to make crime endogenous. This extension would be significantly more substantial, but it would be of high value to society. This study of the relation of trial menu choice and the crime rate would be entirely novel and would enable stronger policy recommendations.

While I certainly do not suggest that ordeals should replace our current legal system, the model presented in this paper suggests that ordeals can exist in ways that are beneficial, defying the misconceptions surrounding ordeals today. It creates a foundation that can only be expanded upon. I hope that my work can motivate further theoretical or empirical research on this topic.

Appendix A - Future Empirical Studies

The original plan for this paper was to conduct an empirical study rather than a theoretical one. The paper would have tested the hypothesis that the pre-modern legal system of ordeals was more efficient than the more modern legal system of jury trials which immediately followed, due to the technological and cultural limitations of the time. The eventual change to a theoretical paper was necessitated due to technological limitations surrounding the translation and interpretation of data that would have been needed. This section lays out the original plans, methods, and motivations behind this analysis with the hope that a future researcher may be able to implement it given changes in data or technology.

Methods

A future empirical study could conduct a differences-in-differences regression to form a causal relationship between trials by ordeals and a different variable of interest, such as violent crime. Murder would likely be the most apparent and available measure in this context but other measures, such as the quantity of criminal cases brought by the government, could certainly be valid as well. This differences-in-differences analysis is possible due to the presence of a natural experiment. The natural experiment emerges in the timing of when different western European countries outlawed ordeals in their legal systems. This officially occurred for all western European countries in question between 1208 and 1225 CE (Leeson 2012).[36]

The easiest regression to conduct would likely be one that uses the existence of ordeals in a country's legal system as a dummy variable, taking the value of 1 when the practice was still

[36]It is important to note that while ordeals may have been officially banned by the clergy or governments in a country, some local municipalities and courts continued the practice for some additional time, ignoring the aforementioned prohibition (McAuley 2006; Leeson 2012).

occurring and 0 when it was banned or no longer occurring. This system would allow researchers to use the different units of data as controls for each other. Alternatively, among others, one could also use the quantity of trials by ordeals in a country regressed on the variable of interest. With any of these analyses, other variables and biases also must be taken into account. In particular, the most significant difficulty will be proving that the unit of data, likely countries, is a proper control. This would involve a detailed analysis regarding similarities in demographics, economic data, and similarities in terms of many of the critical assumptions described in the model section of this paper such as corruption or the certainty that punishments will actually be carried out.

Data

In terms of data for the analysis described above, one must collect the data needed to regress ordeals on a casual variable of interest such as crime. In terms of data on ordeals themselves, most European governments have kept fairly comprehensive court records in their national archives. In particular, I was able to identify and acquire the primary data sources of two interesting databases: English plea rolls and the Regestrum Varadinense, a record of Hungarian crime and ordeals. Unfortunately, while I was able to receive this data from the national archives, it was in the form of images and scans of original court proceeding transcripts. Furthermore, these records are often in other languages, usually Latin, and are not in the form of a usable database. These complications would make a regression on a quantity of ordeals more complicated than using a simpler dummy variable. However, future advances in technology could permit more accessible digitization, translation, and organization of this data in question.

In terms of data on the other variables of interest, it depends on the specific variable chosen for the future experiment. For this study, we will consider murder as a proxy for

violent crime. The majority of this data is available on the country level, but a more local level could be used if available. Unfortunately, this data is often randomly missing for certain years in some countries, raising concerns of bias. One database does exist with a comprehensive collection of this data. The "History of Homicide Database," is privately run by the Department of Criminology at the University of Cambridge. However, this database is not publicly available and appears to share many of the consistency issues described above.

Motivation

By examining changes in crime rates using this empirical design and a differences-in-differences regression, a researcher would be able to establish causality and determine the veracity of the hypothesis. Essentially, the lack of causality in our theoretical model is its biggest weakness. The benefits of this new design are the same in terms of overall contributions, but the addition of causality would allow greater certainty in outcomes and make any result more convincing in potential policy applications.

Appendix B - Future Field Studies

Outside of the theoretical and empirical approaches previously described, future researchers may also benefit from conducting a field study. While it would be unethical to manipulate trial options as an experiment, countries such as Liberia and Sierra Leon present current opportunities to observe first hand, without the need for experimentation, how moving away from a system of ordeals can affect society and individual preferences or behavior.

A field study would allow the collection of data that may not otherwise be recorded, and that is difficult to come by historically. It would also allow for a more tailored collection of data that may better represent preferences, as researchers can directly interact with local actors. Such data would be invaluable in enhancing the approaches of theoretical models and conducting an independent empirical study based on the fieldwork.

Appendix C - Parameter Ranges

		Innocent		
		Plead	*Trial*	*Ordeal*
Guilty	*Plead*	$G \leq min\{\frac{c}{(1-\beta)}, \frac{\alpha\theta}{(1-\alpha)}\}$, $G \leq min\{\frac{c}{(1-(\beta(1-\delta)))}, \frac{(\alpha(1-\gamma))\theta}{(1-(\alpha(1-\gamma)))}\}$	$G \leq min\{\frac{c}{(1-\beta)}, \frac{\alpha\theta}{(1-\alpha)}\}$, $G \geq max\{\frac{c}{(1-(\beta(1-\delta)))}, \frac{c-(\alpha(1-\gamma))\theta}{(\alpha(1-\gamma))-(\beta(1-\delta))}\}$	$G \leq min\{\frac{c}{(1-\beta)}, \frac{\alpha\theta}{(1-\alpha)}\}$, $\frac{(\alpha(1-\gamma))\theta}{(1-(\alpha(1-\gamma)))} < G < \frac{c-(\alpha(1-\gamma))\theta}{(\alpha(1-\gamma))-(\beta(1-\delta))}$
	Trial	$G \geq max\{\frac{c}{(1-\beta)}, \frac{c-(\alpha\theta)}{(\alpha-\beta)}\}$ $G \leq min\{\frac{c}{(1-(\beta(1-\delta)))}, \frac{(\alpha(1-\gamma))\theta}{(1-(\alpha(1-\gamma)))}\}$	$G \geq max\{\frac{c}{(1-\beta)}, \frac{c-(\alpha\theta)}{(\alpha-\beta)}\}$, $G \geq max\{\frac{c}{(1-(\beta(1-\delta)))}, \frac{c-(\alpha(1-\gamma))\theta}{(\alpha(1-\gamma))-(\beta(1-\delta))}\}$	$G \geq max\{\frac{c}{(1-\beta)}, \frac{c-(\alpha\theta)}{(\alpha-\beta)}\}$, $\frac{(\alpha(1-\gamma))\theta}{(1-(\alpha(1-\gamma)))} < G < \frac{c-(\alpha(1-\gamma))\theta}{(\alpha(1-\gamma))-(\beta(1-\delta))}$
	Ordeal	$G \leq min\{\frac{\alpha\theta}{(1-\alpha)}, \frac{c-(\alpha\theta)}{(\alpha-\beta)}\}$, $G \leq min\{\frac{c}{(1-(\beta(1-\delta)))}, \frac{(\alpha(1-\gamma))\theta}{(1-(\alpha(1-\gamma)))}\}$	$G \leq min\{\frac{\alpha\theta}{(1-\alpha)}, \frac{c-(\alpha\theta)}{(\alpha-\beta)}\}$, $G \geq max\{\frac{c}{(1-(\beta(1-\delta)))}, \frac{c-(\alpha(1-\gamma))\theta}{(\alpha(1-\gamma))-(\beta(1-\delta))}\}$	$G \leq min\{\frac{\alpha\theta}{(1-\alpha)}, \frac{c-(\alpha\theta)}{(\alpha-\beta)}\}$, $\frac{(\alpha(1-\gamma))\theta}{(1-(\alpha(1-\gamma)))} < G < \frac{c-(\alpha(1-\gamma))\theta}{(\alpha(1-\gamma))-(\beta(1-\delta))}$

Table 4: Conditions for Stage 2 Game when $\alpha > \beta$ and (α (1 - γ)) > (β (1-δ))

		Innocent		
		Plead	*Trial*	*Ordeal*
Guilty	*Plead*	$G \leq min\{\frac{c}{(1-\beta)}, \frac{\alpha\theta}{(1-\alpha)}\}$, $G \leq min\{\frac{c}{(1-(\beta(1-\delta)))}, \frac{(\alpha(1-\gamma))\theta}{(1-(\alpha(1-\gamma)))}\}$	$G \leq min\{\frac{c}{(1-\beta)}, \frac{\alpha\theta}{(1-\alpha)}\}$, $\frac{c}{(1-(\beta(1-\delta)))} < G < \frac{c-(\alpha(1-\gamma))\theta}{(\alpha(1-\gamma))-(\beta(1-\delta))}$	$G \leq min\{\frac{c}{(1-\beta)}, \frac{\alpha\theta}{(1-\alpha)}\}$, $G \geq max\{\frac{(\alpha(1-\gamma))\theta}{(1-(\alpha(1-\gamma)))}, \frac{c-(\alpha(1-\gamma))\theta}{(\alpha(1-\gamma))-(\beta(1-\delta))}\}$
	Trial	$G \geq max\{\frac{c}{(1-\beta)}, \frac{c-(\alpha\theta)}{(\alpha-\beta)}\}$, $G \leq min\{\frac{c}{(1-(\beta(1-\delta)))}, \frac{(\alpha(1-\gamma))\theta}{(1-(\alpha(1-\gamma)))}\}$	$G \geq max\{\frac{c}{(1-\beta)}, \frac{c-(\alpha\theta)}{(\alpha-\beta)}\}$, $\frac{c}{(1-(\beta(1-\delta)))} < G < \frac{c-(\alpha(1-\gamma))\theta}{(\alpha(1-\gamma))-(\beta(1-\delta))}$	$G \geq max\{\frac{c}{(1-\beta)}, \frac{c-(\alpha\theta)}{(\alpha-\beta)}\}$, $G \geq max\{\frac{(\alpha(1-\gamma))\theta}{(1-(\alpha(1-\gamma)))}, \frac{c-(\alpha(1-\gamma))\theta}{(\alpha(1-\gamma))-(\beta(1-\delta))}\}$
	Ordeal	$G \leq min\{\frac{\alpha\theta}{(1-\alpha)}, \frac{c-(\alpha\theta)}{(\alpha-\beta)}\}$, $G \leq min\{\frac{c}{(1-(\beta(1-\delta)))}, \frac{(\alpha(1-\gamma))\theta}{(1-(\alpha(1-\gamma)))}\}$	$G \leq min\{\frac{\alpha\theta}{(1-\alpha)}, \frac{c-(\alpha\theta)}{(\alpha-\beta)}\}$, $\frac{c}{(1-(\beta(1-\delta)))} < G < \frac{c-(\alpha(1-\gamma))\theta}{(\alpha(1-\gamma))-(\beta(1-\delta))}$	$G \leq min\{\frac{\alpha\theta}{(1-\alpha)}, \frac{c-(\alpha\theta)}{(\alpha-\beta)}\}$, $G \geq max\{\frac{(\alpha(1-\gamma))\theta}{(1-(\alpha(1-\gamma)))}, \frac{c-(\alpha(1-\gamma))\theta}{(\alpha(1-\gamma))-(\beta(1-\delta))}\}$

Table 5: Conditions for Stage 2 Game when $\alpha > \beta$ and (β (1 - δ)) > (α (1 - γ))

		Innocent		
		Plead	*Trial*	*Ordeal*
Guilty	*Plead*	$G \leq min\{\frac{c}{(1-\beta)}, \frac{\alpha\theta}{(1-\alpha)}\}$, $G \leq min\{\frac{c}{(1-(\beta(1-\delta)))}, \frac{(\alpha(1-\gamma))\theta}{(1-(\alpha(1-\gamma)))}\}$	$G \leq min\{\frac{c}{(1-\beta)}, \frac{\alpha\theta}{(1-\alpha)}\}$, $G \geq max\{\frac{c}{(1-(\beta(1-\delta)))}, \frac{c-(\alpha(1-\gamma))\theta}{(\alpha(1-\gamma))-(\beta(1-\delta))}\}$	$G \leq min\{\frac{c}{(1-\beta)}, \frac{\alpha\theta}{(1-\alpha)}\}$, $\frac{(\alpha(1-\gamma))\theta}{(1-(\alpha(1-\gamma)))} < G < \frac{c-(\alpha(1-\gamma))\theta}{(\alpha(1-\gamma))-(\beta(1-\delta))}$
	Trial	$\frac{c}{(1-\beta)} < G < \frac{c-(\alpha\theta)}{(\alpha-\beta)}$, $G \leq min\{\frac{c}{(1-(\beta(1-\delta)))}, \frac{(\alpha(1-\gamma))\theta}{(1-(\alpha(1-\gamma)))}\}$	$\frac{c}{(1-\beta)} < G < \frac{c-(\alpha\theta)}{(\alpha-\beta)}$, $G \geq max\{\frac{c}{(1-(\beta(1-\delta)))}, \frac{c-(\alpha(1-\gamma))\theta}{(\alpha(1-\gamma))-(\beta(1-\delta))}\}$	$\frac{c}{(1-\beta)} < G < \frac{c-(\alpha\theta)}{(\alpha-\beta)}$, $\frac{(\alpha(1-\gamma))\theta}{(1-(\alpha(1-\gamma)))} < G < \frac{c-(\alpha(1-\gamma))\theta}{(\alpha(1-\gamma))-(\beta(1-\delta))}$
	Ordeal	$\frac{c-(\alpha\theta}{(\alpha-\beta)} < G < \frac{(\alpha\theta)}{(1-(\alpha)}\}$, $G \leq min\{\frac{c}{(1-(\beta(1-\delta)))}, \frac{(\alpha(1-\gamma))\theta}{(1-(\alpha(1-\gamma)))}\}$	$\frac{c-(\alpha\theta}{(\alpha-\beta)} < G < \frac{(\alpha\theta)}{(1-(\alpha)}\}$, $G \geq max\{\frac{c}{(1-(\beta(1-\delta)))}, \frac{c-(\alpha(1-\gamma))\theta}{(\alpha(1-\gamma))-(\beta(1-\delta))}\}$	$\frac{c-(\alpha\theta}{(\alpha-\beta)} < G < \frac{(\alpha\theta)}{(1-(\alpha)}\}$, $\frac{(\alpha(1-\gamma))\theta}{(1-(\alpha(1-\gamma)))} < G < \frac{c-(\alpha(1-\gamma))\theta}{(\alpha(1-\gamma))-(\beta(1-\delta))}$

Table 6: Conditions for Stage 2 Game when $\beta > \alpha$ and (α(1 - γ)) > (β (1 - δ))

		Innocent: *Plead*	Innocent: *Trial*	Innocent: *Ordeal*
Guilty	*Plead*	$G \leq min\{\frac{c}{(1-\beta)}, \frac{\alpha\theta}{(1-\alpha)}\}$, $G \leq min\{\frac{c}{(1-(\beta(1-\delta)))}, \frac{(\alpha(1-\gamma))\theta}{(1-(\alpha(1-\gamma)))}\}$	$G \leq min\{\frac{c}{(1-\beta)}, \frac{\alpha\theta}{(1-\alpha)}\}$, $\frac{c}{(1-(\beta(1-\delta)))} < G < \frac{c-(\alpha(1-\gamma))\theta}{(\alpha(1-\gamma))-(\beta(1-\delta))}$	$G \leq min\{\frac{c}{(1-\beta)}, \frac{\alpha\theta}{(1-\alpha)}\}$, $G \geq max\{\frac{(\alpha(1-\gamma))\theta}{(1-(\alpha(1-\gamma)))}, \frac{c-(\alpha(1-\gamma))\theta}{(\alpha(1-\gamma))-(\beta(1-\delta))}\}$
	Trial	$\frac{c}{(1-\beta)} < G < \frac{c-(\alpha\theta)}{(\alpha-\beta)}$, $G \leq min\{\frac{c}{(1-(\beta(1-\delta)))}, \frac{(\alpha(1-\gamma))\theta}{(1-(\alpha(1-\gamma)))}\}$	$\frac{c}{(1-\beta)} < G < \frac{c-(\alpha\theta)}{(\alpha-\beta)}$, $\frac{c}{(1-(\beta(1-\delta)))} < G < \frac{c-(\alpha(1-\gamma))\theta}{(\alpha(1-\gamma))-(\beta(1-\delta))}$	$\frac{c}{(1-\beta)} < G < \frac{c-(\alpha\theta)}{(\alpha-\beta)}$, $G \geq max\{\frac{(\alpha(1-\gamma))\theta}{(1-(\alpha(1-\gamma)))}, \frac{c-(\alpha(1-\gamma))\theta}{(\alpha(1-\gamma))-(\beta(1-\delta))}\}$
	Ordeal	$\frac{c-(\alpha\theta}{(\alpha-\beta)} < G < \frac{(\alpha\theta)}{(1-(\alpha)}\}$, $G \leq min\{\frac{c}{(1-(\beta(1-\delta)))}, \frac{(\alpha(1-\gamma))\theta}{(1-(\alpha(1-\gamma)))}\}$	$\frac{c-(\alpha\theta}{(\alpha-\beta)} < G < \frac{(\alpha\theta)}{(1-(\alpha)}\}$, $\frac{c}{(1-(\beta(1-\delta)))} < G < \frac{c-(\alpha(1-\gamma))\theta}{(\alpha(1-\gamma))-(\beta(1-\delta))}$	$\frac{c-(\alpha\theta}{(\alpha-\beta)} < G < \frac{(\alpha\theta)}{(1-(\alpha)}\}$, $G \geq max\{\frac{(\alpha(1-\gamma))\theta}{(1-(\alpha(1-\gamma)))}, \frac{c-(\alpha(1-\gamma))\theta}{(\alpha(1-\gamma))-(\beta(1-\delta))}\}$

Table 7: Conditions for Stage 2 Game when $\beta > \alpha$ and (β (1 - δ)) > (α (1 - γ))

		Innocent: *Plead*	Innocent: *Trial*	Innocent: *Ordeal*
Guilty	*Plead*		No Change: (Plead, Trial)	$(Plead, Plead)$ $\frac{c}{1-\beta} > G, \frac{c}{(1-(\beta(1-\delta))} > G$; $(Plead, Trial)$ $\frac{c}{1-\beta} > G, G > \frac{c}{1-(\beta(1-\delta))}$
	Trial		No Change: (Trial, Trial)	$(Trial, Plead)$ $G > \frac{c}{1-\beta}, \frac{c}{(1-(\beta(1-\delta)))} > G$; $(Trial, Trial)$ $G > \frac{c}{1-\beta}, G > \frac{c}{(1-\beta(1-\delta)))}$
	Ordeal			$(Plead, Plead)$ $\frac{c}{1-\beta} > G, \frac{c}{(1-(\beta(1-\delta)))} > G$; $(Plead, Trial)$ $\frac{c}{1-\beta} > G, G > \frac{c}{(1-\beta(1-\delta)))}$; $(Trial, Trial)$ $G > \frac{c}{1-\beta}, G > \frac{c}{(1-\beta(1-\delta)))}$

Table 8: Parameter Ranges for Strategy Changes Under Menu 1 (Plead or Trial)

		Innocent: *Plead*	Innocent: *Trial*	Innocent: *Ordeal*
Guilty	*Plead*		$(Plead, Plead)$ $\frac{\alpha\theta}{1-\alpha} > G, \frac{\theta(\alpha(1-\gamma))}{(1-(\alpha(1-\gamma)))} > G$; $(Plead, Ordeal)$ $\frac{\alpha\theta}{1-\alpha} > G, G > \frac{\theta(\alpha(1-\gamma))}{(1-(\alpha(1-\gamma))}$	No Change: (Plead, Ordeal)
	Trial		$(Plead, Plead)$ $\frac{\alpha\theta}{1-\alpha} > G, \frac{\theta(\alpha(1-\gamma))}{(1-(\alpha(1-\gamma)))} > G$; $(Plead, Ordeal)$ $\frac{\alpha\theta}{1-\alpha} > G, G > \frac{\theta(\alpha(1-\gamma))}{(1-(\alpha(1-\gamma))}$; $(Ordeal, Ordeal)$ $G > \frac{\alpha\theta}{(1-\alpha)}, G > \frac{\theta(\alpha(1-\gamma))}{(1-(\alpha(1-\gamma))}$	$(Plead, Ordeal)$ $\frac{\alpha\theta}{1-\alpha} > G, G > \frac{\theta(\alpha(1-\gamma))}{(1-(\alpha(1-\gamma))}$; $(Ordeal, Ordeal)$ $G > \frac{\alpha\theta}{(1-\alpha)}, G > \frac{\theta(\alpha(1-\gamma))}{(1-(\alpha(1-\gamma))}$
	Ordeal			No Change: (Ordeal, Ordeal)

Table 9: Parameter Ranges for Strategy Changes Under Menu 2 (Plead or Ordeal)

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