RELIGION, LONGEVITY, AND COOPERATION:
THE CASE OF THE CRAFT GUILD.

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ABSTRACT

When the mortality rate is high, repeated interaction alone may not sustain cooperation, and religion may play an important role in shaping economic institutions. This insight explains why during the fourteenth century, when plagues decimated populations and the church promoted the doctrine of purgatory, guilds that bundled together religious and occupational activities dominated manufacturing and commerce. During the sixteenth century, the disease environment eased, and the Reformation dispelled the doctrine of purgatory, necessitating the development of new methods of organizing industry. The logic underlying this conclusion has implications for the study of institutions, economics, and religion throughout history and in the developing world today.

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1 Introduction

Religious beliefs influence economic activity. A large literature establishes that fact.[1] Why religion matters remains the subject of debate. Recent research elucidates how economic incentives shape the organization of congregations, why religious sects specialize in particular niches, and when economic opportunities induce trade-offs between spiritual and secular activities.[2] This research extends earlier scholarship that explores the influence of religion on individuals' tastes, desires, proclivities, and habits and emphasizes how religion shapes both preferences for and constraints upon human action.[3]

The earlier literature grew from Max Weber's work on *The Protestant Ethic and the Spirit of Capitalism*.[4] Weber argued that in Protestant nations, the Reformation changed preferences for labor relative to leisure, for savings relative to consumption, and for physical goods relative to emotions such as acceptance by peers and fear of damnation, encouraging the accumulation of capital and expansion of industry. Weber's thesis emerged from his dissertation on *The History of Commercial Partnerships in the Middle Ages*, which established a baseline from which to assess how the Reformation influenced commerce and industry.[5]

Comparing recent and earlier research reveals a line of argument analogous to Weber's, in the sense that it explains the symbiotic evolution of religious and economic institutions during the centuries crucial for the formation of the modern market economy, and complementary to Weber's, in the sense that it illuminates an additional channel through which religion affected the economy. Religious beliefs shaped the evolution and influenced the effectiveness of occupational organizations.

Our analysis of this observation begins at the same point as Weber's. We examine the organization of industry in late medieval England, a society where artisanal activity occurred in organizations called craft guilds. These associations of artisans dominated economic activity for centuries, during which the foundations of modern economic progress—including

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[1] See for example, Iannaccone (1998), Barrow and McLeary (2003), and Mokyr (1990)
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[2] Abramitzky (2005), Berman (2000), and Iannaccone (1992, 1994, and 1998).

[3] McClearly and Barro (2006). See also Hume (1993), Smith (2003), and Tawney (2000).

[4] Weber (1930).

[5] Weber (2003)

industries such as clothmaking, metallurgy, and manufacturing, which took off during the Industrial Revolution, and concepts such as contract and incorporation, which comprise the legal foundation for capitalist economies—evolved.

Scholars have long pondered craft guilds' rise and decline. In 1776, Adam Smith attributed guilds' origins to the universal "interest of the freemen of a corporation to hinder the rest of the inhabitants from employing any workmen but themselves."[6] In 1848, Karl Marx argued that guilds were the late-medieval manifestation of the materialist dialectic, in which "guild-master and journeyman, in a word, oppressor and oppressed, stood in constant opposition to one another ... [until] guild-masters were pushed aside by the manufacturing middle class."[7] Subsequent scholars attributed the origins of guilds to continuity from Roman *collegia*; descent from fraternal associations abundant in ancient Germanic societies; a universal taste for association; the need for collective defense; urban political imperatives; government regulatory and taxation policies; and changes in technology, prices, and transaction costs. No consensus concerning these theories exists, probably because few of the theories generate testable implications, and all are inconsistent with some facts.[8]

This essay offers a new theory of the rise, decline, and changing nature of craft guilds that is consistent with the evidence. The key is to understand how guilds convinced members to cooperate, and how exogenous changes in the environment influenced the effectiveness of guilds' enforcement mechanisms. The principal driving forces were the disease environment and religious doctrines.

Disease influenced craftsmen's ability to cooperate by determining the mortality rate. Folk theorem logic holds that cooperation occurs more readily when individuals care more about the future, which in turn, depends on how long one expects to live. Low mortality rates meant long lives and extensive cooperation. High mortality rates meant short lives and little cooperation. The mortality rate for craftsmen fluctuated dramatically during the Middle Ages, as the introduction of virulent, infectious diseases, such as the Black Death, scourged urban populations.

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[6]Smith (2003), Book 4, Chapter 3, Part 2

[7]Marx and Engels (2004).

[8]See Richardson (2001, 2004, and 2005) for discussions of these theories.

Religion influenced the way in which craftsmen cooperated by emphasizing the concept of an afterlife. The late-medieval Christian church promoted the doctrine of purgatory, which stated that after death, individuals experienced excruciating pain, which purged them of sins in preparation for entrance into Heaven, where one experienced ecstasy. Purgatorial pain could be lessened by the prayers of the living, particularly by pious people who knew one well, such as family, friends, and colleagues. Guilds were organized to provide prayers for the souls of deceased members. Guilds threatened to punish members caught breaking the rules by excluding them from intercessory services. This threat became more salient when belief in the doctrine spread and mortality rates rose, enabling guilds that bundled together religious and occupational activities to sustain occupational cooperation in environments where purely secular associations employing folk-theorem threats could not.

This logic provides a new understanding of the rise, decline, and changing nature of guilds in medieval and early modern England. During the twelfth and thirteenth centuries, when industrial activity initially expanded in towns, urban residents formed organizations focused on secular, economic, and legal concerns. During the fourteenth century, as the doctrine of purgatory spread and the disease environment deteriorated, craftsmen organized increasing numbers of guilds that prayed for the souls of deceased members. Guilds that engaged both in religious and occupational activities proved especially effective at facilitating cooperation. During the sixteenth century, mortality rates fell, religious reformation swept aside the doctrine of purgatory, and new methods of organizing industry evolved.

This logic builds a bridge between hitherto unrelated literatures. The first employs game theory to study economic institutions. Avner Greif pioneered this line of research.[9] His work reveals how reputations, repeated relationships, and folk-theoretic interactions fostered the rise of anonymous exchange during the later Middle Ages. Institutions that foster cooperative endeavors arise endogenously, and these institutions and individuals' beliefs in the institutions' ability to sustain cooperation, coevolve through time. The second employs club theory to study religious institutions. Laurence Iannaccone pioneered this line of research.[10] His work reveals how the imposition of sacrifices and the threat of exclusion shape

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[9] Greif (1992, 1993, 1994, 1998, 2006) and Greif et. al. (1994).

[10] Iannaccone (1992, 1994, and 1998).

the behavior of congregations that provide religious services. We study groups that operated both as Greif-style economic cooperatives and Iannaccone-style religious cooperatives. In our work, the types of institutional arrangements that arise to foster cooperation depend on environmental factors. We show that under some social, cultural, economic, and demographic conditions, purely occupational institutions akin to those studied by Greif can sustain cooperative endeavors. Under other conditions, such institutions cannot sustain cooperation, and other institutional arrangements can arise endogenously that bind secular and religious form to foster collective success along both fronts.

The remainder of this paper develops our argument, that exogenous shocks on two fronts, mortality rates and religious beliefs, shaped the structure of industrial organization in late medieval and early modern Europe, when guilds of craftsmen used spiritual sanctions to sustain occupational cooperation in settings where purely economic threats could not do so. Section 2 summarizes the essential historical evidence. Section 3 presents a game theoretic model that illustrates how religious sanctions fostered cooperation among groups of craftsmen in a single industry. Section 4 uses the model to describe how changes in religious doctrines and the disease environment influenced an economy consisting of numerous independent industries. Section 5 considers how changes in doctrines and disease influenced the level of cooperation within organizations. Section 6 relates our findings to the broader literature and discusses the implications of our analysis. Religion can form a foundation for cooperation in environments where folk theorems function poorly.

2   Historical Background

In England from 1275 to 1550, an era often called "Industrial Revolution of the Middle Ages," cooperatives formed the foundation of industry and society. Three kinds of cooperatives existed in the largest numbers: those engaged principally in occupational activities, which we refer to as a occupational cooperatives; those engaged principally in praying for the souls of deceased members, which we refer to as intercessory cooperatives (or chantries); and those engaged in both activities, which we refer to as a combined cooperatives. Past scholars typically referred to both the first and third as craft guilds, not distinguishing the

religious component of the latter, and typically referred to the second as chantries or parish guilds. Here, we use new terminology to highlight these organizations' similar structures and different objectives.[11] These three ubiquitous organizations are the subject of our study. This section describes them; how their structure, numbers, and effectiveness changed over time; and the exogenous forces driving these developments.[12]

Occupational cooperatives operated in many sectors of the urban economy. Cooperatives of manufacturers made durable goods which they exported from their towns to distant markets and consumers in the countryside. Manufacturers often established reputations for product quality, fostering the expansion of anonymous exchange. Cooperatives of victuallers bought agricultural commodities, converted them to consumables, and sold finished foodstuffs. Victuallers often manipulated input and output markets to their own advantage. Both manufacturers and victuallers managed (or manipulated) labor markets, and at times, advanced senior craftsmen's interests at subordinates' expense.

Intercessory cooperatives (a.k.a. chantries) organized, managed, and financed members' collective quest for eternal salvation. A chantry's objective was the salvation of the soul. The doctrine of purgatory dictated that goal.[13] The doctrine declared that after death, all individuals spent a period in purgatory, where torments purged them of sins and prepared them for Heaven. The torments (such as the burning one felt as their flesh decayed and the freezing one felt as their bare bones froze in the cold earth) could be alleviated by the prayers of the living. Particularly beneficial were prayers of persons who knew the deceased intimately, such as relatives, friends, neighbors, and colleagues, and who prayed regularly

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[11]Note: Medieval men and women referred to these organizations by a wide variety of names including brotherhoods, companies, confraternities, chantries, crafts, fraternities, guilds, and mysteries. Modern historians typically refer to all of these organizations as guilds, often prefacing the term with an adjective indicating the leading members or principal activity of the organization (e.g. merchant guild, craft guild, social guild, parish guild, or religious guild). Modern theorists often refer to organizations like these as cooperatives. Because our study analyzes dimensions of these organizations that have hitherto escaped academic attention and because we wish to avoid the often bitter battle over appropriate terminology, we employ new terms – occupational cooperative, intercessory cooperative, and combined cooperative – to refer to the taxonomy of interest.

[12]In a series of essays, Richardson (2000, 2001, 2004, 2005a, 2005b) establishes the factual foundation for the historical patterns described in this section. See those articles for additional details and citations to primary and secondary sources. A companion paper, entitled "A Pious and Profitable Mystery," delves into the historical issues, data details, and comparative statistics pertinent to this paper.

[13]See Le Goff (1984) for an overview of the doctrine and history of purgatory.

and devotedly on their behalf. Chantries' intercessory efforts began with indoctrination, activities, and monitoring to maintain the piety of members. Piety was important because members' fates were linked together. The more pious the supplicant, the more salutary the supplication. The more pious one's brethren, the more beneficial their prayers, and the less the pain of purgatory. The endeavor continued after death with elaborate and expensive funerals. Postmortem prayers continued as long as the chantry existed, hopefully into perpetuity.

Combined cooperatives bundled together the functions of intercessory and occupational cooperatives. All three of these organizations—occupational, intercessory, and combined cooperatives—provided members with collective goods. Examples include reputations for quality, manufacturing technology, low prices for inputs, high prices for outputs, shared religious rituals, and prayers from a pool of pious persons. All three required members to contribute to the costs of these collective endeavors. For example, manufacturing cooperatives required members to bear the costs of using high-quality inputs, rather than cheaper alternatives. Chantries required members to contribute time, emotion, exertion, and energy; to participate in religious rituals; to attend funerals; to regularly pray for the souls of the deceased; and to pay period dues (which paid salaries of priests and purchased pious paraphernalia). Chantries also required members to abstain from pleasures of the flesh and material temptations of secular life.

Because a key task for all three organizations was to induce members to bear their share of the collective costs and to discourage free riding, all three organizations possessed mechanisms for monitoring members' contributions, encouraging cooperation, and punishing defection. Manufacturing cooperatives, for example, employed officers known as searchers who scrutinized members' merchandise to make sure it met guild standards and inspected members' shops and homes seeking evidence of attempts to circumvent the rules. Chantries employed officers who monitored members' behavior to ensure that they lived piously and prayed faithfully. Members of chantries, guilds, and cooperatives who failed to fulfill their obligations faced punishments of various sorts. Punishments varied across transgressions, guilds, time, and space, but a pattern existed. First time offenders were punished lightly, perhaps suffering public scolding and paying small monetary fines, and repeat offenders pun-

ished harshly. The ultimate threat was expulsion. These voluntary organizations could do nothing harsher because laws protected persons and property from arbitrary expropriations and physical abuse.

Table 1 summarizes evidence concerning the scope and scale of these organizations' activities during the later Middle Ages. From the revival of urban life (circa 1000) to the initial spread of doctrine of purgatory (circa 1275), occupational cooperatives existed in many English towns. The greatest concentration existed in clothmaking industries. Some towns and industries lacked cooperatives of craftsmen; in all towns and industries, many craftsmen worked outside of cooperatives. During the three generations following the introduction of the doctrine of purgatory to England (roughly 1275 to 1350), the number of occupational cooperatives and chantries grew gradually. The first combined cooperatives were formed. Growing numbers of craftsmen belonged to these organizations, but many craftsmen continued to work independently. Following the Black Death (circa 1348 to 1350), the number of chantries skyrocketed. Within a generation, almost all adults in England belonged to an intercessory organization. Many intercessory societies evolved into combined cooperatives. The number of combined cooperatives increased exponentially. Almost all urban artisans belonged to an organization that provided both intercessory and occupational services. After the Reformation (circa 1547), the number of combined cooperatives plummeted. Within a generation, combined cooperatives ceased to exist. Some of these pious and profitable organizations shed their religious dimensions and survived as purely occupational cooperatives. In many industries, however, new organizational forms arose. The putting-out system became increasingly popular. Mutual insurance societies began constructing the first actuarial tables. Industry shifted from the towns where it had been centered for centuries to villages where it began to expand.

Table 1: Evidence of Medieval English Cooperatives by Type and Time Period

Period	Years	Occupational	Intercessory	Combined
Before Doctrine of Purgatory	pre 1275	○		
Purgatory to Black Death	1275 to 1350	○	○	○
Black Death to Reformation	1350 to 1550		●	●
Post-Reformation	post 1550	○		

Notes: An open circle indicates that during the time period, evidence demonstrates that cooperatives of this type existed. The cooperatives were rare to common. Some craftsmen belonged to them, but other craftsmen operated independently and/or outside of these organizations. A filled circle indicates that during the time period, evidence demonstrates that cooperatives of this type were ubiquitous. All individuals living in urban areas belonged to organizations of this type. Few if any craftsmen operated independently. A blank space indicates that during the period, cooperatives of that type did not exist.

Figure 1 depicts trends in the two exogenous variables which, we argue, propelled the changing nature of economic cooperation in late medieval England: the mortality rate and the doctrine of purgatory. During the late thirteenth and early fourteenth centuries, mortality rates rose gradually, as the expansion of trade and changes in climate brought virulent, infectious diseases into contact with northern European townsmen who lacked immunity to these pathogens. In 1348, the death rate rose to a catastrophic level, as the Black Death ravaged unprotected populations. In some towns, more than half of the residents perished. Within a generation, repeated epidemics reduced the aggregate population by twenty-five to thirty-three percent. Mortality rates fell gradually during the fifteenth century, as Europeans developed immunity to the new diseases, and as the diseases themselves evolved to become less pathogenic.

The doctrine of purgatory came to England during the late thirteenth century. Mendicant friars spread it as part of their proselytizing mission. During the fourteenth century, the doctrine of purgatory became increasingly widespread and influential; after the Black Death, belief in purgatory became universal and transcendent. Teaching the doctrine was the focus of church activity. The doctrine dominated Christianity for the next 175 years. Reformers attacked the doctrine during the second quarter of the sixteenth century. The Reformation came to England during the reign of Henry VIII. Henry's son and heir, Edward IV, completed the transformation, and in 1547, banned the belief in purgatory, suppressed all institutions that promoted it, and prohibited guilds (and all other groups) from praying for the souls of

the deceased.

3 Model: Cooperation in a Single Industry

This section models cooperatives of craftsmen as repeated games. The presentation of the model proceeds in stages. Subsections 3.1 through 3.3 examine occupational, religious, and combined cooperation respectively. Subsection 3.4 examines extensions of the model and answers questions about the structure of cooperatives such as why did guilds adopt particular punishment strategies and whether chantries' by-laws were self enforcing.

To clarify our exposition, we posit specific actions in our model, while realizing that the mathematics (and the logic that the mathematics encapsulates) is general enough to represent the spectrum of activities described in the preceding section. For example, in our model, craftsmen manufacture cloth for export. With minor adjustments to the profit function, our hypothetical cloth exporters could be victuallers acting as Cornout oligopolists, master craftsmen monopsonizing markets for journeymen and apprentices, a guild of goldsmiths lobbying authorities for favorable policies, or a group of pewterers jointly developing a new technology for manufacturing lead-free flatware.

3.1 Occupational Equilibrium

Our occupational cooperative depicts a typical situation in the largest medieval industry. A group of clothmakers manufacture textiles for export to the wider market. The craftsmen live in the same town, own their own workshops, employ identical technologies, and manufacture indistinguishable merchandise. The craftsmen develop a collective reputation for product quality. They differentiate their wares from textiles made in other towns by giving their cloth a conspicuous characteristic, such as a unique weave or color, which outsiders cannot copy. The conspicuous characteristic and collective reputation provide pricing power. When our clothmakers manufacture high-quality merchandise, they sell their wares at premium prices and earn large profits. When they manufacture shoddy merchandise, consumers refrain from purchasing their products. They sell limited quantities at low prices, and earn small sums.

The occupational cooperative consists of a group of n craftsman, labeled $i = 1, 2, 3, ..., n,$

who interact during periods labeled $t = 1, 2, 3, ..., \infty$. Each period consists of a sequence of three moves in the following order. One, each craftsman simultaneously decides the quality, $q_{it} \in \{q_H, q_L\}$, of the cloth that he manufactures. H stands for high quality, L stands for low quality, and $q_H > q_L$. Two, nature chooses which craftsmen die. The mortality rate m, $0 < m < 1$, is the probability that craftsman i dies. This probability is independently and identically distributed across craftsmen. Three, period t ends and payoffs are received.

Craftsman i chooses $\{q_{it}\}_{t=1}^{\infty}$ to maximize his expected present discounted payoff, U_{it}.

$$U_{it} = \sum_{t=1}^{\infty} (1 - m)^t \pi_{it} (q_{it}, q_{-it}), \tag{1}$$

where $\pi_{it} (q_{it}, q_{-it})$ is i's profit in period t given the qualities chosen by all craftsmen in that period. A craftsman's profits, $\pi_{it} (q_{it}, q_{-it})$, increase as the average quality $\frac{1}{n} \sum_{j=1}^{n} q_{jt}$ of the cloth made by other members of the cooperative increases because the craftsmen share a collective reputation for product quality. But, a craftsman's profits decrease as the quality of his own cloth, q_{it}, increases, because manufacturing high-quality cloth costs more than manufacturing low-quality cloth.

To solve the model, three single-period profit levels must be defined. Denote i's single-period profit level as π_C, the cooperative level of profits, if all craftsmen choose q_H in period t. Denote i's single-period profit level as π_D, the defector's profit level, if all craftsmen other than i choose q_H in period t but craftsman i chooses q_L. Denote i's single-period profit level as π_{NE}, the single-period Nash Equilibrium profit level, if all of the craftsmen including craftsman i choose q_L in period t. Our assumptions about π_{it} imply $\pi_D > \pi_C > \pi_{NE}$.

Additional assumptions complete the model. First, all choices are publicly observable, i.e., at the end of step 1, all of the craftsmen know the quality levels chosen by all of their colleagues in that and all previous periods. This assumption seems reasonable, since the occupational cooperatives under investigation were small (10 to 50 members), close-knit associations of individuals interacting on a frequent (daily or weekly) basis with periodic (quarterly or annual) administrative meetings attended by all members where the organization reviewed the conduct of its members and officers. In addition, these cooperatives devised rules, established revelation mechanisms, invested in technology, and employed administrators for the explicit purpose of illuminating members' quality choices. Second, each

craftsman who dies in period t is replaced by a new, identical craftsman at the start of period $t+1$. This assumption simplifies the analysis and is consistent with the structure of these organizations. Occupational cooperatives (as well as chantries) recruited new members continuously and screened them intensively. Occupational cooperatives possessed ranks of journeymen and apprentices awaiting promotion to the rank of master. These provisional members participated in the social and ritual life of the organization. So, they had the ample opportunity to observe events that transpired and learn the history of the organization. Often, when a master died, one of his subordinates—typically either his son, senior journeyman, or former apprentice—inherited his workshop, paying his widow for the privilege of taking over the productive capital.

In this situation, the cooperative can maintain high-quality production if all the craftsmen play the trigger strategy: "produce high quality in period 1; in period $t > 1$, produce high quality if all others have produced high quality in all prior periods; otherwise produce low quality." These trigger strategies yield an equilibrium when for each i

$$\sum_{t=1}^{\infty} (1-m)^t \pi_C \geq (1-m)\pi_D + \sum_{t=2}^{\infty} (1-m)^t \pi_{NE} \Rightarrow$$

$$\frac{1-m}{m}\pi_C \geq (1-m)\pi_D + \frac{(1-m)^2}{m}\pi_{NE} \Rightarrow$$

$$m \leq \frac{\pi_C - \pi_{NE}}{\pi_D - \pi_{NE}} = m^*. \tag{2}$$

Inequality (2) indicates that traditional trigger strategies sustain the high-quality equilibrium if the mortality rate is sufficiently low. This condition coincides with the logic of the standard folk theorem. As long as craftsmen care enough about consumption in future periods, they can sustain economic cooperation today by threatening economic sanctions in the future. Figure 2(a) plots in the two-dimensional space spanned by our two exogenous variables the values for which (2) holds as an equality. The plotted line is vertical, since the occupational cooperative engages in no religious activities, and its existence is unaffected by individuals' beliefs about purgatory. At any point to the left of the line, the occupational cooperative can be sustained as an equilibrium. At any point to the right of the line, threats of punishments in the future cannot deter defection today, and the cooperative cannot be sustained as an equilibrium.

3.2   Intercessory Equilibrium

A chantry was a religious organization that specialized in the production of intercessory prayers. The prayers reduced the pain (i.e. increased the utility) that individuals experienced in purgatory and sped their entry into Heaven. The chantry was an economic club, and the prayers were a club good, since the prayers were jointly produced, easily excludable, and non (or minimally) rival.[14] Depicting religious goods as club goods is standard for social scientists studying religious organizations.[15]

Our chantry consists of a group of n craftsman, labeled $i = 1, 2, 3, ..., n$, who interact during t periods, labeled $t = 1, 2, 3, ..., \infty$. Each period consists of a sequence of moves in the following order: One, all craftsmen simultaneously decide whether to join , $j_{it} = 1$, or not join $j_{it} = 0$, the chantry. Joining/re-joining entails paying membership fee f. Two, nature chooses which craftsmen die. The mortality rate m, $0 < m < 1$, is independently and identically distributed across craftsmen. Three, surviving chantry members vote on how to spend the chantry's resources, $\widehat{n}_t f$, where $\widehat{n}_t$ is the number of craftsmen who joined the chantry in step 1 of period t. The surviving members may spend the resources on prayers for the souls of deceased chantry members, or divide the resources among surviving members, or some combination of both. Four, period t ends and payoffs are received.

Craftsmen i's Bellman equation is

$$
\begin{aligned}
U_{it} \;=\; & \max\{mI\,(\text{pray})\,v_{it}\,(\text{prayer expenditures}) \\
& -I\,(j_{it} = 1)\,f + (1 - m)\,(r_{it} + U_{t+1})\}.
\end{aligned}
\tag{3}
$$

$I\,(\text{pray})$ takes the value 1 if i dies and is prayed for in t by the surviving chantry members and takes the value 0 otherwise. The prayer value function, $v_{it}\,(\cdot)$, represents i's valuation today (i.e. before step 3 in time t) of the prayers that he believes will be said on his behalf

[14]To enable this essay to focus on the connection between religious and economic cooperation, we abstract from issues concerning the credibility of promises paid-off after death and free-rider problem inherent in the production of religious services. We assume that craftsmen believe the Doctrine of Purgatory, that contributions to chantries can be perfectly monitored, and that benefits of postmortem prayers are perfectly excludable. In another essay, "The Afterlife as a Disciplinary Device," we ponder these issues, determine how chantries solved the free-rider problem, and explain why craftsmen believed promises to pray for the salvation of their souls would be fulfilled, even after their deaths, when they lacked the ability to monitor the behavior of their former colleagues or to retaliate against those who do not live up their part of the bargain.

[15]Iannaccone (1998) describes why religious activities should be modelled as club goods.

after he dies. v_{it} is increasing in the amount (of money and/or effort) expended on prayers and is non-rivalrous. $I(j_{it}=1)$ is an indicator function that has value 1 if i joins in t but takes value 0 otherwise. r_{it} is the amount of club resources redistributed back to i in step 3.

Additional assumptions complete the model. First, all actions are publicly observable. Second, any member who dies in period t is replaced in the next period by an identical individual. These assumptions appear realistic and reasonable for the reasons indicated in our description of an occupational cooperative. Third, the spending option with most votes in step 3 is chosen. If there is a tie among options, then the option outlined in the club by-laws is chosen.

The chantry's by-laws consist of two edicts. First, in step 3 of period t, the chantry includes a member on the prayer roll if he joined the chantry in all prior periods of his life and died in period t. Second, in step 3 of period t, the chantry spends all resources from fees collected in step 1 on prayers for members who are on the prayer list from by-law 1. These by-laws encapsulate an assumption that simplifies the mathematics of the model because a craftsman that does not join the chantry in one period never receives prayers in future periods, and therefore, has no incentive to cycle in and out of the organization. These by-laws also reflect the by-laws of the typical medieval chantry, which stated that the association would pray only for the souls of members who died in good standing. Those names were inscribed on rolls of parchment read during intercessory services. To simplify our analysis, we assume for now that these by-laws are contractually binding. In a subsequent subsection, we explain why these by-laws are self-enforcing.

The chantry exists as an equilibrium when all craftsmen join the chantry in step 1 of period t and in all future periods. This equilibrium exists when all craftsmen play the strategy: "in each period t, join the club in step 1 and vote according to the by-laws in step 3." Choosing this strategy given that all others choose this strategy yields the utility U_{it}

$$U_{it} = mv_{it}(nf) - f + (1-m)U_{t+1}.$$

Since the strategic situation repeats itself in all periods, $U_{it} = U_{it+1}$. Therefore,

$$U_{it} = v_{it}(nf) - \frac{f}{m}.$$

A craftsman will follow this strategy when all other craftsmen follow this strategy if doing so yields a higher expected payoff than all possible deviations. The only deviation for i in t is to not join the club, which yields payoff normalized to 0 in round t and all future periods. Therefore, choosing the strategy "join the chantry now and forever after" is optimal when

$$
\begin{aligned}
U_{it} &\geq 0 \Rightarrow \\
v_{it}(nf) - \frac{f}{m} &\geq 0 \Rightarrow \\
v_{it}(nf) &\geq \frac{f}{m} \equiv v^*.
\end{aligned}
\tag{4}
$$

Inequality (4) states that craftsmen form chantries when the spiritual benefits that one expects to receive after death, $v_{it}(nf)$, are equal to or greater than membership costs that one expects to pay during their lifetime. The value depends upon the intensity of craftsmen's beliefs in the doctrine of purgatory. The more intensely they believe, the more they value prayers for the salvation of their souls.

Inequality (4) reveals the minimum spiritual benefit necessary for a chantry to exist at any given mortality rate. The minimum increases in f but decreases in m. The minimum also approaches ∞ as $m \to 0$ from above and approaches f as $m \to 1$ from below. Thus, the chantry is more likely to exist as an equilibrium when the mortality rate, m, is high. When the mortality rate rises, life expectancies decline. Intuitively, individuals expect to enter purgatory sooner and so place a higher value on intercessory prayers. When the mortality rate falls, life expectancies rise, and craftsmen place less weight on the anticipated benefits of postmortem prayers.

Figure 2(b) depicts this relationship by plotting combinations of m and $v(nf)$ in $(m, v(nf))$-space for which (4) holds as an equality. The area along and above the curve, v^*, indicates combinations of m and $v(nf)$ for which chantries will exist in equilibrium. Below v^*, individuals do not value post-mortem prayers highly enough for the chantry to function.

3.3   Combined Equilibrium

Our model of a combined cooperative is a combination of our separate models of an intercessory cooperative and an occupational cooperative. Our combined cooperative consists of

n craftsman and t periods, where each period consists of a sequence of moves in the following order. One, all craftsmen simultaneously decide whether to participate in the groups' religious activities. Craftsmen who participate pay membership fee f. Two, irrespective of the choice made in step 1, all craftsmen simultaneously decide whether to produce high or low quality merchandise. Three, nature decides which craftsmen die. The mortality rate, m, is distributed identically and independently across craftsmen. Four, cooperative members decide how to employ the groups' religious resources. Five, payoffs for the period are received.

Combining equation (1), the objective function for members of our occupational cooperative, and equation (3), the objective function for members of our intercessory cooperative, yields the Bellman equation for the ith member of the combined cooperative.

$$
\begin{aligned}
U_{it} &= \max\{mI\,(\text{pray})\,v_{it}\,(\text{prayer expenditures}) \\
&\quad -I\,(j_{it}=1)\,f + (1-m)\,(\pi_{it}\,(q_{it}, q_{-it}) + r_{it} + U_{it+1})\}.
\end{aligned} \tag{5}
$$

Members choose contributions to the religious and occupational aspects of this organization to maximize their expected utility functions.

The organization's by-laws consist of two ordinances. First, in step 4 of period t, add to the prayer list any individual that (a) participated in the organizations' religious activities in that and every prior period of his life, (b) chose $q_{it} = q_H$ in all prior periods of his life, and (c) died in period t. Second, in step 3 of period t, spend all resources from fees collected in step 1 on prayers for the salvation of the souls of the persons on the prayer list. These by-laws link the cooperative's religious and occupational endeavors by promising spiritual benefits only to those who cooperated professionally. Economic cooperation is sustained by threats of religious, rather than economic, retaliation. We assume that the organization operated in this manner because by-laws of this type are the only ones observed historically. In the next subsection of the essay, we explain how such by-laws could be sustained as an equilibrium.

Given these by-laws, we can determine the payoff from following a strategy of cooperating religiously and economically. "In each period, join the chantry in step 1; set $q_{it} = q_H$ in step 2; and vote according to the by-laws in step 4." If all craftsmen follow this strategy, then

craftsman i's expected payoff is

$$
\begin{aligned}
U_{it} &= mv_{it}(nf) - f + (1-m)(\pi_C + U_{it+1}) \Rightarrow \\
U_{it} &= \frac{(1-m)}{m}\pi_C + v_{it}(nf) - \frac{f}{m}.
\end{aligned}
\tag{6}
$$

A craftsman has two potential deviations from this strategy. First, craftsman i can deviate in step 1 by not joining the chantry. Under this deviation, he will forever be excluded from the religious benefits. Moreover, since all others continue to choose q_H, he can set $q_{it} = q_L$ and receive π_D in every period. The present value of this deviation is $\sum_{t=1}^{\infty}(1-m)^t \pi_D$, which equals $\frac{1-m}{m}\pi_D$. Second, after joining the chantry in step 1, craftsman i can deviate in step 2 by choosing $q_{it} = q_L$. This deviation yields a lower expected payoff than the first deviation since the deviating craftsman pays the membership fee f in step 1, but never receives religious benefits. Since it is a dominated strategy, to determine when the guild can be sustained as an equilibrium, we only need to compare the present value of the payoff in (6) to the payoff from deviations of the first type.

The comparison indicates that pursuing the cooperative strategy when all other craftsmen do also is optimal for i when

$$
\begin{aligned}
\frac{(1-m)}{m}\pi_C + v_{it}(nf) - \frac{f}{m} &\geq \frac{1-m}{m}\pi_D \Rightarrow \\
v_{it}(nf) &\geq \frac{1-m}{m}(\pi_D - \pi_C) + \frac{f}{m} \Rightarrow \\
v_{it}(nf) &\geq \frac{1-m}{m}(\pi_D - \pi_C) + v^* \equiv v^{**}.
\end{aligned}
\tag{7}
$$

Inequality (7) states that joint religious and economic cooperation can be sustained in equilibrium if the value of the religious benefits is sufficiently high.

Figure 2(c) plots combinations of m and $v(nf)$ in $(m, v(nf))$-space for which (7) holds as an equality. The parameters are the same as those in Figures 2(a) and (b). The area along and above the curve, v^{**}, indicates combinations of m and $v(nf)$ for which joint cooperation exists as an equilibrium. The shape of the v^{**}-curve is similar shape to the v^*-curve, but lies above it, because the potential benefits from deviating from a combined religious and economic cooperative are larger than the potential gains from deviating from single-task organization. The combined cooperative, therefore, needs a greater threat to deter deviation.

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As the mortality rate, m, increases, v^{**} converges to v^*. The curves converge because as life expectancies fall, the economic incentive to deviate diminishes, and the punishment needed to sustain combined religious and economic cooperation approaches that needed to sustain religious cooperation alone.

In addition, for $m > m^*$ and holding the membership fee f fixed, the benefits provided by membership in a combined cooperative equilibrium, determined by v^{**}, are strictly larger than the benefits of provided by membership in a chantry equilibrium, determined by v^*. This relationship exists for a simple reason. With fixed fee and mortality rate, the combined cooperatives provide both religious and economic services, and therefore, provide both religious and economic benefits.[16]

Figure 3 reveals the types of organizations that exist at different points in our parameter space. At mortality rates below m^*, an occupational equilibrium will exist. The value of $v(nf)$ will determine the nature of the equilibrium. If $v(nf)$ lies below v^*, an occupation cooperative will exist. If $v(nf)$ lies between v^* and v^{**}, two separate cooperatives – one occupational and one intercessory – will exist. If $v(nf)$ lies above v^{**}, a combined cooperative will be the optimal institutional form. At mortality rates above m^*, purely economic cooperation collapses, because the incentive to free ride dominates potential punishments. Occupational cooperatives cannot exist. As long as craftsmen care enough about the afterlife, however, religious cooperation thrives. If $v(nf)$ lies between v^* and v^{**}, an intercessory cooperative will exist. If $v(nf)$ lies above v^{**}, a combined cooperative will be the optimal institutional form. The combined cooperative functions effectively because craftsmen can sustain occupational cooperation by bundling together economic and religious activities. The allure of intercessory prayers, fear of postmortem pains, and threat of exclusion from eternal salvation can induce individuals to honor pecuniary agreements.

Figure 4 compares our model from Figure 3 (gray curves) with movements in exogenous forces from Figure 1 (dark arrow). The comparison reveals a connection between our

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[16]With higher benefits, we may also suppose that the combined cooperative will charge higher fees, potentially reducing the net benefits. Such a case could be examined in a richer model in which the cooperative strategically chooses f. We note, however, that although increasing f increases the cost of membership, it also increases the resources to be spent on prayers, thereby increasing the benefits. The change in net benefits will depend on the slope of the prayer valuation function.

model and the evolution of occupational cooperation in medieval England. During the fourteenth century, as the doctrine of purgatory spread and the disease environment deteriorated, craftsmen found purely occupational cooperation difficult to sustain, and in response, formed cooperatives that engaged in both religious and occupational activities. During the sixteenth century, mortality rates fell, religious reformation swept aside the doctrine of purgatory, and occupational cooperation returned to a secular form.

3.4 Theoretical Considerations

Self-enforcing by-laws. The preceding analysis assumes that the by-laws of guilds and chantries are contractually binding, yet chantries and guilds were ultimately voluntary, and their rules had to be self-enforcing. Guilds' by-laws, in other words, had to arise as an endogenous equilibrium from a game in which craftsmen chose how to allocate resources. We have analyzed an extended version of our model (not shown here) that endogenizes such choices. The extended model shows that by-laws similar to the ones in our model could be sustained as self-enforcing. We say "similar" because in the extended model, craftsmen's strategies must account for a variety of rare, extreme states of the world (e.g., all craftsmen die, or only craftsman i survives, or nobody ever dies) and all possible deviations in those states. We simplify the presentation of our model by imposing by-laws that directed craftsmen to behave during extreme states as they behaved during typical times.

The substantive results presented in our paper remain unchanged. The reason is that when the value of intercessory prayers is sufficiently large, their denial becomes an excruciating punishment, and when the mortality rate rises high enough, defection from occupational organizations becomes irresistibly enticing.

That said, several subtle differences are worth mentioning. First, if the mortality rate is extremely high (m close to 1), then there is a chance that all members will die. No members will survive to spend club resources on prayers. Specifically, the probability of receiving $v_{it}(nf)$ is no longer m but is instead $(m - m^n)$, which approaches 0 as m approaches 1. For the expected benefits of membership to be sufficiently high when m is close to 1, $v_{it}(nf)$ must then be very large. This results in U-shaped v^* and v^{**}-curves. The upward turn of the v^* and v^{**}-curves occurs at an extremely high value of m. Above that value, as m

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approaches 1, no type of cooperation can be sustained. This intriguing subtlety may explain the breakdown of both religious and economic institutions during the first few years of the Black Death's initial onslaught into Europe, when many people believed the end of the world was at hand.

Second, if the mortality rate is very low (m close to 0), then there is a high probability that no member of the organization will die, and no money needs to be expended on prayers. Allowing the club to reward living members, either in the form of a refund of club fees or by producing a club good to be consumed by living members, will lower the expected cost of joining the club. This flattens the v^* and v^{**}-curves at low mortality levels. However, both v^* and v^{**} will remain downward sloping at low m, as long as surviving chantry members cannot refund resources in their entirety and must spend some on prayers. There are many reasons to believe that contributions to chantries were not completely refundable. First, chantries, like all clubs, had fixed operating costs that consumed a portion of the resources. Second, a substantial portion of contributions to chantries were time, effort, emotion, and energy put into religious rituals and efforts to lead pious lives. Those non-monetary sunk costs could not be refunded.

In sum, the model with binding by-laws presented earlier is equivalent to a model with self-enforcing by-laws where mortality rates are bounded away from 0 and 1. Since this interior range corresponds to the range of actual mortality rates observed (with the possible exception of a few years around 1350), the model with binding by-laws elucidates the essential issues.

Punishment Mechanism: Exclusion versus Nash Reversion. A ubiquitous feature of late-medieval guilds was their reliance on individually-targeted religious sanctions to enforce rules regarding occupational activities. Other game-theoretic options existed, of course. Guilds could have punished uncooperative members by taking actions with wider consequences. Members of a manufacturing guild who caught one of their own passing off shoddy merchandise under the guilds' good name could have punished the offender by collectively lowering the quality of their products for a prolonged period. That would lower the offender's income, albeit at the cost of lowering the income of all other members as well. Similarly, members of a guild that caught one of their brethren shirking on prayers and

sinning incessantly could have punished the offender by collectively forsaking the Lord and descending into debauchery. Then, no one would or could pray for the soul of the offender, and his period in purgatory would be extended. In broader terms, cheaters could have been punished by any action that reduced the average incomes of all guild members or increased the pain that all members expected to endure in purgatory.

The combination of these punishments could have sustained cooperation for a wider set of parameter values than when relying on either Nash reversion or religious exclusion alone. In our basic model, where monitoring and enforcement are perfect and Nash threats are free, we can define joint punishment strategies and by-laws that sustain cooperation for all $v_{it}(nf) \geq v^{***}$, where v^{***} is the dual-threat version of v^{**} defined in inequality (7). Specifically, we calculate

$$v_{it}(nf) \geq -\frac{1-m}{m}(\pi_C - \pi_{NE}) + v^* \equiv v^{***}.$$

Because $\pi_C > \pi_{NE}$, $v^{***} < v^*$ for all m. Thus, the parameter space in which dual-threat guilds exist is a strict superset of the parameter space in which exclusion-only guilds exist.

In theory, such threats could have convinced even the most recalcitrant members to contribute to the common good. But, no evidence exists that craft guilds ever operated in such a manner. None of the hundreds of surviving guild ordinances contains threats of such a kind. No surviving guild documents describe punishing the innocent along with the guilty. Guilds eschewed indiscriminate retaliation for several salient reasons. First, monitoring members' behavior was costly and imperfect. Since time and risk preferences varied across individuals and uncertainty of many kinds influenced craftsmen's decisions, some members would have attempted to cheat regardless of the threatened punishment. Punishments would then have occurred in equilibrium, and the cost of carrying out an equilibrium-sustaining threat of expulsion would have been lower than the cost of carrying out an equilibrium-sustaining threat that reduced average income. Hence, expelling members caught violating the rules was an efficient method of enforcing the rules. Second, punishing free riders by indiscriminately harming all guild members may not have been a convincing threat. Individuals may not have believed that threats of mutual assured destruction would be carried out. The incentive to renegotiate would have been strong. Third, skepticism

probably existed about threats to do unto others as they had done unto the guild. That concept contradicted a fundamental teaching of the church, to treat others as you wished them to treat you. It also contradicted the New Testament admonition to turn the other cheek and not to fight others, but to let them punish themselves, by excluding themselves from God's covenant. Thus, indiscriminate retaliation based upon hair-trigger strategies was not an organizing principle likely to be adopted by guilds whose members hoped to speed passage through purgatory.

The first and second explanations come from the literature on industrial organization, where they have been discussed in other contexts. The third comes from the historical circumstances in which these organizations operated. Our model suggests a fourth explanation, which is unique to the strategic situation faced by craftsmen in the later Middle Ages. Equations (7) and (8) indicate that as m increases, both v^{***} and v^{**} approach v^*. The convergence implies that as mortality rates rise, the threat of religious sanctions grows, while the threat of Nash reversion diminishes, since individuals expect postmortem punishments to be inflicted sooner, but do not expect to suffer lengthy secular punishments (they expect to die soon). In other words, when mortality rates were high and the bundling of economic and religious activities was important for sustaining cooperation, the threat of Nash reversion had little marginal value. Executing Nash reversion entailed substantial costs, and even threatening Nash reversion entailed spiritual costs, because Christian doctrines encouraged "turning the other cheek" and discouraged indiscriminate retaliation. Because the benefits were low and the costs where high, guilds that bundled together religious and economic activities did not employ Nash threats.[17]

Outside Options and Renegotiation. Our model assumes that craftsmen must choose whether or not to join an economic, religious, or combined cooperative. Other organizations do not exist. The assumption obviously colors our result. A guild's spiritual threat would be weaker, and a combined cooperative might not form, if a craftsmen could cheat his colleagues by manufacturing low-quality merchandise, and after suffering expulsion, quickly

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[17]Taking a first derivative, we obtain $\frac{\partial v^{***}}{\partial m} = \frac{1}{m^2}(\pi_C - \pi_{NE} - f)$. With $\pi_C - \pi_{NE} < f$, then v^{***} will have the same general shape as v^* and v^{**}, but if $\pi_C - \pi_{NE} < f$, then v^{***} will be positively sloped. In this case, the dual-threat guild can sustain cooperation in many more places than the exclusion-only guild. However, $v^{***} \to v^*$ as $m \to 1$ in both cases.

use a portion of his ill-gotten gains to join an independent chantry which would pray for the salvation of his soul.

We rule out this possibility because historic and strategic factors limited craftsmen's outside options. Historically, most medieval chantries had long probationary periods through which new members had to pass before receiving religious benefits. These probationary periods enabled guilds to size up new members, helping them to screen out bad apples and limit adverse selection. Chantries also charged sizeable entrance fees, as did guilds, which further required prospective members to serve long apprenticeships. These organizational attributes would have made it difficult and may have precluded the possibility of joining a new chantry. Moreover, since the value of postmortem prayers depended upon the piety of those doing the praying, a known deviator would be perceived as a bad candidate for membership in a new organization. This reduced the number of organizations willing to accept defectors.

The last reason helps us understand the limited possibilities for renegotiation between defectors and religious cooperatives. When a craftsman defected, he demonstrated his lack of piety, and the other members' valuation of that defector's membership decreased. For this reason, religious organizations had little (and perhaps no) incentive to renegotiate expulsion. In contrast, the incentive to renegotiate Nash reversion was strong, because Nash reversion hurt honest craftsmen who remained faithful to their colleagues as much as it hurt those who had been caught defecting. This contrast is an additional reason that guilds emphasized religious punishments during the later Middle Ages.

Endogeneity of Religious Beliefs and Beliefs about Others' Beliefs. In our model, all agents commonly know that everyone values prayers identically (i.e., $v_{it}(\cdot)$ is commonly known for each individual i). This is a simplifying assumption that does not substantively affect the main logic of our argument, and we here elaborate why. There are two parts to this assumption: first, that individuals believe the Purgatory doctrine, and second, that individuals commonly know that others believe in the doctrine. We do not propose any explanation for the first point. We take it as given that individuals maintain beliefs about religious ideas. We also acknowledge that an individual's belief may change for various reasons. For example, the intensity of an individual's belief in Purgatory could

increase as the mortality rate increases or repeated interaction with other believers could increase one's own belief. In either of these cases, the religious threats increase in salience, thereby reinforcing the logic of our analysis. Thus, relaxing the assumption of exogenous belief in Purgatory is not crucial for our argument.

More crucial for our argument is that members be confident that other organization members believe in the doctrine because it is this belief about other's beliefs that gives an individual confidence, in the equilibrium, that fellow members will choose to pray for her when she dies. Indeed, it is useful here to make another distinction between beliefs about others' religious beliefs and beliefs about others' equilibrium behavior. Our simplifying assumption that all players commonly know that everyone has the same prayer valuation function produces common knowledge of equilibrium behavior trivially in our equilibrium. However, convergence in beliefs about others' behavior also occurs in richer models with heterogeneity in degrees of religious beliefs across individuals. What is important is that the group can successfully screen out "non-believers." If its screening is effective, then an individual who joins the group will know, in equilibrium, that all others who join are "believers," and he can thereby have full confidence in other members' beliefs and behavior. Beliefs about other's religious beliefs would thus arise endogenously as part of the equilibrium. Thus, the main logic of our argument survives in this more general setting when the group's screening process is sufficiently successful. We note as well that actual medieval organizations did screen their members to assess their religious commitment. The key distinction is that between religious beliefs, which might or might not shift exogenously, and beliefs about other members' equilibrium behavior, which are entirely endogenous in our model. Given others' religious beliefs and local social, cultural, economic, and demographic conditions, we describe how different forms of organizations can arise endogenously to solve collective action problems.

4 Model: Cooperation and the Aggregate Economy

The previous section examines a group of craftsmen in a single cooperative in a particular economic, legal, and social setting. The setting determines the values of the parameters of the

model, such as π_C, π_D, and π_{NE}, and the shape and location of the curves in Figures 2 and 3. Changes in the parameters alter the curves' shapes and locations. This section extends our analysis to a world composed of numerous groups of craftsmen operating in a variety of industries, facing an array of economic opportunities, under a spectrum of institutional conditions. In this world, we ask: how do changes in the exogenous variables influence the organization of industry?

Proposition 1 *(Mortality and Organizational Structure)*

(a) At low mortality rates, there can exist either (i) occupational cooperatives, or (ii) separate occupational and intercessory cooperatives, or (iii) any combination of occupational, intercessory, and combined cooperatives.

(b) At high mortality rates, all organizations must have a religious basis.

(c) As mortality rates increase, the fraction of organizations dependent on religious sanctions to induce occupational cooperation increases.

The proof of the proposition appears in Appendix A. Here, we explain the rationale. Variation in industry specific parameters generates an m^* for each industry. At a mortality rate below the m^* for all industries, individuals have long time horizons and highly value future consumption. Individuals prefer the long-run benefits of occupational cooperation to the short-run benefits of cheating their colleagues. Occupational organizations can thus sustain themselves as equilibria without recourse to religious sanctions. At a mortality rate above m^* for all industries, however, time horizons are too short to sustain occupational cooperation, and cooperation among craftsmen only occurs when sustained by religious sanctions. At an intermediate mortality rate, craftsmen in some industries may be able to sustain purely economic cooperation, while craftsmen in other industries need to bundle occupation with religion to sustain economic cooperation. As mortality rates rise, the later case becomes more common.

Notice that religious vitality (as measured by the percentage of organization engaged in religious activities) does not depend on religious beliefs alone. The choice to participate in religious activity is like any other economic decision in that it depends on the expected benefits and costs of that religious activity, such as the mortality rate. When the mortality

rate rises, occupational organizations cease operations, and intercessory societies flourish. At high levels of mortality, cartels cannot operate, leaving chantries and guilds as the only organizations in existence. Thus, the percentage of organizations engaged in religious activities may rise even though religious beliefs remain constant. When the mortality rate rises to extreme levels, it is even possible for the religious vitality of society to increase even if the amount that individuals value religion falls.

Proposition 2 *(Purgatory and Organizational Structure):* *As the value of post-mortem prayers increases, the fraction of occupations with intercessory and combined cooperatives increases.*

Why? As the value of post-mortem prayers rises so that for a particular industry, $v_{it}(nf)$ exceeds v^*, the craftsmen can organize a chantry. As the value of $v_{it}(nf)$ increases above the threshold for other industries, more chantries can operate. If m exceeds m^* and $v(nf)$ exceeds v^{**}, the craftsmen can convert their chantry into a combined occupational and religious cooperative. If m falls below m^*, the craftsmen may form a combined cooperative, or they may operate separate religious and economic organizations, depending on the circumstances for that particular occupational and institutional setting (i.e. the guild equilibrium dominates the chantry plus cartel equilibrium in some instances but not others).

The proposition yields an illuminating corollary. The nature of the industry, craftsmen's cost and revenue functions, market opportunities, and any legal, social, or cultural institution that influences individuals' per period income or rate of time preference can generate variation in the structure of and participation within religious organizations.

Proposition 3 *(Guilds and Deviation Payoffs):* *As the payoff to economic defection increases, only organizations that use religious sanctions can sustain occupational cooperation.*

As the payoff to economic defection increases, purely occupational cooperation is more difficult to sustain. The maximum mortality rate for which occupational cooperation exists in equilibrium decreases, and the parameter space in which occupational cooperation can be sustained in equilibrium shrinks. Holding m fixed, occupational sanctions alone might no

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longer be sufficient to sustain cooperation, and bundling religious and economic activities might now be necessary for cooperation, because the benefits to free riding on the cartel have increased.

Propositions 1 through 3 connect our model to the evidence presented in Table 1. The propositions indicate that at a point in time, the types of organizations in existence should vary across industries due to variation in m^* across industries. The variation should depend on industry specific factors that influence the ability of groups to enforce cooperation. The pattern of variation should change as the two exogenous factors, which influence organizations' ability to enforce their rules, change. The historical evidence indicates that organizations did, in fact, react to changes in the exogenous variables in the manner predicted by our model.

5 Organization and the Level of Cooperation

The previous sections examine the existence but not the extent of cooperation. This section allows the level of cooperation to vary within organizations. This extension of our basic model enables a group to alter its degree of cooperation – instead of its organizational structure – in response to changes in the mortality rate and the religious environment.

To consider this possibility, suppose craftsmen choose the level of quality, q_{it}, and per-capita expenditures on intercessory services, f, from a continuum of choices, i.e., $q_{it} \geq 0$ and $f \geq 0$. An increase in the level of quality chosen by the group represents an increase in occupational cooperation. An increase in the level of intercessory expenditures chosen by the group represents an increase in religious cooperation. Appendix B presents this extended model. The appendix shows that the equilibrium level of cooperation within an organization may change in response to changes in the mortality rate or the perceived efficacy of post-mortem prayers. The following proposition summarizes the implications of this extended model.

Proposition 4 *(Mortality, Purgatory, and the Level of Cooperation)*

(a) When the mortality rate increases, the level of occupational cooperation in occupational organizations falls.

(b) When the mortality rate increases, the level of occupational cooperation in organizations combining occupational and intercessory activities rises.

(c) When the value of postmortem prayers rises, the level of occupational cooperation in occupational organizations remains unchanged.

(d) When the value of postmortem prayers rises, the level of occupational cooperation in organizations combining occupational and intercessory activities rises.

The proposition indicates that when cooperation occurs along a continuum, the exogenous variables determine the maximum level of cooperation that can be sustained as an equilibrium. This maximum level depends upon the punishment that can be inflicted upon free riders. When mortality increases, an occupational organization's power to punish free riders falls, and the level of quality that it can sustain in equilibrium declines. Conversely, an intercessory organization's power to punish free riders rises, and the level of religious expenditures that it can sustain in equilibrium increases. Increased mortality influences these two organization's differently because it alters the relative value of temporal and postmortem punishments. When mortality rises, individuals place less weight on future occupational punishments (they are less likely to survive until they receive the punishment), but individuals place greater weight on the threat of postmortem punishments (they expect to enter purgatory sooner). Thus, changes in the mortality rate—or more broadly speaking, changes in intertemporal preferences—influence occupational and intercessory organizations differently. Increased mortality weakens occupational organizations but enhances religious cooperation. When the value of postmortem prayers changes, so does the salience of religious punishments. This will no have no effect on the operations of an occupational organization because it sustains cooperation via occupational threats, but it will alter the ability of a combined cooperative to enforce cooperation.

The logic underlying Proposition 4 implies continuous versions of Propositions 1 through 3. Changes in mortality rates and religious beliefs, therefore, induce changes in the level of cooperation in two ways. First, they influence the ability of organizations to enforce rules, encourage cooperation, and discourage defection. Second, they induce industries to adopt more effective organizational structures.

6 Discussion

Our argument—that religious beliefs influenced the organization of industry, the scope and scale of occupational cooperation, and extent of economic activity in late medieval England—complements Greif's insights into the institutional foundations of late medieval trade and the influence of culture, broadly defined, on the evolution of the modern economy.[18] Our research links the literature that employs game theory to study market institutions, pioneered by Greif, to the literature that uses club theory to study religious institutions, pioneered by Iannaccone.[19] Our research helps to fill the gap between the work of Greif, which focused on economic institutions, and the ideas of Hume, Marx, Smith, and Weber, who emphasized the ways in which religion influenced individuals' values, tastes, and desires, and thereby, influenced individuals' choices.[20] We show that changes in religious belief influenced the structure and performance of economic institutions.

This is not the only channel through which religion influenced economic development. Religions are complex, ever-changing packages of beliefs, behaviors, and relationships that impact society in many ways only now being studied by social scientists. We emphasize the purgatory–occupation–cooperation channel not because we perceive it to be the only way in which religious beliefs influenced economic activity, but because it had a dramatic, demonstrable impact on European society during a period crucial for the formation of the modern market economy.

We suspect that similar dynamics operate today in poor and war-torn nations with high-mortality rates and radical religious traditions. Our model and historical analysis generate insights of interest in such circumstances. The first is that when high mortality rates limit the amount of economic cooperation, religious beliefs about an afterlife can provide an alternative method of sustaining cooperation.[21] The effects are likely to be larger in societies where

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[18] Greif, 2006.

[19] Iannaccone, 1998.

[20] Hume, 1993; Smith, 2003; Tawney, 2000; and Weber, 1930.

[21] This is not the only way that religious beliefs may enhance cooperation. Jerome et al. (2008), for example, explain how the Judeo-Christian teachings on forgiveness can lower the cost to invidiuals of making consumption choices by allowing individuals to more easily adjust their consumption choices through time. Such a process, which could be at work in a model of consumer choice with changing endowment effects, can foster cooperation by making individuals more willing to enter into mutually benefical transactions.

mortality rates are higher and life expectancies low, like some regions of the developing world, such as sub-Saharan Africa, where there exists a correlation between mortality, poverty, extremism, and violence.

Another potential application of our model is to religious conflicts in modern times. In recent years, many organizations—including churches, nations, and terrorist networks—have influenced adherents by promising postmortem benefits to those who undertake onerous or risky actions. Some of the benefits are spiritual, such as the heavenly brides reportedly promised to suicide bombers. Others are pecuniary, such as the payments by Saddam Hussein's government to the families of Palestinians who died attacking Israel.

Our framework can accommodate benefits of both types. Incorporating the latter into the model will make it applicable to a wide range of risky occupations where promises of postmortem pensions form an important part of the compensation package, such as soldiers and firemen. Our model may also have applications to situations where individuals face the risk of an absorbing state other than death, such as incarceration. In this case, the cooperative organization might be a criminal gang, such as *La Cosa Nostra*, which aids imprisoned members and their families. An interesting policy issue would be designing laws that minimized the cost of inducing criminals to defect from the coalition.

To each of these examples, our model contributes a general insight. There are risks, such as mortality, that shift individuals between states of the world where people value time, emotions, and goods differently. Organizations whose activities span these states may be able to generate cooperation in situations where repeated interaction in a single state cannot. This is why religion can form a foundation for cooperation in situations where standard folk-theorem interaction functions poorly.

A Proofs of Propositions 1-3

Consider an economy with Z industries labeled $z = 1, ..., Z$. Suppose that the economic, legal, and social setting yields for each industry a unique π_C^z, π_D^z, and π_{NE}^z, which implies an industry specific m^{z*}. Rank the industries by m^{z*} and label them so that $m^{1*} < m^{2*} < \cdots < m^{Z*}$. Assume $v_{it}(\cdot)$, n, and f are identical for all industries. These assumptions imply

that v^* is the same for all industries. Differences across industries in π_C^z and π_D^z, however, imply that v^{z**} differs across industries. Create a second ranking of the industries, denoted $\hat{z} = 1, ..., Z$, where $v^{1**} < v^{2**} < \cdots < v^{Z**}$. The $\hat{z}$ ranking's order may differ from the z ranking's order.

Our analysis in Section 3 discussed three possible types of equilibrium cooperatives. Let O represent the occupational cooperative. Let I represent the intercessory cooperative. Let C represent the combined cooperative. Let E_z represent the set of equilibria cooperatives in industry z given π_C^z, π_D^z, π_{NE}^z, $v_{it}(\cdot)$, n, and f.

Proposition 1(a): If $m \leq m^{1*}$, then for each z either (i) $E_z = \{O\}$, (ii) $E_z = \{O, I\}$, or (iii) $E_z = \{O, I, C\}$.

Proof: Consider industry 1. As shown in Section 3, the O-equilibrium exists because $m \leq m^{1*}$. Whether or not the I-equilibrium also exists depends on the value of $v_{it}(nf)$. As shown in Section 3, if $v_{it}(nf) \geq v^*$, then the I-equilibrium will exist in addition to the O-equilibrium, but it will not if $v_{it}(nf) < v^*$. Moreover, as shown in Section 3, if $v_{it}(nf) \geq v_1^{**}$, then the C-equilibrium will exist in addition to the O and I-equilibria, but will not exist if $v_{it}(nf) < v^{**}$. Summarizing for industry 1:

$$E_1 = \begin{cases} \{O\} & \text{if } v_{it}(nf) < v^* \\ \{O, I\} & \text{if } v^{**} \leq v_{it}(nf) < v_1^{**} \\ \{O, I, C\} & \text{if } v_{it}(nf) \geq v_1^{**} \end{cases}.$$

By the ranking of the industries, it must also be true that $m \leq m^{z*}$ for any z. Applying the same logic as above, we see that

$$E_z = \begin{cases} \{O\} & \text{if } v_{it}(nf) < v^* \\ \{O, I\} & \text{if } v^{**} \leq v_{it}(nf) < v^{z**} \\ \{O, I, C\} & \text{if } v_{it}(nf) \geq v^{z**} \end{cases}.$$

for each z. $\square$

Proposition 1(b): If $m > m^{Z*}$, then $O \notin E_z$ for each z.

Proof: Consider industry Z. As shown in Section 3, the O-equilibrium does not exist if $m > m^{Z*}$. Because $m > m^{z*}$ for all $z = 1, ..., Z$ by the ranking of industries, it must also be true that the O-equilibrium does not exist for all $z = 1, ..., Z$. $\square$

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Definition: Given a profile of parameters, ϕ_z is an indicator function that takes the value 0 if the O-equilibrium exists in industry z and 1 otherwise:

$$\phi_z = \begin{cases} 0 & \text{if } m \leq m^* \\ 1 & \text{if } m > m^* \end{cases}.$$

Definition: Given a profile of parameters, Φ is the fraction of industries for which the O-equilibrium does not exist: $\Phi = \frac{1}{Z} \sum_{z=1}^{Z} \phi_z$.

Proposition 1(c): Φ is monotonically increasing in m.

Proof: By the definition of ϕ_z, it follows that $\Phi = 0$ for all $m \leq m^{1*}$. It also follows that $\Phi = \frac{1}{Z}$ for all $m^{1*} < m \leq m^{2*}$. By induction using the same logic we obtain the following function which is increasing in m:

$$\Phi(m) = \begin{cases} 0 & \text{if } m \leq m^{1*} \\ \frac{z}{Z} & \text{if } m^{z*} < m \leq m^{z+1*} \text{ for } z = 1, ..., Z-1 \\ 1 & \text{if } m > m^{Z*} \end{cases}. \quad \square$$

Definition: Given a profile of parameters, ψ_z is an indicator function that takes value 1 if the I-equilibrium exists in industry z and 0 otherwise:

$$\psi_z = \begin{cases} 0 & \text{if } v_{it}(nf) < v^* \\ 1 & \text{if } v_{it}(nf) \geq v^* \end{cases}.$$

Definition: Given a profile of parameters, Ψ is the fraction of industries for which the I-equilibrium exists: $\Psi = \frac{1}{Z} \sum_{z=1}^{Z} \psi_z$.

Definition: Given a profile of parameters, $\omega_{\widehat{z}}$ is an indicator function that takes value 1 if the C-equilibrium exists in industry $\widehat{z}$ and 0 otherwise:

$$\omega_{\widehat{z}} = \begin{cases} 0 & \text{if } v_{it}(nf) < v^{\widehat{z}**} \\ 1 & \text{if } v_{it}(nf) \geq v^{\widehat{z}**} \end{cases}.$$

Definition: Given a profile of parameters, Ω is the fraction of industries for which the O-equilibrium exists: $\Omega = \frac{1}{Z} \sum_{z=1}^{Z} \omega_{\widehat{z}}$.

Proposition 2: Both Ψ and Ω are monotonically increasing in $v_{it}(nf)$.

Proof of Proposition 2: By the definition of ψ_z, it follows that $\Psi = 0$ if $v_{it}(nf) < v^*$ and that $\Psi = 1$ if $v_{it}(nf) \geq v^*$. Thus, Ψ is monotonically increasing in $v_{it}(nf)$. By the definition of $\omega_{\widehat{z}}$, it follows that $\Omega = 0$ for all $v_{it}(nf) \leq v^{1**}$. It also follows that $\Omega = \frac{1}{Z}$ for

all $v^{1**} < v_{it}(nf) \leq v^{2**}$. By induction using the same logic we obtain the following function which is increasing in $v_{it}(nf)$:

$$\Omega\left(v_{it}(nf)\right) = \begin{cases} 0 & \text{if } v_{it}(nf) \leq v^{1**} \\ \frac{\widehat{z}}{Z} & \text{if } v^{\widehat{z}**} < v_{it}(nf) \leq v^{\widehat{z}+1**} \text{ for } \widehat{z} = 1, ..., Z-1 \\ 1 & \text{if } v_{it}(nf) \leq v^{Z**} \end{cases} \quad . \quad \square$$

Proposition 3: If $\pi_D^z > \frac{1}{m}\left(\pi_C^z - \pi_D^z\right) + \pi_{NE}^z$, then $O \notin E_z$.

Proof of Proposition 3: From Section 3, we know that the O-equilibrium does not exist if $m > \frac{\pi_C - \pi_{NE}}{\pi_D - \pi_{NE}} \Rightarrow \pi_D > \frac{1}{m}\left(\pi_C^z - \pi_D^z\right) + \pi_{NE}^z$. $\square$

B Model with Continuous q_{it} and f

B.1 Occupational Cooperative

Craftsman i chooses $\{q_{it}\}_{t=\infty}$, $q_{it} \geq 0$, to maximize

$$U_{it} = \sum_{t=1}^{\infty} (1-m)^t \pi_{it}(q_{it}, q_{-it}).$$

Let the single period profit function for each i take the form

$$\pi_{it}(q_{it}, q_{-it}) = r\left(\frac{1}{n}\sum_{j=1}^{n} q_{jt}\right) - c(q_{it}),$$

where $r(\cdot)$ is the revenue function that is increasing in the average quality and $c(q_{it})$ is the cost function.

As is standard, assume that both functions are twice differentiable, with the revenue function being strictly concave in its argument and cost being convex: $r'(\cdot) > 0$, $r''(\cdot) < 0$, $c'(\cdot) > 0$ and $c''(\cdot) \geq 0$. To capture the free-rider incentive, assume $r'(0) > c'(0)$ and $\frac{\partial \pi_{it}}{\partial q_{it}} < 0$. The first condition implies that there is any non-zero level of quality, if chosen by all craftsman, will make everyone better off than if all chose quality 0; i.e., some degree of cooperation is desired. The second condition implies that i's single period payoff is always highest by choosing the lowest possible q_{it} no matter what the other craftsman do; i.e., i has the incentive to free-ride on others' quality.

We now derive the highest level of quality (i.e., cooperation) that can be sustained in a symmetric equilibrium. First notice that with concave revenue function and convex cost

function, there will exist a quality level $\overline{q} > 0$ above which the group would never want in equilibrium. To see this, consider $\pi_{it}(q,q)$, which is the single period payoff if all i choose $q_{it} = q$. Choosing q to maximize $\pi_{it}(q,q)$, we obtain the following first order condition

$$r'(\overline{q}) = c'(\overline{q}).$$

This $\overline{q}$ always exists and is unique by our assumptions on $r(\cdot)$ and $c(\cdot)$. Call this quality level $\overline{q}$ the maximum desirable quality level, and let us restrict our attention to $[0, \overline{q}]$ as the set of possible equilibrium quality levels.

If craftsmen all choose $\overline{q}$, then say that the craftsmen achieve *full cooperation*. Of course, it might or might not be possible to sustain full cooperation as an equilibrium using trigger strategies, and if not, it might instead be possible to sustain a degree of *partial cooperation* at a lower yet non-zero quality level. The trigger strategy that will sustain the highest level of cooperation (whether partial or full) will be the one that includes the harshest punishment. Because revenue is increasing in the average quality level, i's single period minmax payoff is when all craftsmen choose $q_{it} = 0$. Thus, if i deviates, the harshest punishment that the others can inflict on i is to choose the lowest quality from then on.

With this mind, consider the following strategy: "choose quality level q in the first period, and punish in period t by setting $q_{it} = 0$ if anyone ever choose quality strictly less than q in period $t' < t$."

To see if quality level $q \in [0, \overline{q}]$ can be sustained using this strategy, we must also consider a craftsman's possible deviations. Should i decide to deviate on others playing this strategy in round t, then in all future rounds $t' > t$, all others will choose quality 0, so his best response in all future rounds would be choosing $q_{it'} = 0$ as well. Because $\frac{\partial \pi_{it}}{\partial q_{it}} < 0$, his best single period deviation payoff is by choosing to $q_{it} = 0$.

Quality level $q \in [0, \overline{q}]$ can be sustained in equilibrium if playing the strategy is better than the best deviation:

$$\sum_{t=1}^{\infty} (1-m)^t \pi_{it}(q,q) \geq (1-m) \pi_{it}(0,q) + \sum_{t=1}^{\infty} (1-m)^t \pi_{it}(0,0) \Rightarrow$$

$$m \leq \frac{\pi_{it}(q,q) - \pi_{it}(0,0)}{\pi_{it}(0,q) - \pi_{it}(0,0)} \equiv m^*(q).$$

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This condition is similar to condition (2) from Subsection 3.1, the only difference being that the payoffs correspond to a continuum of possible q's. In words, $m^*(q)$ is the highest possible mortality rate m that can sustain average quality level q in equilibrium.

Because both the numerator and denominator of $m^*(q)$ increase in q, $m^*(q)$ is monotonically decreasing in q over $[0, \overline{q}]$ when its numerator grows at a slower rate than the denominator:

$$\frac{\partial}{\partial q}\pi_{it}(q, q) - \frac{\partial}{\partial q}\pi_{it}(0, 0) \;<\; \frac{\partial}{\partial q}\pi_{it}(0, q) - \frac{\partial}{\partial q}\pi_{it}(0, 0) \Rightarrow$$

$$r'(q) - c'(q) \;<\; r'\left(\frac{n-1}{n}q\right)\left(\frac{n-1}{n}\right) \Rightarrow$$

$$r'(q) - r'\left(\frac{n-1}{n}q\right)\left(\frac{n-1}{n}\right) \;<\; c'(q).$$

We expect this inequality to hold in our scenarios of interest for most values of m. The right hand side of this inequality is clearly positive, so a negative left hand side is sufficient (thought not necessary) for the inequality to hold. The left hand side is negative when $r(\cdot)$ is sufficiently concave or when n is sufficiently large. The intuition straightforward. When the revenue function is concave, the gains from an initial degree of cooperation can be quite large, but those gains disappear rapidly as q increases. Thus, the incentive for partial cooperation is great, but a decrease in the mortality rate is necessary for craftsmen to care enough about the future so as to increase their level of cooperation. When n is small, defecting by setting $q_{it} = 0$ has a large impact on overall average quality, and this acts to decrease the payoff to defecting. Thus, n must be large enough for cooperation even at low levels. Yet, both of these conditions would hold in our settings of interest. The guilds were large in size so that one person's defection would hurt overall average quality but not disproportionately so, and there were many benefits to even small amounts of cooperation.

Given m, any occupational cooperative with q such that $m \leq m^*(q)$ can be an equilibrium. With $m^*(q)$ monotonically decreasing in q, there exists a function $q^*(m)$, the inverse of $m^*(q)$, such that an equilibrium exists if $q \leq q^*(m)$. Given the voluntary nature of the cooperative, it is reasonable to suppose that the craftsmen will choose that level of quality that yields the net benefits to the cooperative members. Thus, we expect the cooperative to chose $q = q^*(m)$ for all $m > m^*(\overline{q})$, and $q = \overline{q}$ for all $m \leq m^*(\overline{q})$. This conclusion yields

a figure similar to that in Subsection 3.1 with an important difference. For any $m \leq m^*(q)$, an equilibrium with full cooperation exists. As m increases beyond $m^*(q)$, the level of cooperation in the most cooperative equilibrium decreases. Qualitatively, as the mortality rate increases, the level of cooperation decreases even if the cooperative organizations still exist. Though the equilibrium with cooperation technically still exists at high mortality rates, there may be very little cooperation in the organization.

B.2   Intercessory Organization

We here relax the assumption that the chantry has an exogenous fee by allowing the chantry to choose any positive fee. To do this, we assume that $v_{it}(\cdot)$ is concave such that $v'(\cdot) \geq 0$, $v''(\cdot) \leq 0$, and $0 \leq v'_{it}(0) < \infty$.

As before, if all other craftsmen join at some specified f (we discuss which f will be chosen below), then craftsman i joins if $v_{it}(nf) \geq \frac{f}{m}$. Yet, given m, there might not be an f for which this is true. Consider the case where $v'_{it}(0) < \frac{1}{m}$. In this case, there does not exist an f such that $v_{it}(nf) \geq \frac{f}{m}$ by the concavity of $v(\cdot)$. This would occur if, for example, there is no belief in purgatory, which implies $v_{it}(\cdot) = v'_{it}(\cdot) = 0$. In a second case of $v'(0) = \frac{1}{m}$, then $v_{it}(nf) = \frac{f}{m}$ at $f = 0$, but $v_{it}(nf) < \frac{f}{m}$ for all $f > 0$. In this border case, the chantry can be said to exist but with fees and benefits equal to zero. It could also be said that the chantry does not exist because no benefits are produced. Only in the third case of $v'(0) > \frac{1}{m}$ does there exist an f which can induce the craftsmen to join and yield strictly positive benefits of membership. Specifically, if $v'(0) > \frac{1}{m}$, then by the concavity of $v_{it}(\cdot)$, there will exist a range $[0, \overline{f}]$ where $v_{it}(nf) > \frac{f}{m}$ for all f in that range.

The chantry equilibrium exists if and only if this *range of feasible fees* exists. Defining $\underline{m}$ to be that minimum mortality rate, i.e., $\underline{m} \equiv \frac{1}{v'_{it}(0)}$, we can trace out a curve similar to v^* in Figure 2(b). This curve traces out the minimum m for which there exists a chantry equilibrium, and it has the same convex shape as before. An increase in religious beliefs is captured by an increase in $v_{it}(\cdot)$ for all values, and this can also imply an increase in $v'(0)$. Mathematically, the increase in $v'(0)$ increases the range of feasible fees. Thus, as beliefs increase, the minimum m necessary for the chantry equilibrium to exist will decrease.

While this curve illustrates when a chantry equilibrium exists, it does not specify what

f will be chosen by the group. Indeed, when $m \geq \underline{m}$ so that the range of feasible fees exists, there will also exist a *best fee* f^*, which is the fee in that range that maximizes the net benefits of membership to the craftsmen. The best fee f^* is the fee that solves the first order condition of the payoff function to joining: $v'_{it}(nf^*) = \frac{1}{m}$. Because of the concavity of $v_{it}(\cdot)$, we know that f^* increases as m increases. Given the voluntary nature of the organization, it is reasonable to suppose that it will choose the best fee as the official fee.

Holding $v_{it}(\cdot)$ fixed, we observe a pattern similar to that in Section 3.2 but different in one important respect. As before, at low m the chantry equilibrium does not exist, and once m reaches a sufficiently high level, the chantry equilibrium will exist. However, now as m continues to increase, we now observe that the chantry in the chantry equilibrium has increased scope and scale. An increase in m leads to an increase in $\overline{f}$ and also in f^*. Thus, as m continues to increase, the equilibrium chantry exhibits a larger scope and scale of operations. In effect, once the organization is formed, further increases in m lead to further increases in the level of cooperation within the same organization, even without any change in religious beliefs.

B.3 Combined Cooperative

We here combine the continuous q_{it} occupational cooperative and the endogenous f to show when a combined occupational-religious cooperative exists as an equilibrium. Similar to the model in Subsection 3.3, this combined cooperative exists when

$$v_{it}(nf) \geq \frac{1-m}{m}\left(\pi_{it}(0,q) - \pi_{it}(q,q)\right) + \frac{f}{m}.$$

Again, the combined cooperative equilibrium exists if the chantry equilibrium exists and if the benefits of the chantry are sufficiently large so that the threat of expulsion is also strong enough to enforce cooperation along the occupational dimension. In other words, $v_{it}(nf)$ must be sufficiently larger than $\frac{f}{m}$.

Our intention here is to illustrate the similarity in qualitative results between the continuous and binary models, and our goal is to demonstrate that there is a region in $(m, v_{it}(nf))$-space where the combined cooperative equilibrium exists and does better than the separate cooperatives. We will not completely characterize that entire space but instead explain that

it exists by focusing on the case where the combined cooperative uses the best fee f^* defined in the chantry equilibrium to sustain a combined cooperative.

Specifically, given some $m > \underline{m}$, there exists an f^* such that $v_{it}(nf^*) > \frac{f^*}{m}$. Moreover, it can be shown that as $v_{it}(\cdot)$ increases then $v_{it}(nf^*) - \frac{f^*}{m}$ also increases. If $v_{it}(\cdot)$ increases sufficiently so that

$$v_{it}(nf^*) - \frac{f^*}{m} > \frac{1-m}{m}\left(\pi_{it}(0, q^*(m)) - \pi_{it}(q^*(m), q^*(m))\right),$$

then there will be a quality level higher than what can be sustained in a purely occupational cooperative, $q > q^*(m)$, that can be sustained by the combined cooperative. Thus, just as the combined cooperative equilibrium exists and yields higher payoffs in Subsection 3.3 if belief in purgatory is sufficiently strong, the combined cooperative equilibrium exists and yields higher payoffs than separate cooperatives in the continuous model examined here if belief in purgatory is sufficiently strong.

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Figure 1

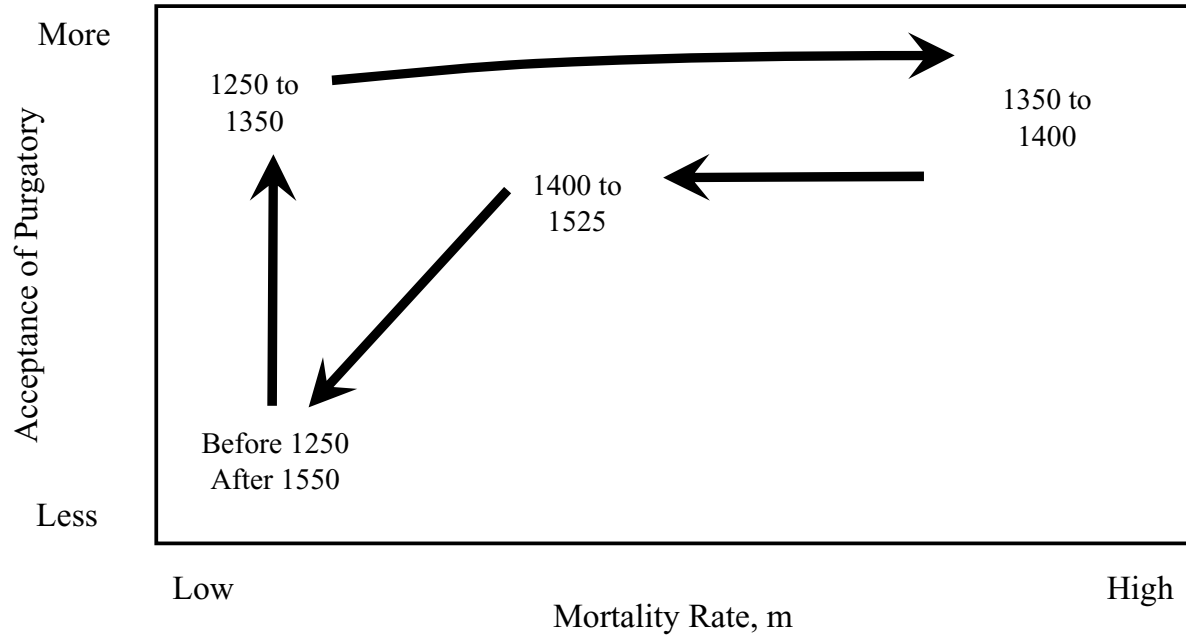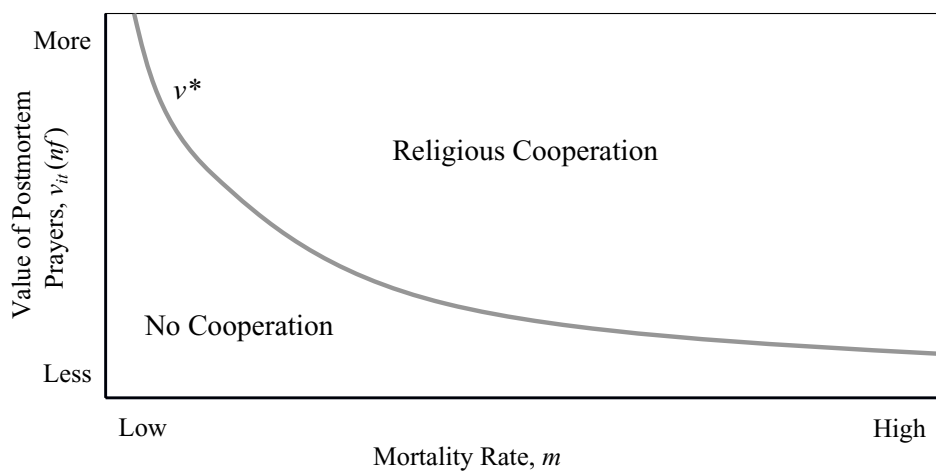Exogenous Forces, Mortality and Acceptance of Purgatory during the Later Middle Ages

Figure 2: Equilibrium Conditions for Occupational, Intercessory, and Combined Cooperatives

(a) Occupational Cooperation

Occupational
Cooperation

No Cooperation

More

Less

Value of Postmortem
Prayers, v_{it} (nf)

Low

$m*$

High

Mortality Rate, m

(b) Intercessory Cooperation

More

$v*$

Religious Cooperation

No Cooperation

Less

Value of Postmortem
Prayers, v_{it} (nf)

Low

High

Mortality Rate, m

(c) Combined Cooperation

More

$v**$

Combined Cooperation

No Cooperation

Less

Value of Postmortem
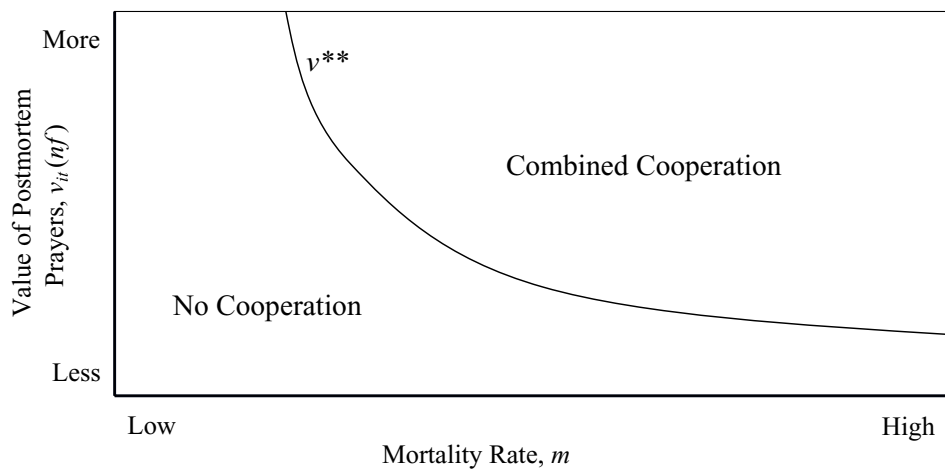Prayers, v_{it} (nf)

Low

High

Mortality Rate, m

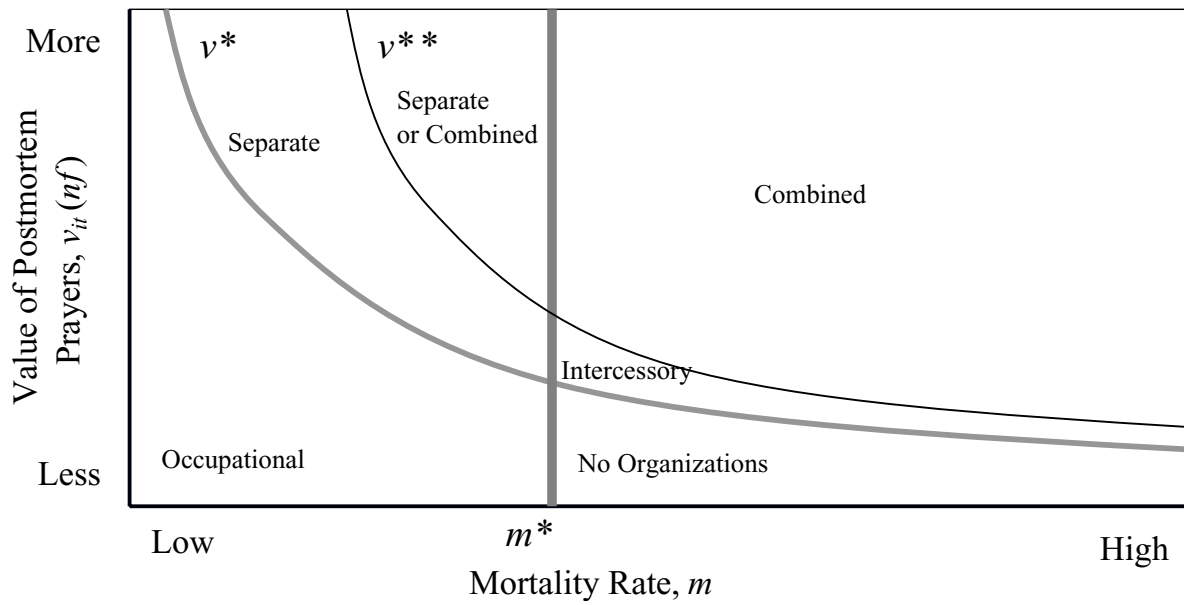Figure 3: Equilibrium Conditions for Three Types of Cooperation

Figure 4: The Evolution of Cooperation in Late Medieval England