Journal of Economic Behavior & Organization 103 (2014) S146–S159

Contents lists available at ScienceDirect

Journal of Economic Behavior & Organization

journal homepage: www.elsevier.com/locate/jebo

Prohibition of Riba and Gharar: A signaling and screening explanation?

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ARTICLE INFO

Article history:
Received 8 April 2013
Received in revised form 2 November 2013
Accepted 14 February 2014
Available online 6 March 2014

JEL classification:
D72

Keywords:
Islamic
Bank
Norms
Piety
Devout
Loyalty
Screening
Signaling

ABSTRACT

The emergence of Islamic Banks (IBs) with Sharia boards that restrict the set of permissible products and enforce prohibition of *riba* and *gharar* raises basic questions about how IB clients benefit when choosing from a restricted menu of possibly higher-cost cash flows. Norms that restrict choice sets, or impose otherwise harsh requirements, would seem to act as a barrier to religious identification by raising costs for IB clients. Contrary to this intuition, our model demonstrates that premium costs associated with restrictions on the set of financing options considered to be Sharia-compliant provide a signaling and screening technology that benefits IB clients who are highly pious. By revealing what would otherwise remain private information about the intensity of religious piety, this signaling technology simultaneously provides a screening service that enables high-piety types to separate themselves and concentrate both social and commercial interactions with others who are similarly pious. Iannaccone (1992) demonstrates a rationale for harsh norms as a mechanism for reducing free-riding in the supply of club goods. In contrast, our model shows that piety can be signaled by the act of choosing to become an IB client and bearing the costs of its restricted choice set and premium pricing for otherwise identical cash flows. Signaling and screening provide a new rationalization for prohibition of *riba* and *gharar* as a stable institution. Signaling piety is especially valuable in environments where piety is uncertain and otherwise difficult for others to observe. The model predicts that IBs' Sharia-compliance criteria will tend to be stricter and IB premiums larger in places where the proportion of highly pious Muslims is small.

1. Introduction

This paper introduces a model in which IBs charge a substantial premium over conventional financial institutions for (ex ante) identical cash flows as an equilibrium outcome. Lower-priced conventional financial services could serve as a perfect substitute were it not for the positive externalities that pious individuals enjoy when conducting business with others who are similarly pious. The model shows that IB clients rationally choose to pay a substantial premium for IB financing, because IB client status reveals information about one's own – and others' – religious piety. Muslims who decide to use this costly signaling technology (depending on their otherwise unobservable piety types) do so because it is used by others to screen for

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http://dx.doi.org/10.1016/j.jebo.2014.02.016
0167-2681/

piety and thereby achieve a separating equilibrium in which high-piety types achieve surplus generated through interaction with other high-piety types.

High- and low-piety types are assumed to have identical intrinsic valuations of the financial products that IBs offer and differ only in the value they place on their beliefs about the piety types of others with whom they associate. The benefits that high-piety types receive from doing business in an environment where most others are similarly pious can be interpreted as reduced transactions costs or other positive externalities flowing from assortative social interaction among high-piety types. This mechanism is proposed as a novel, but of course partial, explanation for the rapid growth in Islamic banking and finance in recent years. The real-world emergence and growth of IBs is, no doubt, complex and therefore likely to require multiple explanations.[2]

According to El-Gamal (2007a), "Islamic finance is first and foremost about religious identity." Prominent among the religious tenets that distinguish the contemporary Islamic finance industry from its non-Islamic or conventional financial services counterpart is the prohibition of *riba*. El-Gamal (2006) emphasizes that *riba* has no precise translation in English, criticizing those who misinterpret it simply as excessive or usurious payment of interest, or as motivated by a generic moral teaching to be kind and avoid exploiting those who are weak.[3] El-Gamal (2006, 2007b) argues instead that prohibition of *riba* should be interpreted as an institution for facilitating improvements in both economic efficiency and social justice, in ways that are easily recognizable to students of economic theory. For example, requiring contracts to clearly specify fluctuating equity stakes (i.e., marking asset values to current market prices), without using conventional credit and interest-rate financing, may help avoid counter-party risk and save costs of contract enforcement in the event of bankruptcy. Similarly, prohibition of *riba* can be interpreted as incentivizing myopic decision makers to use mutually owned profit/loss sharing as a commitment device that helps avoid temptation and produces greater accumulations of capital, anticipating by centuries the literature in behavioral economics on dynamic inconsistency. At the same time, El-Gamal (2001) also expresses concern that pious Muslims who choose to become IB clients may face excessive costs.[4]

This paper undertakes to complement previous work explicating the benefits and costs of prohibition of *riba* and *gharar* by proposing a simple model in which higher costs charged by an IB endure as a stable institution, precisely because paying those premiums enable IB clients to reveal otherwise difficult-to-observe information. Costly signaling achieved by restricting oneself to the Sharia-compliant financial services provided by IBs incurs both direct and indirect costs: the sum of premium financing fees (if any) charged by IBs for securities with identical cash flows and the opportunity cost of forgoing financial products not included in the restricted set offered by IBs. The model described in the next section shows that excess financing costs can be optimally chosen by the institutional designer (in this case, the IB and the Sharia board it employs) as a harsh norm that generates a separating equilibrium. IB clients wanting to signal their high-piety type choose to pay the premium associated with choosing to be an IB client even though they receive no intrinsic benefit other than the opportunity to be publically acknowledged as a high-piety type (i.e., devout or loyal). Our model is a thought experiment demonstrating that premium IB financing, represented as a restricted (i.e., strict) subset of risk-return attributes (or other stochastic characteristics relevant to clients of the financial services industry), can serve as a signaling technology that provides real, economic benefits in the form of coordination among the pious – even when the financial services offered by IBs deliver no extrinsic or intrinsic (i.e., religious or non-pecuniary) benefits.

The assumption that IBs provide only the benefit of coordination among the pious through signaling serves as a modelling device to focus attention on this mechanism while abstracting from other motives that might explain the decision to become an IB client. We enthusiastically acknowledge the vision of improved alignment of incentives between banks and their clients, in addition to the real value of improved social responsibility, which has drawn interest in the analysis of IBs. Abedifar et al. (2013) argue that pious Muslims who hold deposits at IBs may enjoy reduced credit risk in their banks because the religiosity among the banks' borrowers decreases rates of default (and withdrawal risk) among clients. Baele et al. (2012) report evidence of reduced default rates consistent with a model (presented in their Appendix E) in which religiosity generates lower default rates and improved stability among IBs relative to non-Islamic banks. And El-Gamal (2002) describes Islamic

[2] As of 2013, more than 700 Islamic Banks (IBs), in addition to many conventional or non-Islamic banks, offer Islamic financial services in more than 85 countries across the Middle East, Europe, the U.S., the Far East, and Southeast Asia, with over $1.2 trillion assets under management (Abedifar et al., 2013, and empirical sources cited therein; Beck et al., 2013; Kahn, 2010; Haque et al., 2007).

[3] Not all *riba* is interest, as illustrated by discussions of *riba al-nasa* versus *riba al-fadl* in El-Gamal (2001, 2003). Conversely, there are transactions that closely resemble interest payments by providing explicit compensation for the time value of money which are nevertheless, in the eyes of authoritative voices on Islamic jurisprudence, not considered *riba*. The time value of money is clearly acknowledged and not universally proscribed in the inspired texts on which Islamic jurisprudence is based.

[4] El-Gamal (2002) analyzes trade-offs between equity (or the production of social responsibility) and financial efficiency. He emphasizes that Islamic jurists advocating stricter limits on Sharia-compliant financial instruments (which, given current financial technology, would appear less efficient) actually have in mind future improvements in efficiency, whereby today's constraints lead to development of new Islamic finance technologies delivering greater levels of both social responsibility and financial wealth. See El-Gamal (2003, 2006) for discussions of the thresholds set by IBs' Sharia boards. Although this does not appear to have been analyzed using the textbook approach of representing financial technologies in risk-return space, we can translate El-Gamal's distinction between long- and short-term efficiency frontiers in risk-return space. (Accounting for differences in the positive externalities of social responsibility requires more subtle specification of expected returns, however, or the inclusion of additional normative dimensions for evaluating securities in addition to risk and financial return.) Suppose, for example, Ω represents the universe of all pairs of risk and expected return provided by non-Islamic financial technology and Ω_S represents the strict subset of Sharia-compliant financial instruments, $\Omega_S \subset \Omega$. The subset-superset relationship holds only in the short-term but is not anticipated to hold in the future if innovative IBs succeed at introducing technological improvements (i.e., if Ω_S expands to exceed part or all of the efficiency frontier representing the "bullet" in conventional finance theory's risk-return space).

jurists' vision of long-term improvements in both social equity and financial efficiency provided by IBs relative to what is currently offered along the envelope of existing financial technologies. Beck et al. (2013), Kahn (2010), and others, however, point to a set of stylized facts suggesting that there are few substantial differences between IBs and conventional financial institutions, at least when measured by standard metrics of business activity and financial performance. Questions raised by this body of empirical work and the theoretical investigations of El-Gamal (2002) and Kahn (2010) lend at least tentative support to the abstractions in our model by suggesting that the emergence and functional differences of IBs (if any) remain open questions and therefore worthwhile targets for new theoretical explanations.

Iannaccone's (1992) seminal paper seeks to explain restrictions on choice sets that religious groups require for group membership. Iannaccone considers a trade-off between secular activities and religious activities. In contrast, our model investigates a trade-off between intrinsic utility (derived from either secular or religious activity) and extrinsic utility that a pious individual receives from signaling his or her true type. In Iannaccone's model, religion is seen as a club good, and seemingly unproductive norms serve to reduce free-riding (inducing group members to switch from secular activities into religious activities by raising the cost of secular activities). Moreover, Iannaccone's model predicts that the cost-shifting which harsh norms generate also produces a screening effect that sorts less committed members into groups with less demanding group norms. There is no reputational concern or individual benefit from signaling one's type to other group members in Iannaccone's model.

The signaling mechanism in this paper provides a new interpretation of higher financing costs relative to non-Islamic banks, which includes situations where IBs do not charge a premium for their services but IB clients nevertheless face an opportunity cost of restricting their choices to Sharia-compliant IB products that do not include the client's most preferred choice from the set of all conventional products. Describing the signaling of inherently heterogeneous and otherwise difficult-to-observe piety status as "reputational concern" does not imply superficiality, as reputations can help coordinate economic and religious decisions while lowering transaction costs that generate important secondary intrinsic payoffs that are not included explicitly in the model.[5] Empirical evidence demonstrating significantly higher rates of contract compliance among those who choose Islamic-compliant contracts over non-IB interest-based contracts provides support for the intuition that signaling, which facilitates interaction among high-piety types, can provide real economic benefits (El-Komi and Croson, 2012). The real economic benefits mentioned in El-Gamal (2006), which include contracts that are disciplined by mark-to-market accounting, Pareto efficiency, and self-commitment devices that mitigate dynamic inconsistency, should also be kept in mind as complementing the signaling and screening motive.

Extant work by economists and other social scientists provide multiple answers to the question of how group norms that constrain individual action can benefit the group, depending on its objectives.[6] The economics literature on social norms draws on insights from the models of Banerjee (1992) and Bikhchandani et al. (1992). Using evolutionary game theory, El-Gamal (1998) provides a model with three types of agents in which "weak" IBs – hybrids that adhere to Islamic norms when dealing with their own types but act as unconstrained conventional banks when dealing with non-Muslims – are necessary for the survival of strictly pious agents, consistent with the signaling motive in this paper.

Kuran's (1998) analysis of dynamical issues in the emergence of group norms through reputational cascades focuses on the case of ethnic group identity. Kuran argues that ethnic norms become more demanding through a process of "ethnification" of group members (i.e., a self-reinforcing process in which group members are motivated to protect their reputations by escalating each other's ethnic-specific activity). Patel and Cartwright (2012) also consider how norms evolve, linking the rigidity of interpretations of a publically observable act of group identification to the number of observers.

Azar's (2004) original take on the frequently studied issue of group norms makes an interesting claim that, it should be pointed out, contradicts one of the predictions of our model. Azar's model implies that hard-to-follow or restrictive norms are, under a wide range of conditions, unstable and can be expected to gradually fade away over time. In contrast, the model in the present paper characterizes IBs that impose excess costs relative to non-Islamic banks as an equilibrium. Our model does make further predictions about the determinants of the size of IB premiums and conditions on belief formation that would lead to competition among IBs toward stricter versus more lenient Sharia-compliance conditions. These predictions link IB premiums and restrictiveness to potentially observable changes in IB clients' environment that have coincided with the emergence and growth of IBs. For example, internet communication and internet banking may reduce the signaling power of alternative means of signaling. As online choice sets available to one's neighbors and business associates expand, it may become more difficult to draw inferences about their piety from previously used signals of piety based on participation

[5] Berman (2000) explains demanding religious practices among Ultra-Orthodox Jews and so-called Islamic fundamentalists as expressing commitment to the group or community, which is similar in spirit to ideas motivating the present paper, without, however, providing a formal model to rationalize the emergence and stability of harsh norms. Aziz (1967) describes how small, seemingly irrelevant features of religious groups' headgear are interpreted as vitally important markers of group identity in India: Hindus belonging to particular religious subgroups wear headgear known as the "Gandhi cap" while Muslims living nearby wear the "Jinnah cap".

[6] Sociologists' definitions of "social group" typically require rules constraining individual action in ways that go beyond shared characteristics such as ethnicity or ancestral religious affiliation. In the sociology literature, hypotheses that link harsh or restrictive norms to group loyalty are well known, although not typically formalized in the language of game theory (Brown, 1988). Drawing on the psychological theory of cognitive dissonance, Aronson and Mills (1959) suggest that unpleasant initiation ceremonies can prepare group members for future disappointment and strengthen their identification with the group. The present paper draws on a more general model focused on screening for group loyalty and the interpretation of distance as the harshness of religious norms (Kim and Berg, 2013).

in religious services and related rites. The same goes for sharp increases in wealth and income, which adds intuitive appeal to the signaling motive, especially for well-off Muslims, for voluntarily choosing higher-cost and/or more restrictive IB financial services as signals that are costly to fake and substantially more effective at shifting others' beliefs about their piety, as more traditional signaling technologies become less persuasive.

The paper is organized as follows. Section 2 introduces the model in which an IB chooses a premium (which represents the distance in terms of additional fees and/or the restrictiveness of Sharia-compliance), and a continuum of agents seeking financing make decisions regarding whether to become IB clients. Section 3 analyzes conditions under which an agent's piety can be signaled by becoming an IB client. Section 4 considers the decision of the IB and its Sharia board in choosing an optimal premium. Section 5 considers the case of multiple IBs that compete. Section 6 presents a discussion and conclusion.

2. Model

This paper describes a game in which IBs set standards that determine the premiums their customers or clients face (above the cost of financing using non-IB products) when deciding whether to become IB clients. The model adapts Hotelling's linear city model with the interpretation of physical distance as a measure of the restrictiveness of Sharia-compliance criteria chosen by the IB. Each agent on the linear city is a potential IB client and has an outside option of using conventional financial products at their location with zero premium. Physical distance from an agent's location to the IB's location represents additional costs that an agent must bear to become an IB client. Agents' locations are assumed to be distributed uniformly on the unit interval, which serves to generate heterogeneity in the publically observable costs borne by individuals deciding whether to restrict their choice sets of financial products to the menu of those approved by the IB's Sharia board. Physical movement in Hotelling's linear city model is interpreted as an agent's decision to move away from his or her exogenously given outside option of using financial products offered by non-Islamic financial institutions.[7]

The model assumes that each agent faces a cost of becoming an IB client proportional to the distance travelled from his or her initial position to the "location" of the IB. The location of the IB, in turn, is the decision of the IB and its Sharia board. By choosing the IB's distance from agents' outside financing options, the IB's choice of location can be interpreted as a scalar-valued proxy that encompasses additional fees for borrowing, lower rates of return (per risk unit) for depositors, and the restrictiveness of the range of products offered, which jointly determine the premium that potential IB clients will publically incur (relative to their outside financing options with conventional banks or financial institutions).

If the IB is located at $z \in [0, \infty)$, then the cost borne by an agent at location x when he or she becomes an IB client (by choosing to use its financial products) is represented by the expression $t|z - x|$, where $t > 0$ translates distance into forgone payoffs and the distance norm is given by the absolute value of the difference between the IB's location z and the agent's location x. The assumption that z can take on any value in the non-negative real line while agents' initial locations are restricted to the unit interval implies that the IB may choose to locate either inside or outside the continuum where agents and their non-IB financing options are located. If the IB chooses to locate outside the unit interval, then all agents face a non-zero cost premium to become an IB client. If the IB is in the unit interval, then there exist dense subsets of the population comprised of IB clients who face an arbitrarily small IB premium. The decision by the IB to locate outside the unit interval implies that the set of products it offers imposes substantial premiums on all clients, although these premiums vary depending on an agent's initial position x.

The model assumes that agents receive no direct utility from using IB financing beyond that of the outside non-IB financing option which, as mentioned before, is normalized to zero. If intrinsic utility from being an IB client is included in the model, the qualitative results continue to hold, as an extension presented in a later section demonstrates. By abstracting from the multiplicity of motives among pious IB clients in the real world, this assumption of zero intrinsic utility derived from IB-client status focuses attention on the signaling mechanism and shows the economically interesting case of IB clients who rationally choose to pay a premium to shift others' beliefs about their piety. Agents whose initial positions are farther away from the IB are endowed with the possibility (or curse) of publically incurring a greater cost of signaling piety that generates a more persuasive signal (i.e., a signal that shifts others' beliefs about their piety closer to 1).

An agent's true but unobservable piety type ω is assumed to be binary: either high ($\omega = H$) or low ($\omega = L$), $H > L$. An agent's piety type is private information that other agents, including the IB and its Sharia board, do not know and can never observe directly. What is common knowledge, however, is that the proportion of pious agents in the whole population is $\mu \in (0, 1)$. It is also assumed that each agent's initial location (x) is known to all agents in the model.

Agents are assumed to make inferences or generate beliefs about the piety of others by observing whether or not that person is an IB client. The observability of piety, which is the key component of the signaling mechanism analyzed in this

[7] El-Gamal (2002) presents a Hotelling-inspired model where, similar to the interpretation in our model, distance represents the restrictiveness of Sharia-compliance criteria. The appendix discusses sources of heterogeneity among agents' outside financing options that give rise to the continuum of IB premiums in our model, represented using textbook diagrams of risk-return pairs in which the Sharia-compliant universe may be thought of as a strict subset of the larger non-IB universe. Baele et al. (2012) present individual-level data on borrowing in Pakistan, indicating that a substantial number of IB clients in the real-world choose to simultaneously buy financial services from non-Islamic financial institutions. Our model abstracts from this possibility by assuming that all agents make a binary choice of IB- versus non-IB-client status. Generalizing the model so that agents can choose weighted portfolios of loan and deposit positions across both IB and non-IB institutions (and the inferences that others draw from these choices) is an issue for future research to investigate.

paper, has two main components. These are the two publically observable variables that each agent is assumed to regard as common knowledge: an agent's initial location and his or her decision of whether to become an IB client. Agents update their beliefs about the distribution of all others' piety types according to Bayes' Rule. Based on an agent's observed IB status, other agents form posterior beliefs about that agent's piety type, denoted $\hat{\mu}$, which (in the context of the stylized model) completely characterize each agent's reputation.

The next step is to specify the social production function that maps an agent's true piety type ω and others' beliefs about his or her type $\hat{\mu}$ into a utility flow. The assumption is that agents receive extrinsic utility directly from their reputations as a function of their true piety type. Together, the exogenously given types and endogenous belief outcomes generate interactions with others that create real flows that are valued differently depending on each agent's true piety type. The model assumes that pious types value their reputations in terms of being willing to bear a higher cost to publically express piety than non-pious types. Interactions with fellow religious group members that have reputations as high-piety types generate positive utility, which may include lower transaction costs from contracting with other pious group members, the provision of aid to fellow high-piety types, benefits resulting from coordination, communication of religiously informed insights among the pious, and other channels as well.[8]

The benefit an individual gets from interacting with another agent is given by $b_\omega \hat{\mu}$, which assumes proportionality to the other agent's perceived type $\hat{\mu}$, with the rate of proportionality b_ω shifted down or up by one's own piety type: ($b_H > b_L > 0$). This simple functional form implies that the marginal productivity of one's reputation in the eyes of other agents depends on those other agents' piety types, capturing the idea that pious agents value other agents' piety more highly than the non-pious do, all else equal.[9]

Given the definitions above, the model is a three-stage game described as follows. First, the IB and its Sharia board choose the IB's location $z \in [0, \infty)$, interpreted as a choice of stringency or restrictiveness of the financial services offered by the IB which, together with the client's outside financing option as determined by his or her location, maps directly into the IB premium that an IB client faces. Second, individual agents decide whether to become IB clients.[10] And third, all agents in the model make inferences about the piety types of other agents based on others' locations (i.e., outside financing option) and their decisions to become IB clients or not.

3. Decision of whether to become an IB client

In this section, the location of the IB, z, is taken as given and decisions by agents of whether to become an IB client are analyzed. Each agent's piety type is assumed to be private information. By incurring the cost of choosing to become an IB, which is observable to others, each agent has an opportunity to send a signal that shifts others' perceptions of his or her piety higher (i.e., resulting in a larger posterior belief among others that the agent is a high-piety type conditional on the agent being an IB client, and shifting lower conditional on not being an IB client).

The analysis in this section restricts attention to strategies based on a threshold rule referred to as the simple partition property (SPP): an agent of type ω chooses to become an IB client if and only if $d_z(x) \leq d_\omega$, where $d_z(x) = |z - x|$ is the distance travelled from the initial location x to the IB located at z, and d_ω is an endogenous threshold measuring maximum willingness to travel to be an IB client (which maps 1-1 into maximum willingness to pay an IB premium in units of forgone utility) depending on one's true but unobserved piety type. Although the previous subsection introduced a simple functional form assuming that the excess financing costs of IB clients (relative to their outside financing option) is proportional to $d_z(x)$, the final section of this paper relaxes that assumption, showing that all the theorems which follow continue to hold using a generalized cost function assumed only to be strictly increasing in $d_z(x)$.

By restricting the preference structure in this way, the strategy rule of all agents in the population can be defined as a pair consisting of (population- and not individual-specific) cut-off values for low- and high-types, denoted (d_L, d_H). The low-type cut-off d_L (which depends on all low-type agents' endogenous choices and beliefs about others) measures the maximum willingness to travel among all low-piety types (proportional to maximum willingness to pay). Similarly, d_H measures maximum willingness to travel among all high-piety types.

An equilibrium is defined as a *separating equilibrium* if $d_H > d_L$, because the posterior rate of high-piety types conditional on being an IB client (i.e., having a reputation for, or being perceived by others as, a high-piety type) will be greater than

[8] Compared with religious communities such as Christian Protestants that emphasize a direct, personal relationship with God requiring few, if any, intermediaries or additional relationships with other humans required to pray and receive blessings from God, one referee suggested that the role of reputations for piety and their implications for interactions with others Muslims may be more important in Muslim communities that do not emphasize a direct, personal relationship with God in the way that Protestant Christians and other religious groups do. Insofar as reputational concern for piety plays a more important role in pious Muslim communities, then this observation would strengthen the case for the model's explanation. We note that there are many Christian banks and financial institutions that serve pious non-Muslim religious communities, although the financial services they offer may be less distinct than in the case of IBs. The final section of this paper takes up this issue of interpreting the model's relevance for the particular case of IBs as a growing and distinct institution.

[9] If interacting with others involves the production of a public good, for example, the functional form $b_\omega \hat{\mu}$ means that a pious agent (who has larger b_ω) values any provision of that public good more than a less pious one values it (assuming that both exert the same level of effort in producing the public good).

[10] As mentioned above, some banks and financial institutions sell both IB and non-IB products. Thus, an individual's choice could be alternatively interpreted as whether he or she buys an IB or non-IB product.

among non-IB clients and will therefore send a meaningful signal. Although the location of the IB (z) is taken as given by agents when deciding whether to become IB clients (analyzed in a later subsection), the inequality that defines separating equilibrium ($d_H > d_L$) suggests the possibility of – without requiring or guaranteeing – that the IB can achieve perfect purity, or 100 percent high-piety types among its clients, by locating at any distance greater than d_L (too far away to be worthwhile for any low-piety type) and less than d_H (worthwhile for at least some high-piety types).[11] It remains to be shown, however, how the IB will choose its location, which is analyzed subsequently.

An equilibrium is defined as a *pooling equilibrium* if $d_H = d_L$, because equal cut-off values measuring willingness to travel imply equal posterior probabilities of being a high-piety type conditional on IB-client status: $\hat{\mu} = \mu$ for all agents in a pooling equilibrium regardless of IB-client status. In contrast to a separating equilibrium in which an agent's reputation ($\hat{\mu}$) generally depends on (and is shifted higher toward 1 when conditioned on) IB-client status, the defining characteristic of the definition of pooling equilibrium is that no information about underlying piety types is revealed. In other words, the reputation for piety among IB clients is equal to (i.e., indistinguishable from) that of non-IB clients, implying that IB-client status conveys no information about underlying type and therefore no informational value as a signal. In a pooling equilibrium, it nevertheless remains rational for high-type agents (whose distance is less than the pooling equilibrium distance) to choose to be IB clients, because if they were to deviate from the pooling equilibrium strategy, then others would regard them as low-piety types with probability 1 (i.e., $\hat{\mu} = 0$). This paradoxical result of a stable pooling equilibrium where IB clients pay for a premium that buys them no reputational gain, but merely serves to prevent reputational loss, is among the striking findings of the model, although one hastens to add that pooling equilibria do not necessarily exist (when society has a sufficiently small proportion of high-piety types, i.e., sufficiently small μ), as shown below.

It is worth emphasizing what is different based solely on the definitions of separating and pooling equilibria given above. In a separating equilibrium, the two types of agents (when located at the same x) will potentially make different decisions about becoming an IB client, depending on their willingness to pay a premium in finance costs for the extrinsic rewards of being an IB client. These different decisions among high- versus low-piety types imply a different posterior probability of being a high-piety type (referred to as the reputation $\hat{\mu}$), which depends on: (i) whether one is an IB client and (ii) the distance between one's initial location or outside financing option and the IB. In a pooling equilibrium, agents of both types at a particular location x behave in the same way regardless of their true piety type.

In the analysis below, this paper employs weak Perfect Bayesian equilibrium (wPBE) as the main equilibrium concept,[12] and universal divinity as a refined equilibrium concept whenever refinement is needed. Agents with $d_z(x) = d$ are sometimes denoted simply by d. An agent's binary decision of becoming an IB client is represented by the action m (i.e., sending a "message" or signal), such that $m = 1$ indicates "IB client" and $m = 0$ indicates "non-IB client."

The posterior belief $\hat{\mu}$ is updated according to Bayes' Rule, conditional on the observed value of an agent's choice of m and his or her distance from the IB $d_z(x)$. The dependence of conditional beliefs (about piety) on an agent's action m and distance $d_z(x)$ is expressed by denoting the posterior belief as $\hat{\mu}(m, d)$. Universal divinity can be invoked at off-equilibrium action profiles where Bayes' Rule is no longer applicable. Universal divinity requires off-equilibrium beliefs to place positive probability only on those types that are most likely to deviate.[13] Formally, define $D(\omega, m) = \{\hat{\mu} \mid \hat{\mu}$ makes type ω better off by sending m than in equilibrium$\}$. Then, for an off-equilibrium message m, universal divinity requires that the posterior belief assigns probability one to type ω' if $D(\omega, m) \subset D(\omega', m)$.

The payoff for an agent of type ω at distance d from the IB can be expressed as:

$$u(m, d; \omega) = \begin{cases} -td_z(x) + b_\omega \hat{\mu}(1, d) & \text{if } m = 1 \\ b_\omega \hat{\mu}(0, d) & \text{if } m = 0. \end{cases} \tag{1}$$

3.1. Separating equilibria

It is not possible to have $d_H < d_L$ in equilibrium. This follows from the utility function above and the observation that a high-piety type prefers being an IB client in equilibrium whenever a low-piety type at the same location and with the same reputation ($\hat{\mu}$) does: $b_H > b_L$ and $\hat{\mu} > 0$ imply that $-td_z(x) + b_H\hat{\mu} > -td_z(x) + b_L\hat{\mu} > 0$. If $d_H < d_L$, then the last inequality implies that the best response for an agent at distance $d \in (d_H, d_L)$ is inconsistent with $d_H < d_L$. Therefore, it must be that

[11] Unlike standard signaling games, in this model, not all agents will choose to reveal their true type in a separating equilibrium. Some high-piety types with initial positions x sufficiently far away from the IB (i.e., facing relatively large costs of becoming an IB client) may not become IB clients.

[12] The wPBE concept is defined as a profile of strategies and beliefs such that (i) each type of agent makes a payoff-maximizing choice based on beliefs at each information set and (ii) the posterior beliefs must be updated according to the Bayesian rule whenever possible. Further details on the definition of wPBE are found in Mas-Colell et al. (1995).

[13] Although this concept was first proposed by Banks and Sobel (1987), it was redefined by Cho and Kreps (1987) whose definitions are followed in the present paper's analysis.

$d_H > d_L$ in a separating equilibrium, which implies that the reputation of an agent conditional on his or her IB client status is:

$$\hat{\mu}(m,d) = \begin{cases} 1 & \text{if } d_z(x) \in [d_L, d_H] \text{ and the agent is an IB client } (m=1), \\ 0 & \text{if } d_z(x) \in [d_L, d_H] \text{ and the agent is a non-IB client } (m=0), \\ \mu & \text{if } d_z(x) \in (d_H \infty) \text{ is a non-IB client, or } d_z(x) \in [0, d_L) \text{ is an IB client.} \end{cases}$$

Rationalization of equilibrium exploits the assumption that agents in this model assign the following belief whenever the signal is ambiguous: $\hat{\mu} = 0$, if either $d_z(x) \in (d_H, \infty)$ and the agent is an IB client or $d_z(x) \in [0, d_L)$ and the agent is a non-IB client.[14]

The incentive compatibility conditions imply that, for any $d_z(x) \in [d_L, d_H]$, $b_L \leq t d_z(x) \leq b_H$. The first inequality requires that the disutility from the extra cost incurred by becoming an IB client exceeds the reputational benefit for a low-piety type ($\omega = L$) with $d_z(x) \in [d_L, d_H]$. The second inequality requires that the reverse is true for a high-piety type ($\omega = H$). Let $\overline{d} = b_H/t$ and $\underline{d} = b_L/t$. Then $\overline{d}$ ($\underline{d}$, respectively) represents the distance for the H type (L type) that makes the cost of becoming an IB client just equal to the extrinsic gain from having a reputation for being a high-piety type. In order for the pair of limit distances (d_L, d_H) to be an equilibrium, it must be that $[d_L, d_H] \subset [\underline{d}, \overline{d}]$, in particular, $\underline{d} \leq d_L$. Otherwise, the incentive compatibility condition for an agent with $d \in (d_L, \underline{d})$ would be violated. To see this, suppose that $d_L < \underline{d}$ and consider a low-piety type with $d \in (d_L, \underline{d})$. This agent will choose to be a non-IB client as a result of the separating equilibrium condition. However, this agent actually prefers being an IB client, because $-t d_z(x) + b_L > 0$. This is a contradiction from which it follows that $[d_L, d_H] \subset [\underline{d}, \overline{d}]$.

For all $d_z(x) \in [0, d_L)$, both types must choose to be IB clients. However, consider a low-piety type with $d_z(x) = \underline{d} - \epsilon$ for an arbitrarily small $\epsilon > 0$. By becoming an IB client, this low-piety type who faces only a small premium over the outside option to become an IB client receives $\Delta = -t d_z(x) + b_L \mu < 0$.[15] This implies that that the low-premium and low-piety agent prefers non-IB-client status. Therefore, no separating equilibrium is possible unless $d_z(x) \geq \underline{d}$ for all $x \in [0, 1]$. This result is summarized in the following theorem stating there can be no separating equilibrium unless the IB is located strictly outside the unit interval. The theorem implies that the IB and the restrictions decided by its Sharia board must be sufficiently harsh to impose a substantial cost on all agents who choose IB financing over their outside financing options.

Theorem 1. *(i) There is no separating equilibrium unless the IB is located outside the unit interval. In other words, a separating equilibrium is impossible if* $z \in [0, 1]$. *Separation of the IB's location from agents implies that all potential IB clients face non-zero costs: all clients must pay an IB premium, and this premium never becomes arbitrarily small for any subpopulation as it would for an epsilon ball in the neighborhood of z if the IB were to choose to locate within the unit interval. (ii)There exists a separating equilibrium if* $z \in [1 + d_L, 1 + d_H]$ *for some* d_L *and* d_H *such that* $[d_L, d_H] \subset [\underline{d}, \overline{d}]$. *In this separating equilibrium, low-piety types never choose to be IB clients, and only some high-piety types choose to be IB clients (i.e., those high-piety types with outside finance options satisfying* $x \geq z - d_H$*). (iii) The universally divine separating equilibria are characterized by* $d_H \in [(1-\mu)\overline{d}, \quad \overline{d}]$. *(iv) The separating equilibria that can be supported for all* $\mu \in (0, 1)$ *have the unique upper bound* $d_H = \overline{d}$.

The proof of Theorem 1 appears in the appendix.

In the real world and as demonstrated by El-Gamal's writings, there is both religious and economic value in the guidelines of Islamic jurisprudence concerning investing and commerce. Theorem 1 demonstrates that, complementing any intrinsic benefits of restricting oneself to financing products offered by IBs, there is also a signaling mechanism that can result in a separating equilibrium which requires the harsh religious norm of bearing higher-than-market costs of financing. The result above shows that, by imposing what some would regard as unnecessary costs that bring no intrinsic benefit, the religiously motivated choice of paying higher financing costs as an IB client can be rationalized as an optimal choice that benefits highly pious individuals who receive extrinsic utility from interacting with other high-piety types. The separating equilibrium that Theorem 1 describes requires that IB financing imposes a non-trivial cost, or premium, on all its customers across the full range of the heterogeneous conditions underlying the different outside financing costs they face. This non-trivial premium corresponds to the dense set on the real line to the right of the unit interval that separates the IB's location (in the separating equilibrium) from the location of agents on the unit interval, indexed by their outside financing options. This gap separating the unit interval from the location of the IB implies non-zero IB premiums for all agents who choose to become IB clients. The IB premium serves as a screening device that accurately and publically sorts at least a fraction of high- from low-piety types, thereby satisfying the incentive compatibility constraints required for the separating equilibrium to occur.

The intuition as to why there can be no separating equilibrium if the IB is located within the unit interval is that high-piety agents who would be clustered densely in a neighborhood about the IB (i.e., those who face arbitrarily small differences between the pricing of IB versus non-IB financial products) do not receive a sufficiently large informational benefit (i.e., do

[14] This pessimistic belief can be justified by a more refined equilibrium concept such as universal divinity. For example, when $d_z(x) \in [0, d_L)$ and the agent is observed to be a non-IB client ($m = 0$), a low-piety type is more likely to make such a deviation, since $D(H, 0) \subset D(L, 0)$ where $D(\omega, 0) = \{\hat{\mu} \mid \hat{\mu} \geq \mu - t d_z(x)/b_\omega\}$ is the set of posterior beliefs that imply that type ω will send signal $m = 0$. This means that the signal $m = 0$ is more likely to come from the low-piety type L and implies that the agent at distance $d_z(x)$ must be type L. For the case that $d_z(x) \in (d_H, \infty)$, the pessimistic belief is incongruous with universal divinity unless $d_H \geq \overline{d} \equiv b_H/t$. For details, see the proof of Theorem 1, part (iii) in the appendix.

[15] The inequality follows from the observation that $\Delta = -t d_z(x) + b_L \mu = -t(\underline{d} - \epsilon) + b_L \mu = -t\underline{d} + t\epsilon + b_L - b_L(1-\mu) = t\epsilon - b_L(1-\mu) < 0$ for a sufficiently small ϵ.

not have access to a sufficiently powerful signaling technology) from choosing to be an IB client, because low- and high-piety types are pooled. In other words, insufficiently harsh IB restrictions and premiums deprive IB clients of the value of sending a meaningful signal. The value of signaling disappears when low- and high-piety types are pooled. With insufficient signaling value, even high-piety types will not choose to be IB clients. No containment of potential clients in the vicinity of the IB (i.e., within any epsilon ball of z) is an essential component of the separating equilibrium. The separating equilibrium provides the highly pious with a signaling technology that serves as a conduit for effectively sending information about piety types that would otherwise be difficult to observe. The signaling technology provided by premium IB pricing enables the highly pious to effectively distinguish themselves from others and facilitates screened interaction among them.

Low-piety types' status as non-IB clients contributes positively to society's ability to draw any meaningful inference about the piety of those who choose to become IB clients. Formally, if $d_L < z - 1 \leq d_H$, then no low-piety types choose to become IB clients, while only a strict subset of high-piety types choose the IB. The difference in extrinsic utility gained from signaling through IB-client status makes separation possible. The universally divine equilibrium in this model does not lead to the so-called Riley outcome, which is the most efficient separating equilibrium.[16] Nevertheless, the main insight from Theorem 1 is that the religious norm of IB-client status among high-piety types, which is designed to be costly, provides informational benefits by screening for piety – helping the pious distinguish themselves and thereby more easily interact with other high-piety types.[17]

A final point regarding the separating equilibrium in Theorem 1 is the requirement that piety types are private information. Greater uncertainty about others' piety and absence of alternative signaling mechanisms (assumed to be unavailable in the model) makes premium-priced IB-client status more valuable as a signaling device. The model therefore predicts that restrictive (i.e., more costly) IB financial services will, all else equal, tend to flourish in environments with the fewest alternative signaling devices for signaling piety. Illustrating how Theorem 1 might be mapped into explanations and predictions regarding the rise of the Islamic finance industry, one may consider the following albeit speculative scenario.

Consider a Muslim society with a large proportion of high-piety types that experiences a sharp increase in income levels and income inequality. With greater wealth, income and *visibility* of that wealth and income, one may suppose that international travel and internet access becomes available for an increasing segment of society, extending across a wider range of income levels. What would these events imply about uncertainty regarding others' piety types? And how would mechanisms previously used for signaling piety be affected?

With greater income and an increasing number of visibly well-to-do Muslims, there would be greater opportunity to use money for signaling piety. There would be greater demand among those with money for technologies that enables them to send persuasive signals for maintaining social cohesion given increased social stresses from rising inequality. With greater access to travel, online trading and a seemingly inexhaustible menu of online entertainment highly inconsistent with piety, there would be greater uncertainty about the piety of those with whom we live and interact, in commerce and culture. In such a scenario, signals of piety that were previously used may no longer provide effective screening in the transformed environment, which can be interpreted as an inward shift in the supply of effective informational supply of signaling technology. Restricting what one does with one's money could be a particularly effective new signaling device.

Greater geographic mobility and increased availability of activities inconsistent with piety would threaten the effectiveness of previously used signaling and screening technologies, which can be interpreted as a decrease in the effective supply of those technologies. Greater income and uncertainty about others' piety would, at the same time, increase demand for new signaling technology. Those factors making it more difficult and/or more valuable for the highly pious to coordinate with others who are similarly pious – when viewed as a simultaneous increase in demand and decrease in the supply of signaling and screening technologies specifically for piety – predict that the price of signaling will rise. In turn, this incentivizes innovation and the entry of new suppliers of signaling technology, consistent with the recent rise of the Islamic banking and finance industry.

3.2. Pooling equilibria

This section analyzes the possibility of a pooling equilibrium. In a pooling equilibrium, a low-piety type successfully pretends to be a high-piety type by becoming an IB client even though he or she values interacting with other high-piety types less than high-piety types do. Let d_p represent the pooling equilibrium distance measuring the maximum distance that both low- and high-piety-type agents are willing to travel to become IB clients. It generates reputations for an individual agent at distance $d_z(x)$ according to the following Bayesian rule: $\hat{\mu} = \mu$ if $d_z(x) \in [0, d_p)$ and the agent becomes an IB client, or

[16] The Riley outcome is the most efficient separating equilibrium, although its application in this context is certainly open to question. The Riley outcome has two key features that distinguish it from other definitions of separating equilibria. First, in a separating equilibrium, high-piety types use a costly signal that would be unnecessary under complete information. In the Riley outcome (which is unique among universally divine equilibria), this waste is maximized, since the separation interval $[d_L, d_H]$ (proportional to waste in payoff or utility units) is the largest. This could be interpreted as the least efficient outcome in the sense that IB clients sacrifice unnecessarily large premiums for IB over non-IB financial products. However, because the separation interval is largest among all the separating equilibria, the largest amount of information about true piety types is revealed. In other words, this outcome is the most informationally productive in the sense of providing the greatest aggregate extrinsic benefit generated by interaction among high-piety types.

[17] It is relevant to compare this result to Hirshman's (1970) interpretation of costly tests of loyalty as being analogous to useful trade barriers described in some models of protective tariffs.

$d_z(x) \in [d_p, \infty)$ and the agent becomes a non-IB client. As in the case of separating equilibria, the most pessimistic belief $\hat{\mu} = 0$ is assumed along off-equilibrium paths.[18] This definition helps characterize the entire set of pooling equilibria as developed below.

The incentive compatibility conditions for both types require:[19]

$$-td_z(x) + b_L\mu \geq 0, \quad \forall d_z(x) \in [0, d_p). \tag{2}$$

Then, it follows that any $d_p \in (0, \underline{d}\mu]$ can be a pooling equilibrium distance.

Theorem 2. *(i) There exists a continuum of pooling equilibria with the equilibrium distance in the interval* $(0, \underline{d}\mu]$. *(ii) Furthermore, the universally divine equilibrium reduces the set of pooling equilibrium distances to* $(\overline{d}(1-\mu), \underline{d}\mu]$.

The proof of Theorem 2 appears in the appendix.

In a pooling equilibrium, regardless of one's piety type, an agent within distance d_p of the IB chooses to become an IB client, and agents farther away than d_p from the IB do not. One may wonder whether a high-piety type might be able to signal piety at farther distances (i.e., incurring greater costs). It is straightforward to show that this is not possible in a pooling equilibrium, based on the assumption that beliefs about off-equilibrium-path behavior elicit pessimistic beliefs. Although seemingly counterintuitive, the pessimistic belief assumption for off-equilibrium paths may be reasonable by the following argument.

The $\omega = H$-type receives a greater benefit from IB-client status than an L-type does. When any agent with $d_z(x) > d_p$ deviates from his or her expected payoff-maximizing behavior and nevertheless chooses to become an IB client implies, under universal divinity, then others believe the deviant agent is a high-piety type.[20] This would mean that the pessimistic belief $\hat{\mu} = 0$ is unreasonable. The consequence of universal divinity is the implication that $\hat{\mu} = 1$, which requires the following incentive compatibility constraints for agents with $d_z(x) \in [d_p, \infty)$ to hold:

$$-td_z(x) + b_H \leq b_H\mu, \quad \forall d_z(x) \in [d_p, \infty). \tag{3}$$

From (3), only equilibrium distances $d_p \in P \equiv (\overline{d}(1-\mu), \underline{d}\mu]$ are reasonable in the sense of satisfying the incentive compatibility constraints with pessimistic beliefs. As stated in Theorem 2, this set may or may not exist. If $\overline{d}(1-\mu) > \underline{d}\mu$, that is, $\mu < \overline{d}/(\overline{d} - \underline{d})$, then no pooling equilibria exist ($P = \emptyset$). Note that $\overline{d}(1-\mu) < \underline{d}\mu < \underline{d} < \overline{d}$ if $\mu > \overline{d}/(\overline{d} - \underline{d})$, which implies that, in pooling equilibria, both types are less likely to be IB clients than under complete information.

4. The IB and Sharia Board's decision

This section analyses the institutional design of the IB's product offerings and their restrictiveness or opportunity cost, identified here (heuristically) with the location of the IB (z). It is well known that proponents of IBs emphasize social welfare (e.g., Koranic notions of justice and social equity) and corporate responsibility in the form of strict Sharia compliance. Based on these motives, we assume that the IB and its Sharia board are, at least to some extent, concerned about their clients' wellbeing and adherence to Sharia. The following assumes that the IB seeks to maximize profits subject to a piety or religious purity constraint. Since no interest rate is involved, maximizing profit (in this model) is the same as maximizing the number of customers. The constraint is that its clients are high-piety types. The IB's objective may therefore be described as maximizing the mass of the population that chooses to become IB clients such that all clients are high-piety types.

The previous section demonstrates that subgames may have multiple equilibria.[21] The analysis below focuses on the equilibrium $[d_L, d_H] = [\underline{d}, \overline{d}]$, which publically reveals the most otherwise private information. Recall that the separating equilibrium is possible only if $z \geq 1 + \underline{d}$. In such a separating equilibrium, it is only high-piety types who become IB clients: an agent with $x \in (z - \overline{d}, 1]$ is an IB client only if he or she is a high-piety type.

As the IB increases z from $1 + \underline{d}$ to $1 + \overline{d}$, some high-piety types who would have chosen IB-client status will drop out and switch to non-IB-client status. Therefore, an IB seeking to maximize the mass of high-piety types who become IB clients will choose the smallest value of z that can achieve a separating equilibrium, yielding the optimal location representing restrictiveness or costliness of the IB's products: $z^* = 1 + \underline{d}$. Fig. 1 illustrates this optimal choice by the IB and its Sharia board, which maximizes the mass in the unit interval (measuring the number of potential IB clients) subject to the constraint that the average piety among clients remains equal to 1. There are points to the right of z^* that are separating equilibria, as shown previously. But the value z^* attracts the largest mass of highly pious agents by selecting the minimum distance to the right

[18] This belief can be justified by universal divinity, although universal divinity is not necessary and therefore not as crucial as it was in motivating the separating equilibrium in the previous subsection. Assumptions about beliefs regarding off-equilibrium paths are discussed below.

[19] Incentive compatibility conditions also imply that $-td_z(x) \leq b_L\mu$ for all $d_z(x) \in [d_p, \infty)$, which is always satisfied if the incentive compatibility constraint for low-piety types is satisfied.

[20] More formally, $D(L, m = 1) \subset D(H, m = 1)$, where $D(\omega, m = 1) = \{\hat{\mu} \mid \hat{\mu} \geq \mu + td_z(x)/b_\omega\}$. Thus, if an agent with $d_z(x) \geq d_p$ is an IB client, then that agent must be perceived as H by universal divinity.

[21] Strictly speaking, the game following the decision of the IB and its Sharia board is not a proper subgame of the larger game in which nature moves first by choosing the distribution of piety types in the population (without making it public). However, the game can easily be transformed into an equivalent game in which the uninformed IB is the first mover and nature is the second mover. Then, the subgames described here would become proper subgames in this equivalent game.

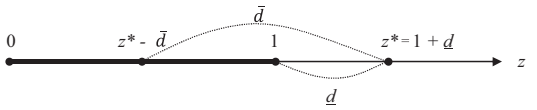

Fig. 1. The IB's optimal location (z^*).

of the unit interval, $\underline{d}$. Fig. 1 shows the threshold distance, $\underline{d}$, to the left of which high-piety types do not choose to become IB clients and to the right of which they do become IB clients.

Theorem 3. *The solution to the problem facing an IB and its Sharia board of maximizing the mass of IB clients subject to the constraint that all clients are high-piety types is* $z^* = 1 + \underline{d}$*, which is the smallest distance (representing the cost the IB imposes on its clients over non-IB financing) that is strict enough to achieve a separating equilibrium.*

Theorem 3 shows that the IB and its Sharia board optimally choose the least-harsh distance among the set of harsh norms represented by the set separating equilibria specified in Theorem 2. The optimally chosen premium implied by the formula for z^* in Theorem 3 confirms the result in Theorem 2 that, in a separating equilibrium, the IB locates outside the unit interval and additionally shows that it chooses the least costly set of restrictions that are costly enough (to its clients) to screen out low-piety types.[22] According to this theorem, the IB adjusts the costliness of its products to screen out all low-piety types at the least possible cost to its clients. The constraint that the IB seeks to attract only high-piety clients requires that it sets its costs just high enough so that the reputational gain for the low-piety type with the largest willingness to pay for a reputation as a high-piety type is just equal to its cost. As a result, the IB imposes greater opportunity costs on its clients, the more that low-piety types would value having a reputation and interaction with other agents with reputations for piety. Note that the value of μ has no effect on z^* in a separating equilibrium. Changes in μ do, however, affect the possibility of pooling equilibria, which require a sufficiently high proportion of high-piety types in the population. This dependence of the existence of the pooling equilibrium on μ suggests that harsh IB premiums may not be necessary, and less likely to be observed, when the population has a high proportion of high-piety types (i.e., for large values of μ), which make the pooling equilibria possible.

5. Competition among multiple IBs

So far, the models above assumed that there is only a single IB. This section considers the case of multiple IBs that compete to attract clients, which follows El-Gamal (2002). Suppose there are two IBs, A and B, and denote their equilibrium locations as z_A^* and z_B^*, respectively. Theorem 3 remains valid in the two-IB case if the equilibrium is symmetric in the sense that $z_A^* = z_B^* = 1 + \underline{d}$. This symmetric equilibrium can be supported by the off-equilibrium belief that a potential client is perceived to be a low-piety type (i.e., $\hat{\mu} = 0$) if he or she is not a client of either A or B. First, the incentive of a high-piety type located at $x \geq z - \bar{d}$ is clear, since $d_z(x) \leq \bar{d} \equiv b_H/t$ implies that $-td_z(x) + b_H \geq 0$. The incentive of a low-piety type is also obvious, since $d_z(x) \geq \underline{d}$ implies that $-td_z(x) + b_L \leq 0$. Finally, we check the incentive of IB A to change its location to $z' = 1 + \underline{d} - \epsilon$ or $1 + \underline{d} + \epsilon$. If we impose the off-equilibrium belief that a potential client is perceived to be a low-piety type if he or she becomes a client of the IB at $z = 1 + \underline{d} - \epsilon$, then no one will buy financial services from the deviant IB A, since $-td_z(x) + b_H \geq -t(d_z(x) - \epsilon)$ as long as $\epsilon < \underline{d}$. It is even more obvious that A has no incentive to change z to $1 + \underline{d} + \epsilon$, since pious IB clients can enjoy an equally good reputation at lower cost by choosing B instead of A.

In the case of symmetric equilibrium with two IBs, high-piety types located at $x \geq z^* - \bar{d}$ signal by being a client of either one of the IBs, and the two high-cost IBs equally split those high-piety-type clients. If an IB adopts a more lenient Sharia-compliance policy, it may seem likely that it would benefit by attracting more clients. But this is not the case. Insofar as clients of the more lenient IB lose their reputations as high-piety types, then neither IB could adopt lenient criteria for Sharia compliance without violating their high-piety constraint, and no agents would have an incentive to seek reputational and screening benefits by becoming clients. Hence, the two IBs must maintain the strict norm that imposes minimally high premiums on their clients.

Next, the possibility of an asymmetric equilibrium is considered in which one of IBs imposes a stricter Sharia-compliance policy (i.e., imposes higher premiums) than the other. Specifically, we consider the following strategies: (i) $z_A^* < z_B^*$ where $z_A^* = 1 + \underline{d}$ and $z_B^* = z_A^* + \epsilon$; (ii) a high-piety type located at $x \geq z_A^* - \bar{d} + \epsilon$ chooses to be a client of B; (iii) a high-piety type located at $z_A^* - \bar{d} \leq x < z_A^* - \bar{d} + \epsilon$ chooses to be a client of A; (iv) a low-piety type deals with neither IB; and (v) clients deviating from the equilibrium path are perceived to be high-piety types only if they are clients of the more remote IB. It is easy to check the incentives of a high-piety type based on the off-the-equilibrium belief specified in (v). The idea is that high-piety types who are clients of either A or B cannot gain by deviating from their strategies: clients of A only face higher costs by switching to B; and clients of B lose their reputation by switching to A.

The incentive of IB B to move slightly toward IB A is so strong that the strategies above could be supported as an equilibrium outcome only under more restrictive off-the-equilibrium beliefs. The problem here is that B is still farther from clients than

[22] In this model, a lower value of z is interpreted as representing an IB choosing looser restrictions in determining Sharia compliance.

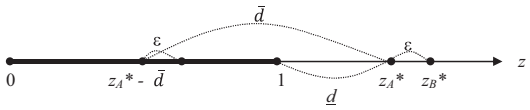

Fig. 2. Asymmetric equilibrium locations for two competing IBs.

A (i.e., stricter) even if *B* moves slightly closer to *A*. This might give *B* an incentive to move toward *A* under the off-the-equilibrium belief stated above in the condition on beliefs stated in (v), which would invalidate the existence of asymmetric equilibrium. If we impose the more stringent belief that a client is perceived to be a high-piety type only if he deals with a more remote IB – and the location of the remote IB is at least $1 + \underline{d} + \epsilon$ – then a deviation of *B* toward *A* is unprofitable under this restrictive belief, and the asymmetric equilibrium is realized. In this asymmetric equilibrium, one IB adopts a more extreme policy than the other.

Without very demanding beliefs about others' piety when off-equilibrium actions are observed, the asymmetric equilibrium may not exist: the stricter IB has an incentive to gain additional high-piety clients by becoming more lenient and moving toward A. Under these dynamics, competition would lead all IBs with stricter Sharia-compliance criteria to become progressively more lenient and cluster in a symmetric equilibrium at $z^* + \underline{d}$. It is also worth noticing that the race toward leniency stops at this minimal level of stringency only if all IBs are committed to satisfying their piety constraint.

In contrast, if agents hold extremely demanding beliefs about others' piety when off-equilibrium outcomes occur by inferring a zero probability of being a high-piety type when others choose a more lenient option than is expected in equilibrium (as discussed above), then competition could push in the opposite direction – toward greater stringency – until a maximally tolerable level of restrictiveness or cost was achieved. Countering the intuition that competition for new clients will necessarily lead IBs to become more lenient, the presence of demanding or pessimistic beliefs about those who make off-equilibrium moves implies the possibility of competition causing arms-race dynamics which result in stricter Sharia-compliance criteria. Competition leading to stricter Sharia-compliance criteria is possible only if highly demanding reputational beliefs conditional on off-equilibrium action impose a real threat of losing one's reputation (conditional on any movement toward leniency). If people believe that others are high-piety types off the equilibrium path only when they are clients of an IB at least as restrictive as the most restrictive IB, then competition for clients may lead to increasing stringency of Sharia-compliance criteria. If an IB provides a more lenient policy, then its clients who are high-piety types will be concerned about their loss of reputation and leave for a stricter IB. In the special case of the asymmetric equilibrium as discussed above, the two IBs, *A* and *B*, divide the high-piety-type clients, but not equally, which is consistent with El-Gamal's (2002) result of market segmentation.

Fig. 2 illustrates what this asymmetric equilibrium looks like (assuming it can be rationalized by off-equilibrium beliefs). The lenient IB *A* is located at the most lenient point that attracts only high-piety types, and the more stringent IB *B* is located to its right, reflecting *B*'s choice of stricter Sharia-compliance criteria or higher fees. *A*'s clients are drawn only from a segment of length ϵ (from $z^* - \bar{d}$ to $z^* - \bar{d} + \epsilon$), and *B*'s clients are drawn from the right-most subset of the unit interval (from $z^* - \bar{d} + \epsilon$ to 1). Without stringent or highly demanding beliefs about others' piety when off-equilibrium decisions are observed, the equilibrium shown in Fig. 2 is likely to unravel, converging toward the symmetric equilibrium with both IBs at $z^* = 1 + \underline{d}$. At an asymmetric action profile, the stricter IB (*B*) typically has an incentive to increase its mass of clients by becoming more lenient – unless its clients anticipate losing their reputations and therefore quit the IB whenever it becomes more lenient.[23]

6. Conclusion

The model demonstrates that costly IB products – whether that cost is thought of as a mark-up over non-IB products with (ex ante) identical cash flows or as the opportunity cost of choosing from a more restrictive set of Sharia-compliant products – can serve as a signaling mechanism that helps highly pious people screen high- from low-piety types. Insofar as the informational benefit of making piety types public facilitates economic coordination and religious gains, then the premiums charged by IBs and restrictiveness of its Sharia-compliance criteria may be interpreted as socially beneficial from the point of view of high-piety types. At the same time, the extra costs that IB clients face, both explicit and implicit, are likely to be viewed by outsiders as harmful or at least puzzling.

Benefit-cost calculus implies, all else equal, that higher financing costs for identical financial securities providing no additional flows of intrinsic payoffs would never be chosen voluntarily. By taking into account the benefits that pious individuals (and their religious group leaders) receive from associating and conducting business with those who are similarly pious, this paper proposes a rational-choice explanation for the persistence and growth of an IB that offers identical cash

[23] Hauswald and Marquez (2006) use a circular city model similar to Hotelling's linear city to analyze competition between banks. The location of a bank is not a strategic variable but rather an exogenous parameter in their model. Degryse et al. (2009) consider banks competing for privately informed customers. They find that customers who possess well-documented information about their projects prefer "hard" or demanding banks, while customers who possess only soft information prefer "soft" or easy banks, mainly due to differences in transportation costs. The result is a segmented market analogous to the asymmetric equilibrium described above.

flows at a significantly higher cost. These higher costs are needed to induce the separating equilibrium that reveals private information regarding piety.

The model introduced in this paper assumes there is an exogenously given distribution of piety types and then undertakes to isolate the information-revelation mechanism that rationalizes the introduction of costly and seemingly irrelevant religious restrictions (in the case of securities with identical cash flows but different labels) in the domain of financial decision making. The higher cost IB services provide a signaling technology that reveals private information in a socially useful manner. The result that IB-client status can be entirely irrelevant to all agents' intrinsic payoffs and nevertheless rationalizable as a stable equilibrium based solely on the informational benefits of the screening technology that IB-client status provides is intended as a thought experiment. This focus on the signaling and screening mechanism by which IBs generate value should complement and in no way exclude other explanations based on intrinsic economic benefits that Islamic banking achieves for its clients.[24]

Of course, the model could be usefully expanded by incorporating benefits beyond signaling that IBs provide their customers. Allowing agents to receive non-informational benefits, say $\nu > 0$, in addition to the informational benefits demonstrated in the model above does not undermine the qualitative results presented in this paper. The generalized counterparts for Theorems 1–3 all continue to hold with the modification that $\bar{d} = (\nu + b_H)/t$ and $\underline{d} = (\nu + b_L)/t$, where ν is the intrinsic utility from choosing to become an IB client. Another variation of the model in this paper would be to allow for nonlinear costs as a function of distance, for example, an increasing function $c(d_z(x))$. Allowing for either convex or concave and strictly increasing cost functions, the only major modification for the three theorems to hold would be that $\bar{d} = c^{-1}(b_H/t)$ and $\underline{d} = c^{-1}(b_L/t)$. Since $c^{-1}(\cdot)$ is also an increasing function, the analysis for the model and theorems carry through to this generalization.

A model that could endogenize the distribution of types might provide even greater applicability to real-world dynamics in the emergence of financial institutions across different Muslim communities. If the type distribution were stochastic in a way that allowed for individual transformations between low- and high-piety types, then the model might address the role of IBs in the emergence or decline of religious sentiment in places where IBs have been active. The possibility of personal transformation and the work that religious institutions, including IBs, do to induce piety-enhancing transitions (and minimize exits) among the devout is a potentially important dynamic missing from models with exogenously given piety types. It would be worthwhile to analyze extensions of the model presented in this paper, which describes endogenously chosen standards of Sharia-compliant finance as an information revelation technology based on exogenously given distributions of piety types.

Finally, one can draw some testable hypotheses from the model regarding the proportion of high-piety types, the stringency of Sharia-compliance criteria, and premiums charged by IBs. The model predicts that pooling equilibria disappear when the proportion of high-piety types, μ, is small.[25] This would imply that a society with a lower proportion of pious Muslims is likely to have stricter IBs.

Appendix A.

Fig. 3 illustrates several interpretations of heterogeneity among agents' outside financing options based on the Markowitz "bullet" from the CAPM model in finance textbooks. In the case of the CAPM's risk-return representation, the range of IB premiums depends on how the Sharia board chooses the vertical gap between the boundary of the set of Sharia-compliant securities and the efficient frontier of portfolios that allow positive weightings on entire universe of securities. Many possible interpretations can be made to fit with the abstraction of our model's continuum of "distances" in the Hotelling framework, which also appears in El-Gamal (2002), in which distance represents stringency or restrictiveness of the IB's Sharia-compliance criteria. In Fig. 3, we suppose that the continuum of agents' outside financing options are represented by the continuum of points along the efficient frontier of the universe of risk and expected return pairs $(\sigma, \mathrm{E}[r])$, denoted Ω, which corresponds to efficient financial positions offered by non-Islamic financial institutions unrestricted by Sharia compliance. Strictly below this unrestricted efficiency frontier is a Sharia-compliant efficiency frontier offered by the IB, denoted Ω_S. Vertical distances between points along the efficient frontier of Ω and Ω_S generate a continuum of risk-adjusted costs in units of forgone expected return (holding σ constant). As depicted in Fig. 3, the vertical gaps between the efficient frontiers of Ω and Ω_S increase from left to right as a function of σ. Three agents at initial points x_1, x_2 and x_3 on the unit interval in the Hotelling model correspond to three different levels of desired risk exposure plotted as the σ-components of these

[24] Akerlof (1983) analyzes where loyalty comes from and those factors that affect its intensity. The IB's decision of setting the restrictions that determine the costs its clients face is formally similar to "standard setting" in Akerlof's model and the law and economic literature. Brown (1973) formalizes tort law in the language of economics and discusses the socially optimal legal standard. In a similar vein, Kim (2011) considers two types of victims and proposes a liability rule that induces high types to signal their type by taking on additional precautionary measures that incur greater cost. Although there is a large body of literature on the efficiency of the negligence rule and the negligence standard (e.g., Cooter, 1985; Edlin, 1994), we are aware of no paper aside from Kim (2011) that takes into account signaling and screening motives in standard setting.

[25] The proportion μ has no effect on stringency in the separating equilibria, as is typical of most signaling games including Spence's job market signaling. It is typical of signaling models that there is a discontinuity in the separating equilibrium set at $\mu = 0$. As long as $\mu > 0$, costly signaling can occur, which easily covers the range of relevant societies and communities we have in mind (i.e., with strictly positive proportions of pious Muslims in the IB context). See, for example, van Damme (1987).

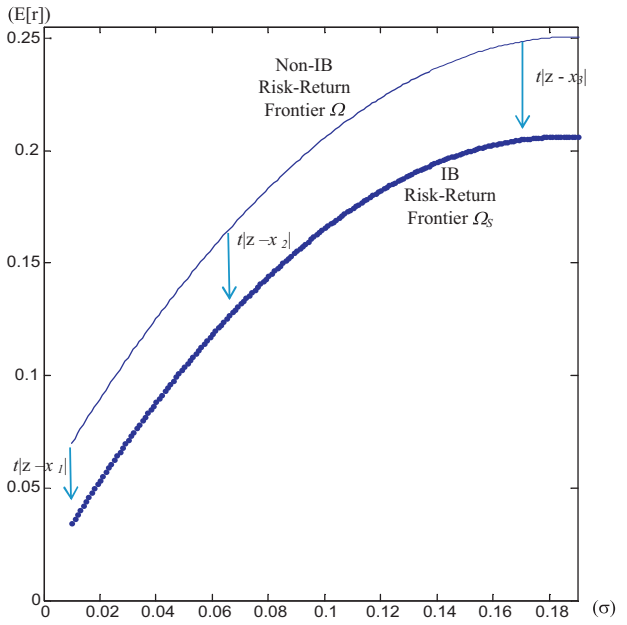

Fig. 3. Premium financing costs, $t|z-x|$, measuring forgone risk-adjusted expected return as an interpretation of distance ($|z-x|$) from the IB (at z) to an agent (at x).

three points in risk-return space. The parameter t in this example re-scales distances in the Hotelling linear city into units of forgone expected risk-adjusted return.

In Fig. 3 (which is only suggestive and far from exhaustive), agents' initial positions are interpreted as exogenously given agent-specific risk preferences. These risk preferences could also be interpreted as non-Islamic banks' risk ratings corresponding to each agent's borrowing and expected future cash flows. The continuum of agents' initial locations would therefore represent a linear re-scaling of investors' risk targets or borrowers' risk profiles. The implication of the linearly increasing gap between the upper boundaries of Ω and Ω_S depicted in Fig. 3 would then imply that agents with the larger desired levels of σ face the greater IB premiums and consequently generate more powerful signals when choosing to become an IB client.

Notice, however, that, contrary to the increasing vertical gaps between efficient frontiers in Fig. 3, the IB could just as well choose the shape of Ω_S so that these vertical distances are constant or decreasing in σ. Therefore, the model imposes no assumption that systematically links the distances measured by $|z-x|$ to financial risk. The model applies to virtually any shape Ω_S chosen by the IB's Sharia board, so long as it generates a continuum of IB premiums relative to agents' outside options for financial services.

Another interpretation of heterogeneity in the Hotelling model is different income levels in a population with identical risk and return targets and a fixed-percentage IB premium. Heterogeneous incomes or currency-denominated financial positions projected through a fixed-percentage IB premium would generate a continuum of IB premiums when measured in levels (i.e., currency units and not as percentages). The parameter t re-scales distance units in the Hotelling city to currency units forgone when choosing to be an IB client. This example where heterogeneous IB premiums are measured in dollars contrasts with the earlier example illustrated in Fig. 3, which measured IB premiums in units of forgone expected return.

The distribution of initial positions x could alternatively result from different credit histories, heterogeneous availability of local banking services, or historical ties with different banking brands. Therefore, this discussion is intended to demonstrate that multiple dimensions of bank clients' heterogeneity can be represented as re-scaled distances travelled in the Hotelling city. Although risk preferences and income are two sources of individual variation that can provide theoretical and possibly empirical links to IB-client status in the real world, our model does not pre-suppose this link. Heterogeneous risk preferences and incomes are not required and need not have anything to do with the model's heterogeneous IB premiums.

Fig. 3 illustrates just one possible source of individual-level heterogeneity that generates an exogenously given distribution of IB premiums. The IB, in turn, has only one scalar-valued decision to make (z). Values of z greater than 1 impose non-vanishing premiums on all agents in the model. Notice, however, that if the IB chooses the boundary of Ω_S to intersect the non-IB frontier Ω at one or more points, this would imply a zero IB premium for at least on agent and would correspond to the IB choosing to locate strictly within the unit interval of the Hotelling city.

Proof of Theorem 1: (i) If $z \in [0, 1]$, then there exists $x \in [0, 1]$ such that $d_x(z) < d_L$, $\forall d_L \geq \underline{d}$ and this agent will never prefer IB client status, regardless of type. Therefore, any (d_L, d_H) cannot be an equilibrium. (ii) (d_L, d_H) can be an equilibrium if $d_x(z) > d_L$, $\forall x \in [0, 1]$ i.e., $z > d_L + 1$. Also, an agent at location x will prefer becoming an IB client if $d_x(z) < d_H$(i.e., if $x > z - d_H$). Thus, a separating equilibrium exists if $1 + d_L < z \leq 1 + d_H$. (iii) For an individual with $d > d_H$ and the off-equilibrium behavior of being

an IB client (i.e., sending the signal $m = 1$), we have the following: $D(L, m) \subset D(H, m)$ where $D(\omega, m) = \{\hat{\mu} \mid \hat{\mu} \geq \mu + td_z(x)/b_\omega\}$. This implies that $\hat{\mu} = 1$. Then, for $d > d_H$, IC conditions imply that $b_\omega \mu \geq -td_z(x) + b_\omega$ for $\omega = L, H$, i.e., $d_H \geq \overline{d}(1-\mu)$. This completes the proof. (iv) This is obvious.

Proof of Theorem 2: (i) If $d_z(x) \leq \underline{d}\mu$, this individual will prefer IB client status since the utility of doing so $(-td_z(x) + b_\omega \mu)$ exceeds the utility of non-IB-client status (which is 0), for all $\omega = L, H$. On the other hand, an agent with $d_z(x) > \underline{d}\mu$ will prefer IB client status and receiving $b_\omega \mu$, since choosing IB client status only incurs the cost $td_z(x)$. (ii) Universal divinity requires $\hat{\mu} = 1$ to be the only reasonable belief given the off-equilibrium signal of IB client status. Consequently, no high-piety type will deviate if $-td_z(x) + b_H \leq b_H \mu$, or equivalently, $d \geq \overline{d}(1-\mu)$. Thus, if $\overline{d}(1-\mu) < \underline{d}\mu$, then no low-piety type with $d_z(x) \geq d_p$ will deviate, and this is the case for all $d_p \in (\overline{d}(1-\mu), \underline{d}\mu]$.

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