

A Multi-Agent Smart E-Market Design at Work for Shariah Compliant Islamic Banking

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Abstract—Though quite fast on growth, Islamic financing at large, and its diverse instruments, is a controversial matter among scholars. This is evident from the ongoing debates on its Shariah compliance. Arguments, however, are inciting doubts and concerns among clients about its credibility, which is harming this lucrative sector. The work here investigates, particularly, some issues related to the Tawarruq instrument. The work examines the issues of linking Murabaha and Wakala contracts, the reselling of commodities to same traders, and the transfer of ownerships. The work affirms that a multi-agent smart electronic market design would facilitate Shariah compliance. The smart market exploits the rational decision-making capabilities of autonomous proxy agents that enable the clients, traders, brokers, and the bank buy and sell commodities, and manage transactions and cash flow. The smart electronic market design delivers desirable qualities that terminate the need for Wakala contracts and the reselling of commodities to the same traders. It also resolves the ownership transfer issues by allowing stakeholders to trade independently. The bank administers the smart electronic market and assures reliability of trades, transactions and cash flow. A multi-agent simulation is presented to validate the concept and processes. We anticipate that the multi-agent smart electronic market design would deliver Shariah compliance of personal financing to the aspiration of scholars, banks, traders and potential clients.

Keywords—Islamic finance, Shariah compliance, smart electronic markets design, multi-agent systems.

I. INTRODUCTION

THE Sharia compliance of Islamic financial instruments is a constant debatable issue since inception. The work here proposes that smart technologies and suitable market design would facilitate Shariah compliance. In that vein, the work examines Tawarruq as a case study to proof the concept. In its 15th session, held in 1998, the Islamic Fiqh Council of Muslim World League [1] defined the traditional personal financing (*Tawarruq Sale*, “*Monetization*”) as the “purchase of a commodity, which is in possession of the seller, at a price to be paid later by the purchaser, who sells it, in turn for cash to a person other than the seller to get cash”. The Fiqh Council confirms that *Organized Tawarruq* is permissible in Shariah, being two separate sales contracts (i.e. Murabaha and Wakala) with no usury, where a bank who possesses commodity sells it, at a price to be paid later to a buyer, who resells it in turn for cash to a 3rd buyer [2]-[4]. The resale, however, may not go to the same seller. In *Organized Tawarruq*, hence, the bank executes (1) a Murabaha contract in which the bank sells the commodity to the client for deferred payments. The bank

owns the commodity before selling it and transferring the ownership to the client, and (2) Wakala contract in which the customer appoints the bank as his agent to resell the commodity on his behalf to a third party (i.e. not same supplier) for direct cash. The commodity should be specific, and the buyer should be well informed about it, while delivery should be immediate. In the 17th session, however, the Fiqh Council [1] reviewed the practically implemented version of the *Organized Tawarruq* and prescribes it as not permissible, in which the bank commits by a contract to sell the commodity as a proxy to the client. Trades would, per se, violate legal ownership that is essential for the validity of the transaction. In [2], furthermore, Tawarruq raises concerns amongst scholars and clients about the credibility of the Islamic finance, as *Retail Tawarruq* is often forbidden by Shariah, in which the bank is contracted to sell commodity warrants and not the real commodity. The bank does not own the physical commodity, and hence, the client, which is forbidden by a Shariah [6]. In general, the Tawarruq trades are not individualized and separated while many forms of Tawarruq is like Bay al-Inah, in which the transaction is deemed to contain the element of the interest (i.e. Riba) that is banned by Shariah [1]. In that vein, the Harvard LSE workshop at the London School of Economics [5] reviewed Tawarruq as not being an ideal instrument, nor being prohibited. Concerns were, rather, about suitability, and not permissibility, hence, their advice to re-examine scope of usage and application.

Our work realizes the controversial fundamental issues of the Tawarruq case and how this personal financing instrument is impacting the credibility of Islamic finance and inciting doubts and concerns among potential clients, henceforth, its adverse impact on this lucrative market. In that vein, the work here investigates, particularly, the scholarly issues related to linking Murabaha and Wakala, the reselling of commodity to the same seller, and the transfer of ownership concerns. The work affirms that smart technologies would facilitate Shariah compliance. We advocate, profoundly, that the deployment of a rational multi-agent proxy system (MAS) that implements a smart electronic market (e-Market) design would deliver a suitable platform for Shariah compliant transactions. The smart e-Market design enables individual stakeholders of (i.e. Tawarruq clients, commodity traders, and the bank) make rationally smart and autonomous decisions on diverse trade transactions, whether directly or using software proxy agents. The fact is that Islamic personal financing requires trade transactions be separated and individualized; hence, this is accomplished by the autonomy of clients and traders who work independently. Furthermore, the smart commerce would

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promote plenitude that facilitates market thickness (abundance) of commodities, transactions, providers and consumers, a condition for rather stable commodity valuation and efficient market clearing with best matching, no monopolies, and fair trades [11]. The work here confirms by a rather basic simulation that smart technologies can resolve Shariah compliance issues. The work introduces a generic multi-agent smart e-Market design for Islamic personal financing that follows our e-Market design in [18], [19]. The smart e-Market design terminates the need for the controversial Tawarruq dual contracts, while reducing the need for Wakala requirements, as clients can trade directly to sell or buy their commodities. The smart e-Markets also enable the clients to prohibit reselling to the same sellers using conditional bidding, while resolving commodity ownership transfers issue by allowing stakeholders to electronically trade (e-trade) directly through proxy agents and be liable for their own transactions. To guarantee reliability of the transactions, the bank would administer the marketplace, qualify and register clients and traders, supervises auction and exchange trades, processes cash flows, and warrants trades for rather fair service charges, using suitable mechanisms and practices. The smart e-Market design for personal financing would deliver, hence, a Shariah compliance instrument to the aspiration of Islamic scholars and comfort of potential clients. Section II reflects on the Islamic finance issues and approach. Section III describes the operational model of the multi-agent smart e-Markets at work. Section IV describes the proposed model of the multi-agent based smart e-Market design, while section V explains the basic simulation and comments on the results. Section VI concludes with highlights on future work.

II. ISLAMIC FINANCE: ISSUES & APPROACH

The Islamic personal financing and its instrument is a controversial issue amongst Islamic scholars evident from the ongoing debate regarding its compliance with Shariah laws. Regrettably, one serious consequence of the constant debate is the concerns and doubts amongst potential clients about the credibility of Islamic finance. In fact, the mounting issues would incite the industry to pursue more resilient delivery and revenue ecosystem friendly mechanisms as reflected by Moore, in *The Death of Competition* [10]. Our investigation realizes that the core issues behind the debate relate to the indirect time-sensitive and liability attributes of the current practices. In fact, the transactions in Commodity Tawarruq are not separated or individualized. The bank, often, represents the client in selling the commodity without his presence or taking physical possession of it. In a practical sense, the Islamic banks sell the warrants that represent the commodity and not the actual one. Therefore, the bank does not take possession when purchasing the commodity from the broker initially. Likewise, the monetizing client does not take possession in any form of the commodity. In fact, the bank operates as an agent for the client to sell the commodity on the exchange e-Market without considering the Shariah compliance of the required contractual commitments. Generally, contemporary forms of organized Tawarruq are very similar to Bay al-Inah

and have been largely detested by most scholars including the International Council of Fiqh Academy. (Resolution 179 (19/5) in relation to Tawarruq: its meaning and types (classical applications and organized Tawarruq)) [1]. Another reliable scholarly foundation is the Accounting and Auditing Organization for Islamic Financial Institutions (AAOIFI), who consider that much of the current day Tawarruq contracts violate, also, the controls and rules on monetizing transactions and general Shariah laws of finance and economics [20]. While all transactions in a Tawarruq should be separated and individualized, their various legs are not individualized and separated; hence, the product is not Shariah Compliant.

The work here examines, particularly, these issues and argues contemporary smart technologies can resolve it beyond the scholarly disputes by facilitating the Shariah compliance. In that vein, our work examines the typical scenario of organized Tawarruq instrument (see Fig. 1), and realizes the controversial issues linking Murabaha with Wakala contracts, the reselling of commodities to same sellers, and the transfer of ownerships between stakeholders.

Our work investigates the above-mentioned issues and exploits contemporary technologies and mechanism design by introducing a multi-agent based smart e-Market system for personal financing that can deliver Shariah compliance. The novel approach to Islamic personal financing utilizes and implements a smart electronic market mechanism design with proxy agents that act on behalf of the clients, traders, and the Islamic bank. The multi-agent based smart e-Market system coordinates all required transactions at real-time. The smart proxy agents manage the transaction's lifecycles to closure. The proposed system resolves the liability issue by enabling all stakeholders that include the bank, customers and commodity traders to work at full autonomy. The bank would own and administer the e-Marketplace and guarantee the reliability of the transactions and the cash flow for rather fair service charges.

III. THE SMART E-MARKET AT WORK

For the Tawarruq case, the proposed system aims at delivering Shariah complaint instrument by: (1) resolving the ownership liability issue through enabling stakeholders (i.e. bank, clients, and commodity traders) trade directly with full autonomy using their software proxy agents and the smart e-Market; (2) resolving banned trading with the same sellers' issue by blocking them, using conditional bidding that controls trade transactions and blocking undesired sellers; and (3) the obsolescence of the Wakala contract is a by-product of the proposed smart e-Market, as stakeholders operate directly with full autonomy and no interference from the bank. The smart e-Market as depicted in Fig. 2, the e-Market system allows the bank to buy the commodity at market thickness (i.e. abundance), sell it to the client on a deferred payment basis and transfer the ownership using the Shariah complaint Murabaha instrument. The client then sells the commodity, which he owns, directly to a third party for cash using the smart e-Market bidding and asking protocols and the pre-familiarized with exchange auction mechanisms. In fact, the smart e-Market guarantees

market participants are fairly informed about the specific details of traded commodities, and the applied bidding and clearing conditions and rules. Also, the delivery must be immediate in the form of official transfer of commodity ownership (i.e. formal digital certificate). The bank is the insuring party being the e-Market administrator that guarantees: (1) the reliability of the registered clients and the traders; (2) the implementation of traded transactions; (3) the formal implementation of the official transfer of ownerships;

and (4) the trusted flow of cash between buyers and sellers. Such formal practices would recover confidence amongst stakeholders, improve the business of Shariah compliant personal financing instruments, and increase the e-Market thickness with the growing number of commodities, traders and potential clients. Thus, the e-Market would be able to return better wins and profits to all stakeholders and facilitates the positive performance of personal financing.

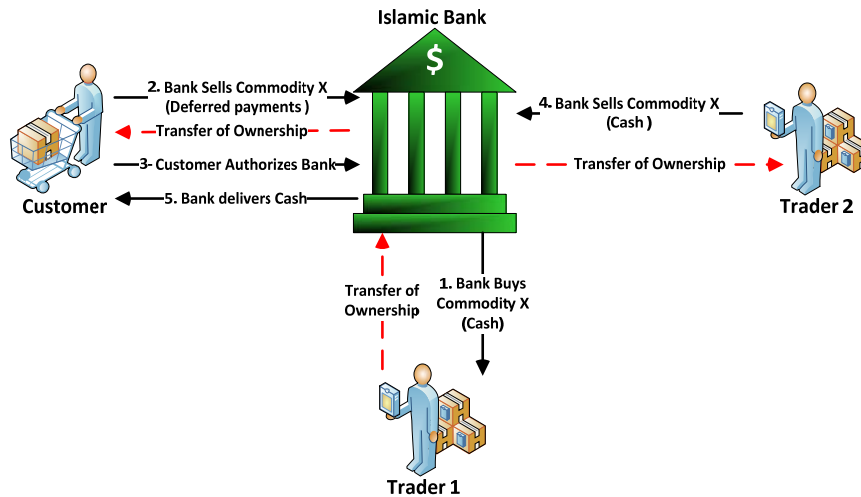


Fig. 1 A typical Tawarruq Scenario

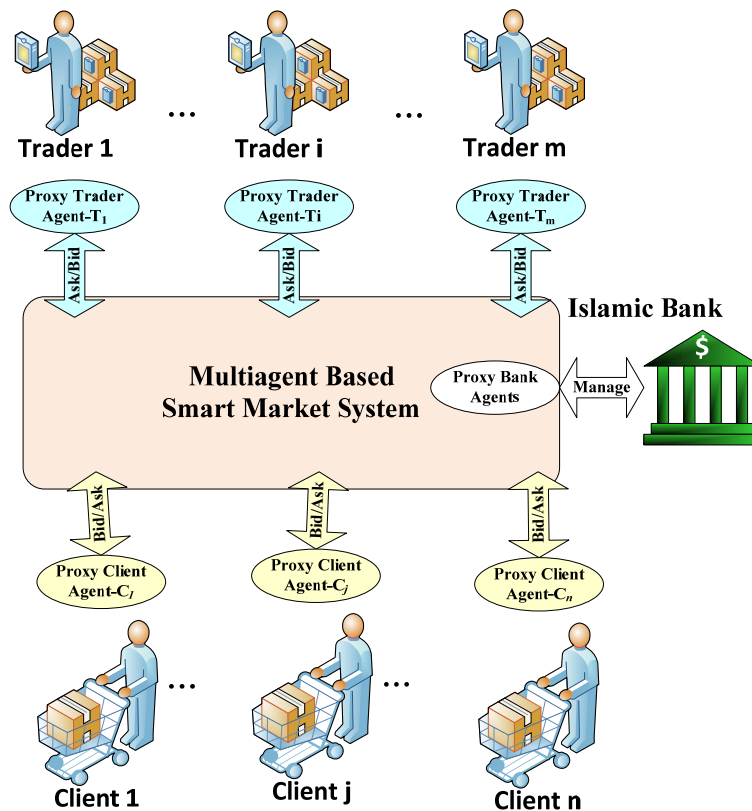


Fig. 2 A Smart E-Market Model

IV. THE SMART E-MARKET DESIGN MODEL

The work here investigates and develops a multi-agent smart e-Market system for the case of Tawarruq personal financing and proves that smart technologies would resolve Shariah compliant issues. The smart e-Market design exploits market economy, microeconomics, and game theoretic rationality of multi-agent systems. We suggest a smart e-Market bidding language and a double auction exchange mechanism that follows our work in [18], [19]. The adopted smart e-Market bidding, deliberation, exchange matching, and clearing would deliver rational decision-making autonomy, game theoretic stability, social efficiency and rapid trades. The smart e-Market mechanism enables the clients take charge of all their trading transactions at time convenience and favoured e-Market dynamic conditions to cash in their deferred payment commodities without the bank intervention; hence, ensuring Shariah compliancy. Registered traders respond to enquiries at the time using proxy agents that hold and execute trading and housekeeping rules (i.e. tactical, strategic, administrative, etc.) for the clients, traders and the bank to ask-bidding, request-bidding, admin-rules, e-Market clearing, and trade-closing, etc. (see Fig. 2). An easy-to-use simple GUI would facilitate the assignment and programming of proxy agents' bidding and trading instructions, tactics, and trading strategies.

The smart e-Market design that follows the free market economy exploits the Rule-based Bidding Language (RBBL) and the Generalized Second Price (GSP) double auction matching mechanism (GSPM) in our work in [18], [19]. The RBBL bidding enables a free and flexible expression of choices and strategic rules. In fact, the limited bidding scope to free choices may be traced to the well-known Vickrey-Clarke-Groves (VCG) mechanisms [12]-[14]. The VCG penalizes bidders with extra charges for reporting untrue (i.e. changes their valuations/preferences with time) strategic preferences, to align payoffs with the social welfare, rather than the desirable self-prosperity. The fact that e-Markets penalize or inhibit strategizing would, ultimately, incite adverse reactions that lead to e-Market failure due to incomplete or false information revelation. The smart e-Market deliberates on logical bidding rules for automatic deduction and formation of bids. The exchange exploits the forward and reverse GSP auctions for efficient matching of bids and asks. The exchange uses tractable heuristics, while delivering social efficiency, game-theoretic stability, and e-Market profitability.

The work proposes a smart e-Market model that includes proxy agents that operates on behalf of the clients, traders, and the bank and follows our formal model in [18], [19] that presented a combinatorial allocation problem (CAP) and explained how the RBBL allows for capturing the CAP as an integer program (IP). The smart e-Market mechanism design delivers efficient winner determination matching and e-Market clearing. The representation in Fig. 3 simulates the request and ask bidding protocols and the autonomous interactions of proxy agents of the clients, traders and the bank, as guided by the smart conduct and self-learning at repetitive trades using

JADE multi-agent platform, MATLAB, Java, and Apache web services.

The RBBL enables a smart, free, flexible and concise expression of choices and strategic actions of bidder proxy agents. The bid structure may include distinct attribute-values of commodities and logical rules formulae that smart e-Market deliberates on. The RBBL subsumes expressive and structural attributes of the *iBundle* tree-based bidding language in [7], [17] and the logical bidding languages $\mathbb{L}_G, \mathbb{L}_B, \mathbb{L}_B^{OR}, \mathbb{L}_B^{XOR}, \mathbb{L}_{GB}$ and $\mathbb{L}_B^{OR*}$ in [8] using the logical rules and operator's formulae in the bid structure and semantics. Our work exploits First Order Logic to model the rules, formulae, and attributes as Q-levels and budget bounds.

The smart e-Market deliberates using artificial intelligence and machine learning, to reasoning on bidding rules, attributes, and valuations of proxy agents for automatic preference deduction, elicitation, aggregation and formation of the selected commodities and bids; hence, causes minimal preference elicitation, more rapid trades; and therefore, more effective matching allocations.

To achieve stable efficiency in matching allocations, our work endows the core smart e-Market engine with a GSPM double auction exchange clearing mechanism that improves incentive compatibility, social efficiency and game-theoretic stability [19]. The e-Market applies the double auction (DA) exchange matching on the induced request and ask-bids to compute an efficient and stable matching. The DA uniquely exploits the forward and reverse- generalized second price (GSP) auction heuristics. The GSP DA targets the symmetric, efficient, and stable matching between multiple buyers and sellers of a class of multiple units of commodity of multiple quality Q-levels. The free e-Market improves truthfulness by implementing a multiple Q-levels GSP DA. The request bidder agent would be better off if he bids truthfully on a commodity of a Q-level, as it minimizes the risk of losing the bid to others at that Q-level, while having an incentive to win a commodity of rather higher quality. The DA heuristics are computationally tractable and secures, also, the e-Market profitability. The multiple Q-levels, DA enable tractable and incentive compatible (i.e. truthful) exchange e-Market. The GSP DA based e-Market secures e-Market profitability that grows with thicker trades.

V. SIMULATION PLATFORM

At this stage, the experimental analysis of our proof of concept would target the multi-agent system performance using an experimental multi-agent technology (i.e. JADE platform). The proof of concept implementation includes the simulation of the RBBL bidding model and the algorithmic GSP DA matching mechanisms of the smart free e-Market using MATLAB, Java, and Web technologies; that delivers the matching allocations and pricing outcomes of the targeted CAP class. The proposed GSP DA e-Market delivers incentive compatibility that drives the truthful bidding of proxy agents. The GSP DA e-Market is stable and efficient due to the pricing rule that narrows down the tactical manoeuvring, the

multiple Q-level cross-matching and best response at repetitive trades that transform the e-Market from an incomplete to complete information truthful model. The GSPM takes advantage of the successes of the efficient, yet simple de facto GSP auction [15], and the repeated best response auction in [16]. The GSPM DA allocation rule follows the Equilibrium Matching (EM) in [9] for single Q-level and multiple Q-levels settings. The multiple Q-levels,

GSPM DA enable tractable and incentive compatible exchange that delivers stable efficiency and profitability. This is evident in the rapid stable convergence of thick e-Markets i.e., substantial number of bidders and transactions. The desirable properties of the RBBL rules bidding and GSPM DA are thoroughly verified through the experimental analysis in [18], [19].

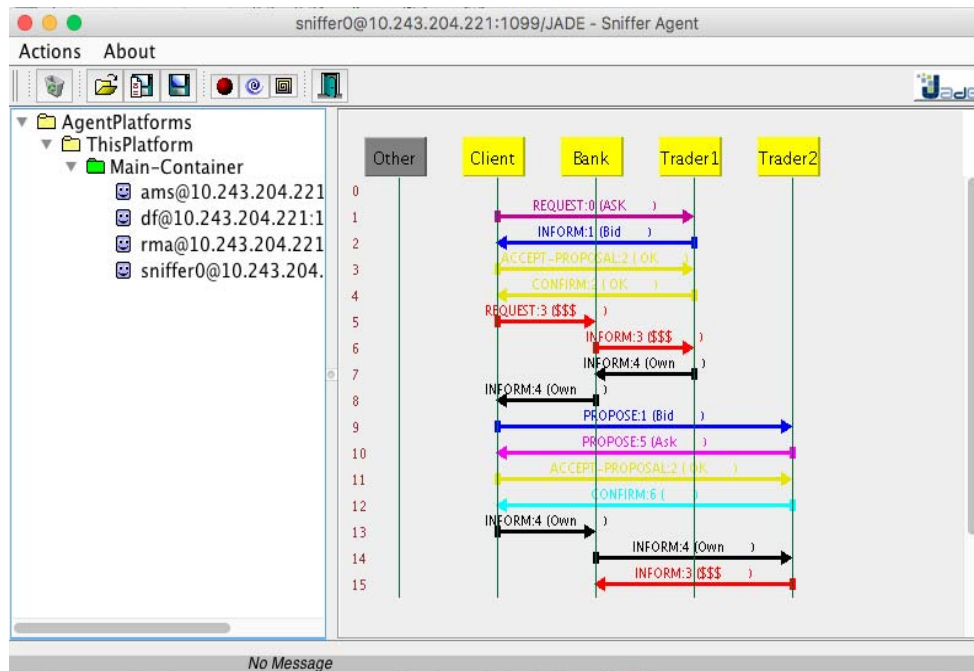


Fig. 3 Autonomous Interactions of proxy agents using JADE

The GSP DA e-Market secures e-Market profitability that grows with thicker trades. The profitability is lucrative to the e-Marketplace that is owned and administered by the bank. The GSP converges to the maximum number of matched pairs close to the true value matched pairs. This is a natural progress of winners who target utility maximization at repetitive trades. Regarding the algorithmic complexity analysis, there would be no extra computational cost in implementing the GSP DA algorithmic heuristics. In fact, the GSP DA mechanisms utilize the e-Market equilibrium matching (EM) algorithms for sorting, grouping, indexing and the allocation matching that often demands the highest computation cost, while applying linear pricing models. Hence, the GSP DA smart e-Market delivers better economic properties such as stable efficiency and e-Market profitability for the same computational cost. The smart free e-Market properties would deliver better and attractive personal financing systems that resolve the discussed Shariah issues, while presenting an attractive trading platform for all stakeholders and potential clients that secures better returns to all parties.

VI. CONCLUSIONS AND FUTURE WORK

As this preliminary stage, this work attempts to ensure that

smart multi-agent technologies can resolve Shariah issues for a case like Tawarruq. We exploit e-Market economy models and autonomous decision-making capabilities of multi-agents to present a rather reliable smart e-Market design for a personal financing system. This work follows our e-Market mechanism design and bidding model in [18], [19] to implement a proof of concept. The smart e-Market coordinates the buy and sell trades using proxy agents. The proposed smart e-Market terminates the Wakala requirement and the reselling to the same traders, while resolving commodity ownerships by allowing stakeholders to trade independently. The bank administers the e-Market and guarantees the reliability of trades and cash flow for fair service charges. The e-Market design for the personal financing delivers Shariah compliance to the aspiration of Islamic scholars and potential clients. The theoretical and empirical findings confirm the soundness of our smart e-Market design and the fact smart technologies facilitates Shariah compliance. The proposed system resolves both the time sensitivity and liability issues that, ultimately, deliver to the aspiration of Islamic scholars and the potential customers of personal financing. This preliminary work is to expand to cover more financial instruments and to incorporate emerging financial technologies. The work here will be

extended with the full algorithmic and game theoretic details of the socially efficient e-Market design and smart bidding that deliver game-theoretic stability for safe and stable trades.

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