

Agent-Mediated Off-Exchange Trading

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Abstract

In this paper, we introduce a prototype approach to automate the off-exchange trading via (intelligent) software agents. An innovative multi-agent based trading system will be presented that permits the trader to initiate automated single auctions and/or dynamic negotiations within a continuous off-exchange trading in the bond market. After deriving the main requirements for this approach, we give an insight into the system's concept.

1. Introduction

In the recent years, the wide-spread usage and the high acceptance of IT and Internet technology have led to new types of markets for commodities and services - for business applications as well as for retail markets. The trend to computerize trading activities and to "virtualize" trading platforms is mainly based on the globalization of communication networks and the reduction of transaction costs within the corresponding trading mechanisms.

Existing electronic markets and exchanges offer different levels of IT-support but they generally pass through intermediate states on their evolution to completely virtual and transparent markets that overcome spatial and temporal distances. In this sense, electronic markets and exchanges tend to approach the neoclassical model of perfect markets where, from a pure theoretical point of view, there is no clear need for any intermediation [1].

Regarding financial markets and exchanges, imperfect sectors can be observed where (i) brokers transact most of the trading volume and (ii) only few electronic trading systems are used: the so called over-the-counter (OTC) or off-exchange markets. In bond markets and derivative markets, the volumes traded off-exchange significantly exceed that of on-exchange trading. In the German bond market for instance only 10 % of the trades are conducted

via the exchange [2]. The volumes in the global market for derivative instruments are shown in table 1.

Table 1. Volumes in derivative instruments [3]

Markets for selected financial derivative instruments				
Instruments	1994	1995	1996	1997 ¹
	in billions of US dollars			
Exchange-traded instruments	8,862.5	9,188.6	9,879.6	12,207.3
Interest rate futures	5,777.6	5,863.4	5,931.2	7,489.2
Interest rate options ²	2,623.6	2,741.8	3,277.8	3,639.9
Currency futures	40.1	38.3	50.3	51.9
Currency options ²	55.6	43.5	46.5	33.2
Stock market index futures	127.7	172.4	195.9	216.6
Stock market index options ²	238.4	329.3	378.0	776.5
Over-the-counter instruments ³	11,303.2	17,712.6	25,453.1	28,733.4
Interest rate swaps	8,815.6	12,810.7	19,170.9	22,115.5
Currency swaps ⁴	914.8	1,197.4	1,559.6	1,584.8
Interest rate options ⁵	1,572.8	3,704.5	4,722.6	5,033.1

¹ For OTC instruments, end-June 1997. ² Calls and puts. ³ Data collected by ISDA only; the two sides of contracts between ISDA members are reported once only.

⁴ Adjusted for reporting of both currencies; including cross-currency interest rate swaps. ⁵ Caps, collars, floors and swaptions.

Sources: Futures Industry Association, various futures and options exchange, ISDA and BIS calculations.

There are products and traditional trading practices where current trading systems are not able to meet the requirements of the traders; exchanges do not have the chance to participate in these sectors of financial trading. On the one hand, exchanges offer large quantities of information to these traders, i.e., they support their information gathering process, but on the other hand they do not easily attract these off-exchange trades via their electronic trading systems.

Most off-exchange trades are still intermediated by brokers via traditional communication channels such as

phone and fax. This occurs even though brokers (in Germany) do not provide any clearing function, but only arrange the contact between potential contract partners. Another, much smaller part of the off-exchange volume is transacted by direct communication and negotiation among big dealers, who know each other, but also using telephone and fax.

The basic reasons for intermediation in off-exchange markets lie in the complex identification process for potential contract partners, the complexity of market transactions, the strategic behavior, and in the need of anonymity within the searching process. In response, we are undertaking a current project with Deutsche Börse AG, the German stock exchange, that focuses on an (prototype) add-on system to the existing trading system XETRA, but for the off-exchange market. The intention is not to eliminate intermediation as a whole, but to bring more efficiency to this sector of the financial market by:

- (i) widening the search space for the traders,
- (ii) accelerating the trading transaction, and
- (iii) providing new information sources in the off-exchange market.

From a technical point of view, the paradigm of (intelligent) software agents provides an attractive technology to meet the requirements for such a trading system.

The agent requirements are derived in the following section 2. In section 3, agent technology will be introduced as the basis of the system's concept, which is described in more detail in section 4. Section 5 discusses the main results and points out some aspects of future research in this area.

2. The Requirements for an Off-Exchange Trading System

Figure 1 shows the transaction chain and the participants in off-exchange trading.

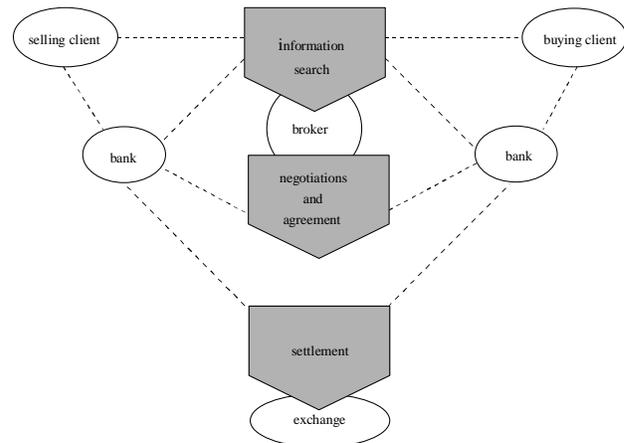


Figure 1. Transaction chain in off-exchange trading: The process begins with a client, who wishes to buy or sell. The information search and the negotiations/agreement usually are performed by brokers, the settlement regularly by exchanges.

Our project focuses on the information search, negotiation, and agreement process. Thus, our approach should provide a system to support traders in searching potential contract partners and in *dynamically* finding prices for the contract which are acceptable for both of the contract partners. In our project, bond trading is chosen as the first application sector in off-exchange trading. In European bond markets, brokers provide a pure search function for partners, products, and contract terms, but usually do not trade as principals using their own capital.

To identify the essential requirements for a system approach, it is necessary to find an adequate structure for the domain as a whole to be supported by a trading system. This is done in figure 2:

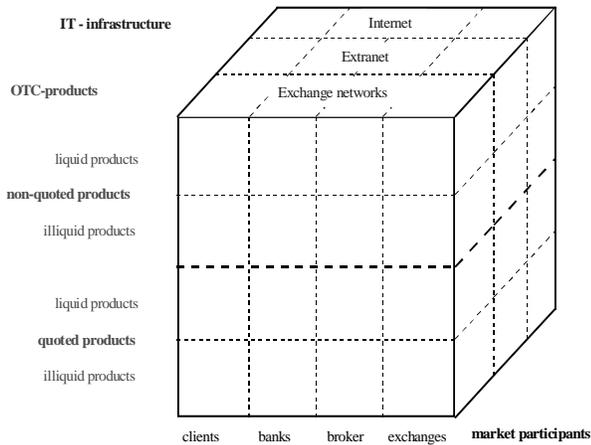


Figure 2. Structure of the off-exchange trading. This 3-dimensional matrix reveals the different products, participants, and potential IT-infrastructure for OTC-Trading.

The structure represents three dimensions: (a) products, (b) market participants, and (c) technical infrastructure:

- (a) The current off-exchange market can be divided into sectors for non-quoted and quoted products. Liquid products and illiquid products are traded both as quoted and non-quoted products.
- (b) Market participants are clients (e.g., institutional traders), banks, brokers, and potentially the exchanges, if they are able to provide an adequate system support.
- (c) Since exchanges already offer trading systems they impose a secure and widely spread communication infrastructure with sufficient acceptance among traders. The Internet provides a global infrastructure, but faces security and performance problems. To overcome these problems, at least partially, the Internet can also be used in terms of an extranet.

Starting with this structure, the main determinants for the success of a system approach are contrasted with the corresponding, traditional way of trading. This provides the requirements for the system concept in the following table 2.

Table 2. Determinants of success in off-exchange trading. The right column generally outperforms the present situation.

criteria or determinants of success	present situation	potential of configuration
immediacy	manual search for partners and negotiations	electronic search for partners and electronic negotiations
anonymity	broker	anonymous, electronic search for partners
liquidity	broker	increase of search space
reduction of counterparty-risk	global player	clustering / OTC - Clearing house
supply of tailor-made products	bilateral, weak structured negotiations	structured (pre-)negotiations between partners

The main goal of the project sketched in this paper is to build a “proof of concept prototype“ and to show that using the software agent technology, it is possible to develop better IT-support for off-exchange trading. To substantiate this, section 3 introduces software agent technology, and section 4 describes our specific implementation.

3 Software Agents as Trading Actors in Off-Exchange Markets

Software agents are “... computational systems that inhabit some complex dynamic environment, sense and act autonomously in this environment, and by doing so realize a set of goals or tasks for which they are designed“ [4]. This common definition of software agents corresponds very well to the requests of a system approach in the off-exchange trading. Table 3 shows the properties of an agent and outlines the relevance for our usage.

Table 3. Required properties of agents in off-exchange trading

Agents are...	in order to...
situated	create an action in the specific domain
using local knowledge and/or data	consider the individual situation
“social”	communicate with users/other agents
autonomous	search and negotiate independently / for with other agents
reactive	monitor and to act
rational	maximize an individual utility function
adaptive	learn from their own and foreign activities
mobile	minimize the costs of using networks

Rationality, adaptivity, and mobility are not necessary to be an agent, but are nice to have. Their usefulness crucially depends on the application area.

From a **local agent** view, on electronic markets/exchanges information systems are:

- providers and evaluators of information,
- autonomous “negotiation machines“ [5], and
- performers of transactions (for execution and/or control).

From a global point of view, a **multi-agent system** turns

- to a decentralized and parallel operating problem solving system and, thus,
- to a global coordination platform in off-exchange trading.

In various applications, agents are used to assist in search processes, e. g., within Internet applications in order to handle huge search spaces [6, 7, 8]. Especially in OTC-markets, where the broker merely supports the identification of potential trading partners and/or products, agent technology offers a high potential for disintermediation and reduction of transaction costs.

4. The System’s Concept

For designing the prototype, it is useful to distinguish between two separate parts of the trading process: searching and pricing. In order to use the agent as a representative of his interests, the trader first has to specify his preferences within a graphical user interface and to activate the agent. The agent then identifies all other participating agents in the trading system (see figure

3). Based on the trader’s specifications, this agent matches his requirements concerning both the product parameters and the contract partners. Product parameters such as coupon, maturity, issuer, and others can be specified in various granularity to allow the representation of the individual preferences. The partner matching based on the above mentioned individual cluster definition (see table 2), helps to cope with counterparty risk [9].

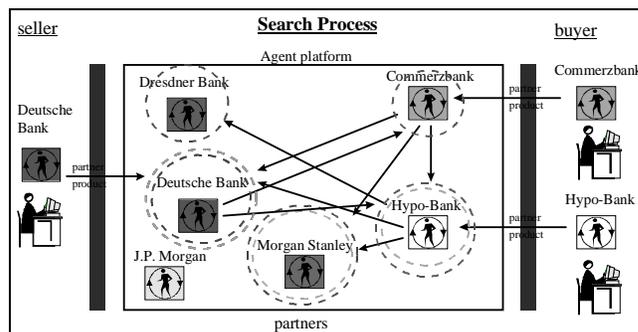


Figure 3. Search process: To guarantee non-disclosure, the search process is performed only among the agents without revealing any information to the traders (see vertical bars).

After successful product and partner matching both traders get the ID of their matching partners. This form of agent-based searching meets the requirements of immediacy, anonymity, and the reduction of counterparty risk by using a clustering concept. Using this clustering actively, it is possible to identify traders who try to gauge the market, i.e., self-selection is supported. Beyond this, a platform- and trade-monitoring tool is implemented which enables the operators to realize incentive mechanisms in order to prevent this kind of manipulation.

Based on the search process, various possibilities for the pricing of the identified products are imaginable. These are implemented into the prototype and will be tested and compared via experimental economics. Beyond this, it is necessary to investigate whether the whole set of pricing alternatives might be provided within the system in order to allow the trader to select between different market models in one trading environment.

Figure 4 shows these alternative pricing procedures. The shaded cells within this picture outline the steps that are conducted among the agents themselves; the white cells show the steps with interaction between the trader and his agent and the other traders, respectively.

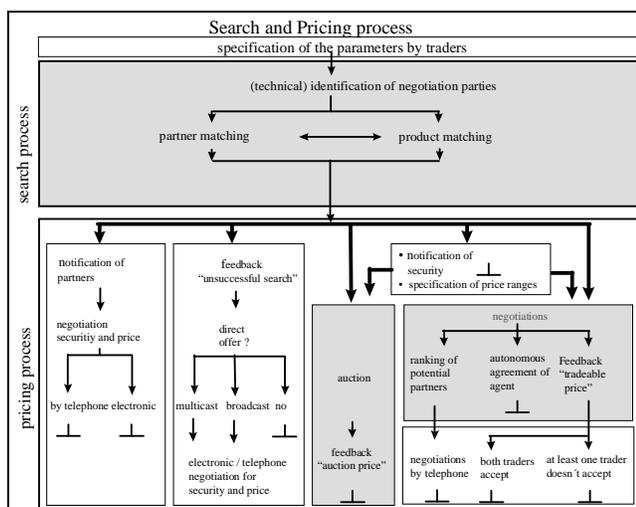


Figure 4. Alternative market models: A successful search process allows alternative pricing procedures. The specific choice depends on the trader's preferences.

First of all, the prototype can function as a pure search-machine. Based on the disclosure of the trader's ids after the search process, negotiations can be conducted bilaterally via telephone or via an electronic chat-like system, which can be compared to the Instinet system's conversational mode.

If the agent-based search ends without success, the trader can address potential partners via direct offers - either by a broadcast to all participants in the system or by a multicast to selected traders.

In order to participate in one of the other two pricing procedures traders have to be informed on the exact product parameters, here: the bond, to enter their prices or price ranges. Then, it is possible to join an auction or to participate in bi- or multilateral negotiations, respectively.

In the single price auction, price discovery process is based upon the Vickrey principle and takes place without any interference by traders.

In contrast to OptiMark [10], traders are able to observe the price discovery process and to engage in current negotiations. In the negotiations, the agents determine the price autonomously, based on the price ranges of the trader. There are three alternatives steps, which may follow:

- The resulting price can be reported to the traders as a "tradable price", then it is necessary that both

traders accept the price negotiated by their agents. If one of them refuses, the deal fails.

- Negotiations can be used to get a ranking of the potential partners for the following telephone based negotiations.
- Beyond this, these prices may also lead to an autonomous agreement among the agents.

Currently, the implementation of the functionality described above is completed. The prototype is implemented in (pure) Java [11], the architecture of the agent system is based upon the FIPA specification [12]. In order to provide a flexible and a highly available system, the agents which are participating in one logical market are physically distributed among various platforms. Each agent is capable to identify the location of any other agent on any platform by queries. This ensures scalability and extensibility of the system also during trading time - simply by adding a new platform [13] (see figure 5).

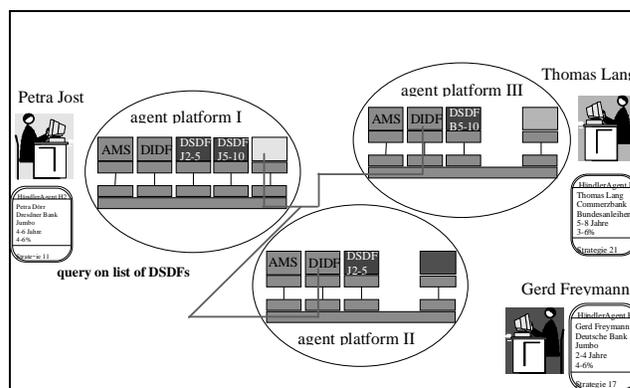


Figure 5. Multiple platforms within the trading system guarantee scalability, extensibility, and availability.

5. Summary and Future Work

Innovative information technology can enable new market structures to exist and can provide new trading facilities. In particular, for the off-exchange markets, with their opaque structure, new technologies should be investigated due to their potential to reduce trading costs and to provide more efficient trading venues.

In this paper, a new prototype approach for a trading system based on agent technology is described. The system provides a platform for bond trading. In an anonymous market, traders are able to identify each other based on

their individual specifications concerning product and partner parameters. An agent-based search can improve immediacy due to a very fast search process and pre-negotiations. Furthermore, the increased search space will help to extend the attractiveness and liquidity of the market.

In the next steps of our project work, black-box and white-box tests are conducted in order to provide a suitable system for testing alternative market micro-structures [14] in an experimental environment. The object-oriented modeling and realization allow the rapid expansion of the system for other market segments in order to support (institutional) investors in the identification of trading partners and to negotiate contract terms very quickly in these new segments also.

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7. References

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