Automated Futures Trading – Environment Effect on the Decision Making

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Abstract:

In this paper, automated trading systems for futures trading will be viewed from the perspective of software agents. The market environment plays an essential role in decision making process of such agents. Decisions and capabilities of such systems are heavily dependent on trading account size. Key factors affecting the account size will be described in this text. There are typical limitations to decision making in automated trading systems, e.g. in the form of money management (risk management) rules. These limitations will be discussed in context of environment perception and interaction. We will be focused mainly on trading with futures and commodities, but most principles are applicable to other, similar, domains as well, e.g. stock market trading.

Key-Words:

agent, automated trading system, trading

1 Introduction

The widespread use of internet technologies in 90s allowed traders to perform commerce operations on futures markets more efficiently by automation of trading process (or its part) with use of computers. These innovations have accelerated the trading process, lowered commissions cost, provided faster access to quotes and created instantaneous order entry based on computerized strategies [2], [3]. Trading platforms allow user to develop a successful trading strategy (or indicator), test it and put into use, with means for controlling of risk. These solutions are almost always stand-alone applications, representing trader`s strategy to approach the market. These applications will be referred to as automated trading systems (ATS) in the following text.

This paper will be dealing with problem of trading from the perspective of software agent, which will mostly represent an ATS in general, for the purpose of this text. The rational agent is, according to [1], an entity “that acts so as to achieve the best outcome or, when there is uncertainty, the best expected outcome”. Other characteristic features of agents will be mentioned in following part. At this point, the rational agent will be used as application platform for the topics/issues discussed here. Concept of the agent is used because of the future aim of our project – to extend the functionality of an ATS to a cooperative multi-agent system. This is, however, beyond the scope of this text at this moment.

Automated trading systems are able to process part of the trading process mechanically, without human intervention. Let us consider the case of fully autonomous trading system. The basic question would arise: “What qualities and attributes would be needed to be present in such a system in order to operate correctly?” The agent approach is, in this case, used to stress the autonomy of decision making we would like to discuss in the following text. If the human operator is omitted from the process of investment decision making, the trading agent would require constraints and safeguards mechanisms implementation in order to be able to ensure long-term survival and profitability in the market environment. The main aim of this text is to discuss influence of market environment on settings of such autonomous trading system – trading agent.

2 Automated Trading Systems

The notion of automated trading system (ATS) was briefly introduced in the previous part of this text. The ATS is generally used because of the following reasons:

- **Accuracy of execution** – ATS maintain same level of precision when executing trading orders all the time.
- **High speed of execution** – ATS reacts much faster than human trader and it is possible to monitor multiple markets simultaneously.
- **Improved decision-making** – ATS can quickly and easily handle complicated calculations required for decision making processes.
- **Emotions-free trading** – traders are frequently influenced by emotions such as fear and excitement,
which may result in mistakes in following their original trading plan. ATS is not influenced by emotions and follows instructions precisely.

- **Automated execution** – once trading strategy is running, the computer is handling strategy management and execution automatically, and trader does not have to be monitoring market all the time.

This short list represents main and most widely presented advantages of the ATS, compared to manual trading. However, many professional traders use an ATS to a limited extend only, relying mostly on their skills and experience. This is a basic problem to be decided at the beginning – what level of autonomy will be implemented in an ATS we are considering to use? This would require further discussion which is not the purpose of this text and therefore we would recommend more detailed discussion of this issue presented in [4]. However, as was mentioned, we will be dealing with an ATS in general and from the perspective of an agent, where user-independent behavior will be required. Level of autonomy will be high, allowing our agent alone to make decisions.

### 2.1 Agent Approach

Agent behavior is generally highly dependent on the interaction with the environment. In order to be successful, any problem-solving agent must be able to perceive its environment and perform actions to fulfill its goal. To do this, agent use sensors for perception and actuators for actions. This typical environment-agent cycle is represented on the Fig. 1.

![Fig. 1: Agent-environment interaction](image)

A detailed specification of the task environment is generally required in order for the agent to function perfectly. This description consists of four parts [1] – performance measure, environment description, actuators and sensors (PEAS). There is no significant difference from the setup shown at the Fig. 1 in futures trading agent. Adaptation of these parameters to the market environment for the agent is presented at the Fig. 2.

![Fig. 2: ATS decision process in market environment](image)

Generally, our agent will be able to perceive its environment through technical indicators, recognized patterns or other signals in market. The following part will be discussing this topic further.

### 2.2 Fundamental and Technical Analysis

ATS are sometimes referred to as automated technical analysis. This is because of extent of technical analysis signals used. There are three main ways to view or describe the environment:

- **Technical analysis** – a set of mathematical and statistical instruments used for identification of trading opportunities, timing of orders and trend recognition. Is based on price charts.
- **Fundamental analysis** – is based on sources of information about a market other than price charts. This includes government statements and reports, expert knowledge about given commodity/futures, news, etc.
- **Psychological analysis**. It is based on study of special psychological market indicators, usually derived from behavior of traders, for more details see [10].

Purpose of these approaches in general is to recognize trends, forecast price movements and allow (profitable) placement of business orders. Technical analysis (TA) is suitable for machine processing, because of its underlying mathematical principles. On the other hand, fundamental analysis (FA) is difficult to be processed algorithmically and often requires expert knowledge of the topic (market in this case). Psychological analysis...
(PA), due to its nature, is the least important for our agent and is mentioned for completeness only.

*Indicators* are tools provided by technical analysis and are based on mathematical or statistical principles. This allows computer to process them very efficiently. There is a large number of indicators present today and it is even possible to create one’s own indicators as well as customize parameters of existing ones (by adjusting its settings). Such wide selection of tools allows us to create an ATS specifically customized for implementation of our business strategy. Again, an importance of simplicity should be stressed at this moment, for an ATS should be maintained at all times comprehensible as much as it is possible [4].

There are virtually hundreds of TA indicators and tools, for more information see [5], [6], [7]. In a single ATS, only a few indicators should be used simultaneously (maximum is 3-4 indicators, more preferably 1-2, see [4]). In an ATS, only one idea how to handle the market should be implemented. For other approach or other idea, another ATS should be created. This will ensure clarity, understanding and simple handling of such system [4]. There are no limits in how many ATS’ may be used simultaneously except for money.

As it was indicated before, there are several types of signals provided by the price chart. *Patterns* are easily recognizable by humans for these are special formations in charts. These formations are usually named after the resemblance they bring up (head and shoulders, double top, double bottom formations, etc.). However, machine processing meets dealing with these signals with a certain level of difficulty. E.g. artificial neural networks were successfully used in past to solve this problem, see [2] for more detailed information.

### 2.3 Margins

Trading with futures is, in fact, trading with futures contracts. From our point of view, it does not matter what exactly is the underlying asset of the contract. The *futures contract* (some authors use a shorter term “futures”) is a standardized contract to buy or sell a specified commodity of specified quality and quantity at certain date in future which price is determined by market. There is a large variety of items traded as futures – commodities, currencies, bonds, financial instruments etc.

Because every futures contract represents a large amount of underlying asset, there is always a high value hidden behind. E.g. one contract of corn represents 5 000 bushels of corn, one contract of Japanese Yen represents 125 000 Japanese Yen, one contract of gold represents 33 Troy Oz of gold, etc. Such amounts of commodities have high value of its own and normally, they would require large sums of money to buy them at full price. The instrument of margin was introduced in order to allow small speculators participate on trades and improve the volume (number of ongoing trades) and liquidity of the market.

The margin is a deposit of money required by the brokerage firms when trading the contract. According to [5]: “All futures are traded on margin, which is usually less than 10% of value of the contract. The result of these low margin requirements is tremendous leverage. Relatively small price moves in either direction tend to become magnified in their impact on overall trading results. For this reason, it is possible to make or lose large sums of money very quickly in futures. Because trader puts up only 10% of the value of the contract as margin, the a 10% move in either direction will either double the trader’s money or wipe it out. By magnifying the impact of even minor market moves, the high leverage factor sometimes makes the futures markets seem more volatile than they actually are.”

The notion of leverage is explained in following part.

### 2.4 Leverage Effect

Leverage effect is a phenomenon always present in futures trading. Notion of leverage is closely related to margins. Let us consider two cases – trade without leverage and with leverage, shown at the Fig. 3.

![Leverage effect](image)

**Fig. 3: Leverage effect**

At the Fig. 3, there are two situations (A) and (B). In both cases we assume profit of 20%. In the case (A), we use standard purchase method, funding full value of the contract from our trading account. The expected profit is $20,000 and we need amount of $100,000 to perform this trade. In the case (B), we use leverage effect. As it was said in part 2.3, common value of margin is usually less than 10% value of the contract, therefore we will use 10% margin in this example. To obtain a contract in value of $200,000, it would require 10% of its value.
$20,000 margin will allow us to trade with $200,000 contract. The expected profit is $40,000 and we needed only $20,000 to perform this trade. Both profit and loss are multiplied by the leverage effect, which makes futures trading risky and potentially profitable at the same time.

[2] presents a following example of leverage effect, which we will use for further explanation and better understanding.

“Consider the case of an investor with $50,000 allocated to futures trading. If the price of soybeans is $6.00 per bushel and silver is $7.00 per ounce, a 5,000 bushel contract of soybeans is worth $30,000 and 5,000 ounce contract of silver is valued at $35,000. With no leverage, the investor could only purchase one contract. Let us assume that, because of fundamental reasons, the investor believes that soybean prices will move to $8 per bushel and silver to $11 per ounce within the next 6 months. If correct, the gross return on investment will be 33% for soybeans and 57% for silver, equivalent to a 20% and 40% return on $50,000 respectively. With no leverage effect and not enough money to invest in both, the choice must be silver which has the highest return; in neither case could there be any risk of ruin. In both cases there would be excess risk capital.

But 100% capitalization is hardly necessary. Even the most conservative investor would agree that the price of either commodity would not drop to 30% of the current value; therefore, there is no significant risk in funding the investment at 70%, rather than 100%, of the contract values. By reducing the individual commitments, the investor can then purchase both silver and soybeans, thus adding diversification and a much higher return on the investment. As the investment is reduced and leverage increased, both risk and return get rapidly larger.”

2.5 Risk Management

In previous two sections, margins and leverage effect were described in detail. The leverage effect multiplies both profit and loss of every trade in futures. It is therefore important to reduce the risk to minimum. The set of measures used to contain the risk at acceptable level is referred to as risk management (or money management, depending on author).

The ever present negative aspect of trading is presence of losses. Due to the stochastic nature of market environments, losses are inevitable. There are two main goals every (automated) trading system or strategy would need to accomplish in order to be used and accepted by traders:

- Ensure long-term survival in market.
- Generate profit.

The problem of generating profit is beyond scope of this text and we would simply assume our system is able to make profit. What we will focus on now is the long-term survival issues. In futures trading, we are in mathematical disadvantage. Every trade requires expenses in the means of slippage and broker commission fees [9]. Therefore, the better strategy is to trade less often and wait for the more profitable opportunities [4]. Such opportunities, supported by indicator signals, will generally occur less frequently. It is always necessary to have our trading decision based on evidence of indicator signals. Emotional trading is equal to gambling.

Since we are considering futures trading from the perspective of small, individual trader, the amount of money is always limited. Small losses of money are inevitable and we need to eliminate the risk of great losses by accepting lost of small amount of money only. It is a psychologically difficult thing to close the position because of the hope that the trend will reverse and loss would be turn into the profit. Use of ATS would allow us to avoid such moments for all the instructions will be followed automatically. In order to survive series of losses the rule of investing only a small portion of portfolio is implemented, i.e. 2-4% of account size spent on single trade, percentage depending on volatility of market. In case of 4% rate, a series of 25 unsuccessful trades would be required in order to force trader to stop trading, which is highly improbable, provided we have backtested, verified trading system.

3 Single ATS Agent Perspective

In the previous part of the text were presented some basic tools an agent (ATS) is using to recognize its environment. Basically, we have mechanisms shown at the Fig. 4 and Fig. 5, which can be used to percept (Fig. 4) or manipulate/interact (Fig. 5) the market environment.

![Fig. 4: Agent inputs](image-url)
Both sets of tools represent only an example of trading agent functions and it is possible there would be other tools implemented in real situation. However, the shown inputs and actions will be present in most cases.

The ATS is generally following sequence of steps shown at the Fig. 6. Numbers on the right side of the figure are used to distinguish pre-trade activities and course of trading itself.

![Fig. 6: Standard sequence of an ATS functioning](image)

**3.1 Preparation Phase**

In this phase, an ATS agent is created and placed on the appropriate market. No single ATS can cover all the business opportunities present in the market. It is important to stress the fact that every ATS is an implementation of a single trading strategy – single idea how to create profit on the market. Such ATS is using respective set of indicators to identify its trade opportunities. Certain combinations of indicators can provide contradictory signals, e.g. trend following indicators vs. anti-trend indicators. It is possible to make profit on trend-following strategies, anti-trend strategies, etc. but not on all such approaches at the same time. This fact alone determines ATS agents as narrowly specialized agents.

When an ATS is implemented, testing phase is taking place. Backtesting (as is such process of extensive testing called) is based on experiments on both historical and real data [2]. This gives a mathematical evidence of success probability and profitability of given strategy and build confidence of trader vs. system. However, it is important to mention that testing should be performed on real trades too (through trading with small amounts of money) for some limited time. It is not uncommon that backtested strategy which worked well on historical data failed in real market.

Funds allocation step is required before agent could start trading. Funds in futures trading agents can be compared to batteries in their hardware counterparts. Without appropriate amount of money, agent functionality is degrading to a level when it cannot perform its function properly. The level of allocated funds should be monitored during trading continuously, because unsuccessful trades cannot be avoided and may occur in sequence of several bad trades.

Market selection step is a moment where either user (in case of low level autonomy) or agent itself assigns appropriate market to the trading agent. There are several key factors to be considered – volatility rate (affects risk), volume, liquidity, etc. The business plan is usually designed for certain environment. However, there are configurations where multiple commodities could be traded with the same strategy at several markets.

**3.2 Evaluation phase**

This phase plays key role for the profitability of the whole system. Generally, there are two strategies that can be followed in trading:

- Less profitable trades with more frequent appearance (A)
- More profitable trades with less frequent appearance (B)

Trading is not a zero-sum game [9] as there always is some transaction cost involved. Broker fees, slippage and margins creates together price barrier that must be exceeded by gained profit, otherwise even a successful trade would be unprofitable. For this reason, a strategy designated as (B) is better.

The frequency of trades is closely connected to the instruments used for its identification. More profitable
trades are usually confirmed by more than one indicator at the moment. The correspondence of more indicator signals at the same time occurs less frequently. In some extreme cases, strategies with only a handful of trades per year could be found.

When a trade opportunity is identified, risk assessment should be done. The strength of signal (opportunity) is reflected by the risk-reward-ratio (RRR). It is generally recommended to be at least 1:3 (invested amount of funds should generate at least triple of its value in case of success) because of transaction costs and risk present. Depending on the strength of signal, size of the position - which is to be opened - should be set.

3.3 Active Trade Phase
This phase is related to the opened position of the trade. Based on the analysis done in the previous phase, the business order is placed together with according stop/loss orders to prevent major loss of money.

Position management is used for position sizing techniques and, thus, maximization of profit. Also, it is possible to trade in multiple units, see [5, pp. 398]. This will increase flexibility and provide better results.

Exiting of trade (i.e. closing position) is more important than entering trade (opening position). The bad entry can be improved by good closing of the trade. On the other hand, bad timing in trade closing cannot be improved by any subsequent action.

3.4 Trading cycle
Steps of the both evaluation and active trading phases (see Fig. 6) are done in loop. In intraday trading (all trades are executed and closed in single trading day), there is an advantage of seeing clear results at the end of each day. This could help in assessing the agent performance and adjust its parameters.

The amount of funds allocated for trading is limiting agent’s ability to trade. These funds are used for paying transaction costs (broker fees, slippage and commissions) and margins.

4 Summary and Future Work
The futures trading agent is strongly influenced by the market environment in both functionality and decision making operations. The functionality is limited by amount of funds provided by the user for trading and rules of risk management. Decision making is influenced by the backtesting results, involved risk and actual situation (trend reversal, chopping, etc.). There are two main goals of any ATS: (a) to ensure long-term survivability of the trader in the market environment; (b) to be profitable. Importance of both goals is determined by its sequencing in previous sentence.

In the previous part, the single ATS agent perspective was used to describe problems of ATS in the market. This is only one point of view at the whole problem. Successful design of such system could be very useful (providing it is accepted by user, see [4]) in the long-term run, but if we would consider even higher level of autonomy given by the user, a multi-agent system could be used. In such system, cooperation between several trading agents would be ensured by special coordinating agent. This coordinator will be covering steps -1 to 1 from the Fig. 6 for others agents, based on their previous profitability and convenience for the given type of market(s).

Study of such multi-agent futures trading system will be the focus of future work and experiments.

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References: