IDEA GROUP PUBLISHING

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ITP4497

A Comparative Assessment of the Costs, Benefits and Risks of Tracking Stock Prices with Intelligent Agents as Compared to Traditional Investing

Patrick Doran, Hawaii Pacific University, 1188 Fort Street, Suite 324, Honolulu, HI 96813, (808) 544-1174, (808) 544-9306 (fax), pdoran@hpu.edu

M. Khristian McAlister, School of Business, University of Alabama at Birmingham
Birmingham, AL 35294-1150, (205) 934-8820, (205) 975-4429 (fax), kmcal@uab.edu

James Floody, Hawaii Pacific University, 1188 Fort Street, Suite 324
Honolulu, HI 96813, (808) 544-1174, (808) 544-9306 (fax)

ABSTRACT

This research examines investor's perceptions of the costs, benefits and risks of using intelligent agents for trading on-line. Telephone interviews were conducted with potential investors. Results show support for the use of intelligent agents due to perceived lower costs, increased benefits, and reduced risks for some classes of investors.

INTRODUCTION

Every player in the financial market (fund managers, brokers, bank analysts, investors, merchant banks, etc.) has one goal: maximize their investment by buying and selling securities at the right time (Costantino, Collingham and Morgan, 1996). Market players have access to vast information stores provided by on-line news agencies, historical archives, government agencies and private organizations that collect, analyze process and distribute information. With the movement of this information to the Internet, the cost of access to this information is decreasing rapidly, making it accessible to small or private investors (Costantino, et al., 1996). A new problem has emerged with the abundance of information on the Internet—the need to locate, evaluate, and react to the information as it becomes available.

The number of investors using the Internet to manage their investments is growing rapidly. The number of online investing accounts is expected to grow from 1.5 million today to 10 million by 2001 (Gomez, Weisman, and Trevino, 1996). This market is estimated to represent 17% of wired households in 2001. There were 12 investment companies doing business on the Internet in 1995; currently, there are more than 56 (Blumberg, 1998). This dramatic shift in the way investors evaluate and compare investment options will have a long-term impact in the securities markets. The revenue per trade to the brokerage house is lower with Internet trading, but the increased usage and lower operating cost make the Internet trades highly profitable (Schifrin, 1997). The change in the means of investing poses new opportunities for the investor and the brokerage houses.

Players in the financial market are increasingly implementing Internet brokerage services (Gomez, Weisman and Trevino, 1996). Intelligent agents, an implementation of artificial intelligence, provide the tools to efficiently and effectively track information. Intelligent agents use fuzzy logic and neural networks to autonomously refine themselves, adapting and "learning" the users needs (Jennings and Wooldridge, 1998). An intelligent agent can be defined as a software entity which functions continuously and autonomously in a particular environment, often inhabited by other agents and processes (Shoham, 1997). The requirement for continuity and autonomy is derived from our requirement that the agent be able to carry out its activities in a flexible and intelligent manner without requiring constant human intervention (Bradshaw, 1997). Intelligent agents are known on the Internet by aliases such as robots, hotbots, personal agents, software agents, worms or spiders (Leonard, 1996). This research will explore the phenomenon of intelligent agents through examination of the perceived costs, benefits and risks to individual investors.

INTELLIGENT AGENTS

Jennings and Wooldridge (1995) describe intelligent agents as a computer system situated in some environment and capable of autonomous action in that environment to meet its design objectives. An autonomous system needs to be able to react without direct intervention of humans or other agents. Autonomous systems are not a new development. Controllers in nuclear reactors are autonomous in that they must react in real-time.

Bradshaw (1997) defines an intelligent agent as a software entity which functions continuously and autonomously in a particular environment, often inhabited by other agents and processes. The requirement for a continuity and autonomy is derived from the desire to have the agent carry out its activities in a flexible and intelligent manner without constant human intervention. The agent functioning continuously for a long period of time would be able to learn from its experience. The presence of other agents and processes allows for communication and cooperation.

The importance of the agent's ability to act independently is critical to the investor. The investor may have the agent searching for information on a given company or the company's industry. The agent may monitor news sources for relevant information on

This paper appears in *Challenges of Information Technology Management in the 21st Century*, the proceedings of the Information Resources Management Association International Conference.

other stock exchanges, SEC, news sources or possibly the company's Web site. Any information discovered is returned to the investor. The investor reviews the information and reacts to it. As the investor responds or reacts to the news, the agent "learns" from the investor's behavior.

If the investor reacts or responds to the news, the relative importance of the relationship is reinforced. If the investor does not react to the news, the relative importance of the relationship diminishes. By this means, the intelligent agent is capable of "learning" investor preferences and refining the search techniques utilized. Over time, the agent becomes more experienced, gradually building a relationship of understanding and trust with the investor (Bradshaw, 1997).

The agent develops its competence from four sources. The agent is constantly monitoring the actions taken by the user. As the agent monitors and tracks the actions of the user for extended periods of time, the agent can identify regularities and recurring patterns of actions and offer to automate these tasks. A second source is direct and indirect feedback. Indirect feedback would occur if the user ignores suggestions offered by the agent or if the user takes a different action instead. The user can give explicit, direct negative feedback for actions automated by the agent. The third source is the direct training of the agent. The user may instruct the agent to act by creating an example and telling the agent what to do in a given situation. The fourth source of training is for the agent to ask advice from other agents that assist other users with the same task (assuming the other agents have built up more experience). The agent may then present the situation for the user, with the recommendation from the other agents. The acceptance or rejection of the suggestion then helps to educate the agent on how to handle, or how not to handle, similar events in the future (Maes, 1997).

The use of intelligent agents to track stock prices requires the trust of the investor and the development of the competency of the intelligent agent. The greater the length of time the investor has been using intelligent agents to track stock prices, news sources, and the other information needs of the investor, the higher the level of trust the investor will have in the use of the intelligent agent.

COSTS

There are a variety of costs that investors may incur, both tangible and intangible. Tangible costs include fees, commissions and other charges paid directly by investors, regardless of the investment approach. Intangible costs include the potential loss of revenue for delayed reaction to market changes and incomplete information needed to make a decision. This research is focused on the tangible costs incurred by the investor.

A survey by Blumberg (1998) of 56 on-line brokerage firms shows the current trend in on-line investing costs. The commissions charged by the on-line brokers average $18.85 per trade. Some of the brokers charge for real-time stock quotes. The fees for the real-time stock quotes range from $20 per month, for a limited number of quotes, to $300 per month for an unlimited number of quotes. Most brokers offer free stock quotes, with a 15 minute delay. Some brokers do not require a minimum balance while others require as much as $10,000. The interest paid on cash balances may vary from broker to broker.

The traditional stockbroker earns commissions on shares traded. The commissions charged vary with the brokerage house. Discount brokers have grown in popularity. Charles Schwab, a discount broker, charges commissions of $30 plus 1.77% for a traditional trade, where the value of the trade is below $2500 (Schwab, 1998). The costs of trading has been measured in actual, direct costs (Blumberg, 1998) and by the simple category scale of "more profitable or less profitable" (Lim, 1997). This research will measure the cost associated with a trade by asking for the actual average cost charged (integer value). Discounts associated with the size of a trade will not be considered.

The first hypothesis (H1) to be tested is that there will be a significant decrease in costs for investors who use intelligent agents to track stocks compared to investors who use full-service brokers. It is evident that some investors will choose to invest both via brokers and through online investing. The second hypothesis (H2) will propose that there will be a significant decrease in costs for investors who exclusively use intelligent agents to track stocks compared to investors who exclusively use full-service brokers.

BENEFITS

The selection of how to trade stock is a personal decision. The benefits from each of the trading options are flavored by personal perception. A feature could a benefit to one investor may be a detriment to another.

Gomez, Weisman and Trevino, (1996) found that some benefits for on-line investors include low cost and personalization. Brokerage houses charge lower fees and commissions to investors trading on-line than they do to investors trading with brokers. The on-line investor prefers the personalization of customizing the information that they receive from the brokerage houses. This personalization allows the investor to maintain a profile of items of interest for them.

On-line investors benefit by more timely access to news sources. The on-line investor may have regular updates from personally selected new sources sent to them regularly. The on-line investor can research both company and industry information online. The on-line investor can check government SEC filing online. The use of intelligent agents to gather and filter information for the investor presents an enticement to the on-line investor.

The traditional investor has the benefit of advice and counsel of the stockbroker. The broker may be able to provide additional insight as to market trends or industry events of which the investor may not otherwise been aware. The prudent investor will verify sources of information related to any stock tips from the investor. The third hypothesis (H3) proposes that there will be a statistically significant increase in perceived benefits for investors who use intelligent agents to track stocks compared to investors who use full service brokers. The fourth hypothesis (H4) will propose that there will be a statistically significant decrease in benefits for investors who exclusively use intelligent agents to track stocks compared to investors who exclusively use full-service brokers.

RISKS

Risks related to the means of investment include trust, security, reliability, accuracy and ease of use. The act of disclosing personal or financial information to an on-line brokerage firm can initially be unsettling. As the investor gains familiarity with the on-line brokerage service, the comfort level will increase. On-line investors are more likely to be experienced with using the Internet, and aware of the expected security measures and etiquette of the Internet. The on-line investor is likely to have already developed a sufficient level of trust in using the Internet.

The security of investing or performing other transactions via the Internet is of concern to the on-line investor. Reputable companies have implemented sufficient security measures to ensure the integrity and safety of information while it is in transit,

and to safeguard account information stored on the brokerage house computers. The possibility of an Internet-based attack on the brokerage house is a possible threat. The brokerage house assumes the risk in such an attack, but the investor may be temporarily unable to gain access to the system to execute trades. This "denial of service" may cost the investor by the lost opportunity to buy or sell stocks.

The risk of reliability includes the accuracy and reliability of information sources selected by the investor. The investor must consider the source of information before basing a decision upon that information. Use of the major news feeds, company Web sites, government entities and other similar, qualified sources should be the primary information sources used by the investor. The investor researching through Usenet or other similar sources must consider the source of the information in deciding the value of the information.

The on-line investor will consider the ease of use or "user friendliness" of the Web of the brokers Web site. The brokerage house's reputation and the ease of use factor and can be dominant factors in the selection of the brokerage house. The ability of the investor to tailor the content when entering the brokerage house's Web site to information they are interested in is important to maintaining the investor as a client.

Trippi and Lee (1996) state that risk means different things to different market participants. The rational investor is assumed to be risk adverse. In assessing risks, the intelligent agent is expected to correctly predict an output from input not contained in the set of data on which the agent was trained.

The fifth hypothesis (H5) proposes that there will be a statistically significant decrease in perceived risk for investors who use intelligent agents to track stocks compared to investors who use full-service brokers. The sixth hypothesis (H6) proposes that there will be a statistically significant decrease in perceived risk for investors who exclusively use intelligent agents to track stocks compared to investors who exclusively use full-service brokers.

METHODOLOGY

A survey instrument was developed and administered using telephone interviews with 512 randomly sampled households in the state of Hawaii. A computerized random digit generator was used to generate the survey sample. There were 352 homes contacted on the island of Oahu, 77 from the island of Hawaii (Big Island), 53 from Maui and 30 from Kauai. Twenty percent of the 512 households made investments in the stock market over the last year. The reported income from the households leaned toward the lower end of the scale with 237 households reporting income of $50,000 or less, 80 households reporting income as $50,000 to 75,000 and 67 households reporting income of $75,000 or more. The gender of the respondents was 247 male and 265 female.

Access to the Internet from the location where investment decisions are made was considered as a potential factor in the use of intelligent agents. Forty-three percent of the investors reported having access to the Internet from the location where the majority of investments are made. The number of hours spent on the Internet was a potential factor in using intelligent agents. Thirty-three percent reported spending between five and ten hours per week on the Internet. Forty-three percent reported spending ten or more hours per week on the Internet. Thirty-five percent of investors reporting using the Internet often or very often for researching stocks. Real-time quotes were used often or very often by 22% and delayed quotes were used often or very often by 24% of the investors.

RESULTS

Hypothesis Set One – Fees

Fees - All Data

The first hypothesis was that there would be a statistically significant perceived decrease in costs for investors who use intelligent agents (IA) to track stocks compared to investors who use full service brokers (F). The test is stated as:

$H1_0$: $XBAR_F < XBAR_{IA}$

$H1_A$: $XBAR_F > XBAR_{IA}$

where $XBAR_F$ represents the average fee for investors utilizing a full-service broker and $XBAR_{IA}$ represents the average fee for investors using intelligent agents. At the 5% level of significance, this hypothesis could not be accepted (Z = -1.3190, p = 0.0936). There was no significant decrease in perceived costs for investors using intelligent agents as opposed to those using full-service brokers.

Table 1 Results of Z-test for hypothesis 1

	Intelligent Agents	Full-Service
Mean	60.9333	77.7111
Known Variance	2417.1646	3655.0300
Observations	30	45
Hypothesized Mean Difference	0	
z	-1.3190	
P(Z<=z) one-tail	0.0936	
z Critical one-tail	-1.6448	

Fees - Mutually Exclusive

The same test was applied to the data with the investors who identified themselves as using both full-service brokers and intelligent agents excluded. This exclusion reduces the sample size, resulting in the use of the t-test rather than the Z-test. The hypothesis is stated as:

$H2_0$: $XBAR_F < XBAR_{IA}$

$H2_A$: $XBAR_F > XBAR_{IA}$

where $XBAR_F$ represents the average fee for investors utilizing a full-service broker and $XBAR_{IA}$ represents the average fee for investors using intelligent agents. At the 5% level of significance, this hypothesis was accepted (t = -3.3928, p = 0.0008). There was a significant decrease in perceived costs for investors using intelligent agents as opposed to those using full-service brokers.

Table 2 Results of t-test for hypothesis 2

	Intelligent Agents	Full-Service
Mean	32.3846	74.6429
Known Variance	1473.0897	1334.6825
Observations	13	28
Hypothesized Mean Difference	0	
t	-3.3928	
P(T<=t) one-tail	0.0008	
t Critical one-tail	-1.6840	

Hypothesis Set Two – Benefits

Benefits – All Data

The third hypothesis was that there will be a significant increase in benefits for investors who use intelligent agents to track stocks compared to investors who use full service brokers. The

hypothesis is stated as:

$H3_0$: $XBAR_F > XBAR_{IA}$

$H3_A$: $XBAR_F < XBAR_{IA}$

where $XBAR_F$ represents the perceived benefits for investors utilizing a full-service broker and $XBAR_{IA}$ represents the perceived benefits for investors using intelligent agents. At the 5% level of significance, this hypothesis was accepted (Z = 1.7989, p = 0.0360). There was a significant increase in benefits for investors who use intelligent agents to track stocks compared to investors who use full service brokers.

Table 3 Results of Z-test for hypothesis 3

	Intelligent Agents	Full-Service
Mean	2.2899	1.9989
Known Variance	0.5171	0.4705
Observations	32	47
Hypothesized Mean Difference	0	
z	1.7989	
P(Z<=z) one-tail	0.0360	
z Critical one-tail	1.6445	

Benefits - Mutually Exclusive

The same test was applied to the data with the investors who identified themselves as using both full-service brokers and intelligent agents excluded. This exclusion reduces the sample size resulting in use of the t-test rather than a z-test. The hypothesis is stated as:

$H4_0$: $XBAR_F > XBAR_{IA}$

$H4_A$: $XBAR_F < XBAR_{IA}$

where $XBAR_F$ represents the perceived benefits for investors utilizing a full-service broker and $XBAR_{IA}$ represents the perceived benefits for investors using intelligent agents. At the 5% level of significance, this hypothesis was accepted (t = 2.125, p = 0.0199). There was a significant increase in benefits for investors who use intelligent agents to track stocks compared to investors who use full service brokers.

Table 4 Results of t-test for hypothesis 4

	Intelligent Agents	Full-Service
Mean	2.1441	1.7337
Known Variance	0.4874	0.2614
Observations	13	28
Hypothesized Mean Difference	0	
t	2.1253	
P(T<=t) one-tail	0.0199	
t Critical one-tail	1.6840	

Hypothesis Set Three – Risks

Risks - All Data

The fifth hypothesis was that there will be a statistically significant decrease in risks for investors who use intelligent agents to track stocks compared to investors who use full service brokers. The hypothesis can be stated as:

$H5_0$: $XBAR_F < XBAR_{IA}$

$H5_A$: $XBAR_F > XBAR_{IA}$

where $XBAR_F$ represents the perceived risk for investors utilizing a full-service broker and $XBAR_{IA}$ represents the perceived risk for investors using intelligent agents. At the 5% level of significance, this hypothesis was accepted (Z = 3.5944, p = 0.0001). There was a significant decrease in risks for investors who use intelligent agents to track stocks compared to investors who use full service brokers.

Table 5 Results of Z-test for hypothesis 5

	Intelligent Agents	Full Service
Mean	2.7000	1.9989
Known Variance	0.4705	1.0968
Observations	32	47
Hypothesized Mean Difference	0	
z	3.5944	
P(Z<=z) one-tail	0.0001	
z Critical one-tail	1.6448	

Risks - Mutually Exclusive

The same test was applied to the data with the investors who identified themselves as using both full-service brokers and intelligent agents excluded. This exclusion reduces the sample size, which may introduce its own discrepancies. The hypothesis can be stated as:

$H6_0$: $XBAR_F < XBAR_{IA}$

$H6_A$: $XBAR_F > XBAR_{IA}$

where $XBAR_F$ represents the perceived risk for investors utilizing a full-service broker and $XBAR_{IA}$ represents the perceived risk for investors using intelligent agents. At the 5% level of significance, this hypothesis was accepted (t = 3.2552, p = 0.0012). There is a significant decrease in risks for investors who use intelligent agents to track stocks compared to investors who use full service brokers.

Table 6 Results of t-test for hypothesis 6

	Intelligent Agents	Full Service
Mean	2.5846	1.7337
Known Variance	1.3831	0.2615
Observations	13	28
Hypothesized Mean Difference	0	
t	3.2552	
P(T<=t) one-tail	0.0012	
t Critical one-tail	1.6480	

SUMMARY

The statistical tests run on the data collected show the investor using intelligent have a perceived reduction in costs, increase in benefits and reduction in risks when compared to investors utilizing full-service brokers.

CONCLUSIONS

Several changes may improve the results of the study. Increasing the sample size will provide for a better analysis. The sample may be increased in geographic scope. This study was restricted to investors who reside in the state of Hawaii. Expanding to an international level will improve this research. The international investor must consider additional factors including exchange rates, political stability, foreign governments and more. The complexity added to the international investment decision process is significant.

Increasing the number of questions that are asked for each hypothesis might improve the results. Costs, benefits and risks are very dependent on personal perceptions. More questions in each of these areas may allow for a more in-depth analysis of the investors perceptions.

Developing other means of segregating the investor type should be considered in future research. The number of investors utilizing both full-service brokers and intelligent agents was more significant than was anticipated. Identifying and segregating investors who use discount brokers and other means of investing should be considered.

PREDICTIONS

Predictions for the growth of intelligent agents are rosy. The growth of the Internet has made available a wealth of information for those able to locate, filter, validate and process it. With the information available, the means to manage it become more critical. Intelligent agents, a form of artificial intelligence, are one method of managing information. Other forms of artificial intelligence are being developed, but intelligent agents have the ability to refine their behavior to the needs of the user; an important consideration in the financial arena. The uses of intelligent agents are growing in many areas, not only in the financial sector. In addition, the use of intelligent agents will continue to grow in all areas of information management.

The use of intelligent agents will grow in other markets. The use of technology to identify a price differential will present an opportunity to the entrepreneur. The ability to exploit differences in price in different markets will create an opportunity for those trading on the margin.

The currency market is another potential use of intelligent agents. Intelligent agents can be effective in identifying different currency prices on different exchanges. Intelligent agents may be used to execute trades in the currency market based rules developed by the investor. The agent may inform the investor of price differences or may actually make the trade on behalf of the investor.

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