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MONTEREY, CALIFORNIA

THESIS

PUTTING A PRICE ON STRATEGY: IMPLEMENTING A PREDICTION MARKET IN A MODERN MILITARY UNIT

by

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June 2012

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Prediction markets are speculative markets created for aggregating relevant information on some measurable future event. Simply put, prediction markets ask participants to trade ideas as stocks. The "market price" of a particular idea or contract can then be interpreted as the probability that an event will occur, or as a feedback mechanism regarding how well some course of action is working. The application and utility of prediction markets to military strategy and decision-making has yet to be adequately tested in any real or empirical way. This thesis seeks to understand the conditions under which the application of a prediction market would be both successful and useful to military commanders. To test this, markets were established with three different organizations and included more than 135 participants. Upon the closing of the markets, results and participant surveys were analyzed. The data collected indicate that such a tool could be quite useful if employed and illuminate a variety of challenges that must be addressed in order to implement a prediction market in a military unit.

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PUTTING A PRICE ON STRATEGY: IMPLEMENTING A PREDICTION MARKET IN A MODERN MILITARY UNIT

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ABSTRACT

Prediction markets are speculative markets created for aggregating relevant information on some measurable future event. Simply put, prediction markets ask participants to trade ideas as stocks. The “market price” of a particular idea or contract can then be interpreted as the probability that an event will occur, or as a feedback mechanism regarding how well some course of action is working. The application and utility of prediction markets to military strategy and decision-making has yet to be adequately tested in any real or empirical way. This thesis seeks to understand the conditions under which the application of a prediction market would be both successful and useful to military commanders. To test this, markets were established with three different organizations and included more than 135 participants. Upon the closing of the markets, results and participant surveys were analyzed. The data collected indicate that such a tool could be quite useful if employed and illuminate a variety of challenges that must be addressed in order to implement a prediction market in a military unit.

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LIST OF ACRONYMS AND ABBREVIATIONS

ACE	Aggregating Contingent Estimation
CDA	Continuous Double Auction
DARPA	Defense Advanced Research Projects Agency
DNI	Director of National Intelligence
FWE	Forecasting World Events
IARPA	Intelligence Advanced Research Projects Agency
IEM	Iowa Electronic Market
JIFX	Joint-Interagency Field Experimentation
MAGTF	Marine Air-Ground Task Force
MCIA	Marine Corps Intelligence Activity
MEF	Marine Expeditionary Force
MSR	Market Scoring Rules
MTH	Marginal Trader Hypothesis
PAM	Policy Analysis Market
PIR	Priority Intelligence Requirement
RELIEF	Research and Experimentation for Local and International Emergency and First Responders
SOF	Special Operations Forces
TSOA	Technical Support and Operational Analysis Activity

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I. INTRODUCTION

In 1968, the *USS Scorpion* (SSN-589), a Skipjack-class nuclear submarine was lost at sea while crossing the Atlantic on the way to her homeport of Norfolk, VA. The Navy's initial search and rescue efforts were fruitless, as they conducted an unproductive search westward from the last known location of the *Scorpion*. It was not until many weeks later that Dr. John Craven, a scientist in the Navy's Special Project Division, was brought in to help. Craven's theory was that the *Scorpion* had been lost due to a catastrophic failure caused by a "hot running torpedo." He posited that the crew of the *Scorpion* likely turned the vessel 180 degrees (heading eastward) in an attempt to disarm the weapon.[1]

Craven reached his conclusion by aggregating the opinions of submarine and salvage experts regarding both the fate and location of the *Scorpion*, asking them to place bets on a map of the sea floor. The map was covered in gridded squares that contained the likely probability of the submarine's location according to Craven's calculations. In order to provide incentive (a crucial aspect of determining the actual interest of the individual) the participants bet bottles of Chivas Regal.[2] Despite Craven's confidence in his prediction, the Navy continued to search westward. It was not until October, after the Navy had nearly called off the search and Craven lobbied for an additional two weeks to search eastward, that the *Scorpion* was found—within 220 yards of where Craven and his team predicted. Craven's method, in effect, was a crude version of a prediction market.

The United States Military of 2012 stands in stark contrast to the same force of 40 years ago. Equipment is more technologically advanced, the service members are better protected and training is more extensive. Perhaps in no other area is this difference more pronounced than in the arena of intelligence

[1] Sherry Sontag, Christopher Drew, and Annette Lawrence Drew, *Blind Man's Bluff: The Untold Story of American Submarine Espionage* (New York: Public Affairs, 1998), 99.

[2] Sontag, Drew, and Drew, *Blind Man's Bluff*, 104.

analysis and information management.[3] While the components of our intelligence and information systems have progressed, the fundamental issue of effective information aggregation that faced Dr. Craven during his search for the USS *Scorpion* remains.

Current operations conducted by the U.S. military, regardless of theater, are not faced with a dearth of intelligence and information, but rather with an abundance of it. According to Major General Michael T. Flynn, "There are literally terabytes of unclassified and classified information typed up at the grassroots level."[4] The result of this dilemma is not a problem of information availability, but of information aggregation**.** CIA analyst Puong Fei Yeh summarizes the issue when he asks "*How do you aggregate, in a timely way, disparate pieces of information that are spread among and within 15 U.S. intelligence agencies into relevant products?"*[5]

Put another way one might ask, *"What is the modern day equivalent of betting a bottle of scotch?"* We posit that the answer lies in prediction markets.

A. BACKGROUND AND PURPOSE

In effect, Craven's process amounted to a non-electronic prediction market, drawing on the knowledge of others and aggregating the information to postulate a probability of success. Prediction markets are speculative markets created for the purposes of aggregating relevant information on some measurable future event; in short, prediction markets ask participants to trade ideas as stocks. The "market price" of a particular idea or contract can then be

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[3] John C. Gannon, "Managing Analysis in the Information Age," in *Analyzing Intelligence: Origins, Obstacles, and Innovations*, eds. Roger Z. George and James B. Bruce (Washington, DC: Georgetown University Press, 2008), 214.

[4] Michael Flynn, Matt Pottinger, and Paul Batchelor, "Fixing Intel," CNAS.org, accessed May 10, 2012, www.cnas.org/files/documents/publications/AfghanIntel_Flynn_Jan2010_code507_voices.pdf.

[5] Puong Fei Yeh, "Using Prediction Markets to Enhance U.S. Intelligence Capabilities," CIA.gov, accessed May 10, 2012, https://www.cia.gov/library/center-for-the-study-of-intelligence/csi-publications/csi-studies/studies/vol50no4/using-prediction-markets-to-enhance-us-intelligence-capabilities.html.

interpreted as the probability that an event will occur, or as a feedback mechanism regarding how well some course of action is working. Prediction markets have become nearly commonplace forecast tools, used by companies such as Google and Hewlett-Packard, to predict the success of various initiatives and create sales forecasts. Additionally, prediction markets have been used to predict everything from the severity of the flu season in a particular year, to the outcome of presidential elections.[6, 7] To this point, prediction markets have yet to be fully examined in the context of military decision-making. A brief attempt at this was made in 2003 with the creation the Defense Advanced Research Project Agency's (DARPA) Futures Markets Applied to Prediction (FutureMAP) Policy Analysis Market (PAM). Prior to the establishment of this market designed to trade in predictions related to strategic policy and potentially catastrophic events, the project was abruptly cancelled based on ethical and moral concerns raised by some in Congress. As a result, the application and utility of prediction markets to military decision-making has yet to be adequately tested in any real or empirical way.

This thesis seeks to understand the conditions under which prediction markets can be an effective decision-making tool for military commanders or institutions. In keeping with this theme, our research is focused primarily on the concerns of *implementation* rather than questions of accuracy or an in depth deconstruction of market function.

B. RESEARCH QUESTIONS

Among the things we are interested in; several questions naturally rise in importance. Our chief research questions then are:

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[6] Philip M. Polgreen, Forrest D. Nelson, and George R. Neumann, "Use of Prediction Markets to Forecast Infectious Disease Activity," *Clinical Infectious Diseases* 44, no. 2 (2007), accessed April 17, 2012, http://cid.oxfordjournals.org/content/44/2/272.full.pdf+html.

[7] Joyce Berg, Robert Forsythe, Forrest Nelson and Thomas Rietz, "Results From a Dozen Years of Election Futures Markets Research," Ch. 80, 742–751 in *Handbook of Experimental Economics Results*, Vol 1, Part 5, Ed, Charles R. Plott and Vernon l. Smith, Elsevier, accessed April 17, 2012, http://econpapers.repec.org/repec:eee:expchp:5–80.

- What are the features of market design that might encourage participation in/from military units/individuals?
- What market attributes are useful for military decision (prediction) markets (number and type of contracts, length of market)?
- How might a military unit employ prediction markets and what types of units might find prediction markets useful?
- What are the challenges associated with the use of prediction markets in military decision-making?

Through experimentation and interviews, we hope to not only answer these questions, but also to offer a first suggestion for the implementation of prediction markets to serve as an aid to the military decision maker.

C. LITERATURE REVIEW

Despite being relatively new in concept, prediction markets have been the focus of a great deal of research. Broadly speaking, the literature falls into two categories: prediction market theory and empirical study and application. In addition, empirical study can be further segmented into three separate areas of research: accuracy, function, and implementation.

In terms of theory, Friedrich Hayek proposed the notion that markets are perhaps the most efficient aggregators of information. In what has become known as the efficient market hypothesis, Hayek emphasized the importance of what is now known as tacit knowledge. Hayek suggests that decisions based on properly aggregated information are theoretically superior in both substance and efficiency to decisions crafted by experts alone.[8] Cass R. Sunstein who compares conventional group decision-making to prediction markets takes this

[8] Friedrich A. Hayek, "The Use of Knowledge in Society," 1945, Library of Economics and Liberty, accessed April 5, 2012, http://www.econlib.org/library/Essays/hykKnw1.html.

concept even further. His research posits that deliberating groups are vulnerable to a wide range of failures ranging from the amplification of cognitive errors to group polarization.[9]

The prediction market is, at its most basic level, an effort to overcome this type of shortcoming in decision-making. Robin Hanson of George Mason University summarized this notion by saying, "speculative markets are a neglected way to help us find out what people know. Such markets pool the information that is known to diverse individuals into a common resource, and have many advantages over standard institutions for information aggregation, such as news media, peer review, trials, and opinion polls."[10] In his bestselling book, *The Wisdom of Crowds*, author James Surowiecki illustrates the potential advantages of collective intelligence. Offering examples such as the 91% accuracy of the "Ask the Audience" lifeline on the hit TV show *Who Wants to be a Millionaire*, the behavior of the stock market immediately following the explosion of the Challenger space shuttle in 1986, and the Iowa Electronic Market's (IEM) performance in predicting political elections, Surowiecki deftly points out the potential of collective intelligence and prediction markets.[11] In short, prediction markets provide a previously unrealized opportunity to overcome the type of cognitive heuristics and negative group dynamics that plagued the U.S. Navy in their search for the *Scorpion* and naturally occur in many institutions, whether civilian or military.

The application and empirical study of prediction markets has been strikingly deep and robust given its relatively recent appearance on the academic scene. For instance, Berg, Forsythe, Nelson, and Reitz detail the evidence of perhaps one of the best known prediction markets, the Iowa Electronic Market

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[9] Cass R. Sunstein, "Deliberating Groups versus Prediction Markets (or Hayek's Challenge to Habermas)," John M. Olin Law and Economics Working Paper no. 321, The Law School, The University of Chicago, accessed April 17, 2012, http://www.law.uchicago.edu/files/files/321.pdf.

[10] Robin Hanson, "Decision Markets," *IEEE Intelligent Systems Magazine*, May/June 1999, accessed April 5, 2012, http://hanson.gmu.edu/decisionmarkets.pdf.

[11] James Surowiecki, *The Wisdom of the Crowds* (New York: Anchor Books, 2004) 4, 7, 18.

which has not only yielded accurate predictions, but has clearly outperformed conventional polling applications.[12] Pursuing the primary source data even further, University of Pennsylvania Professor Justin Wolfers and Dartmouth Professor Eric Zitewietz detail the extent to which private industry has embraced the technology and the results therein. They analyze the accuracy and design of various markets such as Intrade (Intrade.com) and the Hollywood Stock Exchange (HSX.com).[13] Additionally, the critical design elements of an accurate market are explored in detail. Their conclusions are unequivocal: given proper market construction, application and participation, the accuracy of prediction markets is significant.[14]

As a result of the attractive forecasting potential of prediction markets, there has been no shortage of attempts to use them in a wide variety of contexts and applications. Hospitals have attempted to use them to predict bed space during particularly busy days, while SimExchange (simexchange.com) utilizes them to predict the sales of video games. In this vein, which is to say civilian entrepreneurship, the literature on prediction market implementation is robust in its depth and detail. We feel that prediction market research is incomplete when it comes to the concept of military implementation or strategic decision-making.

This particular gap provides a critical point of departure for prediction market research. To date, there has been no research conducted on the viability of prediction markets within military, or even “military-like” organizations, short of DARPA’s failed PAM project. While there are clear conclusions that can be drawn from the published research with regards to the utility of prediction markets for civilian enterprise, without further research, it cannot be unequivocally stated that these same deductions will apply in a military context.

---

[12] Berg, Forsythe, Nelson and Rietz, “Results from a Dozen Years of Election Futures Markets Research.”

[13] Justin Wolfers and Eric Zitzewitz, “Prediction Markets,” *Journal of Economic Perspective,* 18(2), 2004.

[14] Wolfers and Eric, “Prediction Markets,” 114.

To that end, this thesis seeks to contribute to the existing body of research by employing prediction markets within a range of military organizations and compare the results with what is currently understood and supported about prediction markets in the civilian sector.

D. METHODOLOGY

This research seeks to build on the robust body of knowledge related to the applicability of the prediction market. First, a review of the mechanics of a prediction market was conducted and various constraints and limitations were identified. Secondly, a practical experiment with a prediction market was conducted with three different organizations. We attempted to use this empirical observation to understand how the previously mentioned constraints apply to a prediction market in the context of a military organization. Finally, recommendations on potential utility, market design, and implementation of prediction markets as a decision making tool were provided.

E. CHAPTER OUTLINE

Initially, prediction markets are explained in depth and a brief background of their use is discussed. This explanation is provided to discern and understand how they function and the various components that comprise a market, as well as the advantages and disadvantages for using such a methodology. Additionally, this chapter offers several examples of both historical prediction markets and current applications.

Chapter III details our experiment design and methodology for the three prediction markets that we ran in support of this thesis. As discussed previously, our experimentation focused on the implementation of prediction markets within military organizations and sought to build on previous research that supports the accuracy and functional mechanisms of prediction markets. This chapter also details the units that participated in our study and the rationale for their selection. Finally, we describe and elaborate on the experimental market's framework and the incentive structure for its participants.

The next section outlines our results for each market, including the number and basic demographics of the participants, the average volume of market activity, the number and nature of participant comments, and an overall assessment of the market's success. This chapter also expounds upon areas of potential improvement to the market's design in such a way that future iterations are more effective and illustrative.

Finally, we offer our conclusions and recommendations for further research. Detailed market data and survey data are included in the appendices.

II. BACKGROUND AND PREDICTION MARKET FUNCTION

A prediction market, also known as an "event market" or "information futures market,"[15] is at its most basic level an information aggregator. The conceptual framework for this notion resides in the efficient market hypothesis and the consideration that, "In a truly efficient prediction market, the market price will be the best predictor of the event and no combination of available polls or other information can be used to improve on the market-generated forecasts."[16] This efficiency is a result of rational trading in the market, which in turn is a function of a trader's knowledge base. In short, a rational trader will "put his money where his mouth is" to the extent that his accumulated knowledge allows him to do so. It is also important to note that a market need not consist entirely of rational traders to operate efficiently. An efficient market however does require the rationality of marginal traders, which is based on the Marginal Trader Hypothesis (MTH).[17] In essence, the MTH holds that a small group of active and well-informed traders are responsible for steering market price to efficient levels.[18] These marginal traders serve to explain how potential pitfalls such as market manipulation and uninformed trading can not only be overcome, but are a necessary component of an efficient market. Prior to any further discussion of benefits and limitations however, it is necessary to discuss the actual market mechanics and composition that are necessary for a prediction market to function.

The first requirement is a clearly stated claim that is both exhaustive and exclusive. These claims, or contracts, are a critical basic component to any PM.

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[15] Wolfers and Eric, "Prediction Markets," 108.

[16] Ibid., 108.

[17] Thomas Clay McManus and Calvin Blackwell, "An Exploration of Market Efficiency and the Marginal Trader Hypothesis," *Undergraduate Economic Review*, Vol. 7, Iss. 1, Article 9: 1, accessed May 14, 2012, http://digitalcommons.iwu.edu/cgi/viewcontent.cgi?article=1099&context=uer.

[18] Ibid., 2.

According to Wolfers and Zitzewitz, contracts must be "clear, easily understood, and easily adjudicated."[19] For example, a contract asking traders to bet yes or no on a statement such as "Bashar al-Assad will soon be deposed as President of Syria" is far too ambiguous and conflated, and many traders will likely dismiss it, opting for contracts with an exhaustive list of possibilities and a clearly defined expiration date. However, a contract of this type could be rephrased to include an exhaustive list and a date by which the event is likely to occur, e.g., "Bashar al-Assad to no longer be President of Syria before midnight ET 31 Dec 2012."

The challenges of crafting these contracts is best summarized by examining a contract from the internal prediction market created by Siemens in 1998.[20] In this particular instance the wording of the contract entitled "Can the project be finished in the planned time horizon?"[21] created enormous confusion when the customer of the project in question changed their requested deadline. Without a definitive and pre-defined outcome, the creators of the market were forced to close it, and subsequently re-create it with a newly defined completion date.

In addition to the wording of the contracts, another important attribute is the contract type. Two of the most common types of contracts are winner-take-all and index. In a winner-take-all contract, a contract will cost $p ($0<p<1$) and will pay $1, if and only if a specific event occurs, and $0 if it does not. Assuming a market is risk neutral, meaning that there is neither a preponderance of risk averse or risk inclined participants, this price $p can be interpreted as the mean

[19] Wolfers and Eric, "Prediction Markets," 120.

[20] Gerhard Otner, "Forecasting Markets 'An Industrial Application," March 1998, Draft Working Paper, accessed May 14, 2012, http://ebweb.at/apsm/fmaia2.pdf.

[21] This contract poses issues of clarity beyond the unspecified completion date as well. The terms "project" and "finish" are also fairly ambiguous as they assume that every market participant understands the definition as the market designer intended it. An improved contract would properly define both of these terms as well as provide an unequivocal date, whether driven by the customer or not.

belief of a market that an even will occur.[22] In an index contract, the cost is represented as $y , where y rises and falls as a function of market activity. These types of contracts can be used to predict specific values such as the number of percentage points of the popular vote candidate "X" might receive in an upcoming election; contracts of this type will be settled in accordance with the real value, e.g., a contract estimating 51.5% of the popular vote will pay $51.50.

While payoffs that are made in this manner are the most common and straightforward, they are not the only ones available to market creators. Slamka et al. conclude that there are alternative payoff mechanisms, referred to as second generation payoff mechanisms, that perform nearly as well as the payoff methods mentioned previously.[23] Slamka et al. tested three different mechanisms against the standard "first generation" methods listed above that require an actual outcome. The first was volume weighted average price (VWAP) of a security during a given time period. The second was the last price of a security and a predetermined and publicly known point in time, and the third was the final price at a random point in time. None of these methods require an actual outcome in order to pay off or "resolve" a contract. The demonstration that these payoff methods have demonstrated accuracy commensurate with first generation payoff mechanisms dispels the notion that a prediction market contract must have an actual and verifiable outcome in order to be a viable security in the marketplace. This finding is of enormous significance in that it opens the door to the application of prediction markets to previously unconsidered environments such as evaluating new product ideas or forecasting long-term events.

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[22] Steven Gjerstad, "Risk Aversion, Beliefs, and Prediction Market Equilibrium," (paper presented at the American Economic Association, ASSA Conference, Boston, MA, January 6–8, 2006), accessed May 14, 2012, http://www.aeaweb.org/assa/2006/0106_1015_0701.pdf.

[23] Christian Slamka, Wolfgang Jank, and Bernd Skiera, "Second-Generation Prediction Markets for Information Aggregation: A Comparison of Payoff Mechanisms," 1, July 2009, accessed May 14, 2012, http://www.marketing.uni-frankfurt.de/fileadmin/Publikationen/SecondGeneration Prediction Markets-Slamka-Jank-Skiera_01.pdf.

After a contract (or a series of contracts) has been clearly articulated to the satisfaction of both the creators and participants, an asset and trading market mechanism must be defined in order to facilitate trading. Generally, the two most common assets to be traded are "real" money and "play" money. Because real money trading inside the United States poses a variety of legal barriers, the largest of which are the anti-gambling laws,[24] "play" money is often substituted with only a marginal decline in market accuracy.[25] Once the asset structure is in place, the next critical component is the trading mechanisms.

While there are a variety of trading mechanisms from which to choose, the most prolific among modern prediction markets are the Continuous Double Auction (CDA) and Market Scoring Rules (MSR). In a CDA market, securities are traded via buy and sell orders by individual traders in much the same way that it occurs in a typical financial securities market. One distinct disadvantage of such a mechanism is the size and activity level required to generate property liquidity. Take for example a small CDA market consisting of perhaps only 20 participants. In such a market, the amounts of securities that are available for purchase are a function of the numbers of participants willing to sell, and vice versa. In this case, contract prices can often stall due to inactivity.[26]

To overcome such a disadvantage, the MSR method was developed by George Mason University Economist Robin Hanson in 2003. The MSR is a mathematical algorithm that allows buyers and sellers to purchase or sell some quantity of a contract at any given time.[27] In short, if a market participant views the price/probability of a given contract as too high or too low, they may purchase

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[24] Robin Hanson, "Combinatorial Information Market Design*," Information Systems Frontiers*, 5:1 (2003): 107, accessed May 15, 2012, http://hanson.gmu.edu/combobet.pdf.

[25] Emile Servan-Schreiber, Justin Wolfers, David M. Pennock and Brian Galebach, "Prediction Markets: Does Money Matter?" *Electronic Markets* 14, 3 (2004): 250, accessed May 15, 2012, http://bpp.wharton.upenn.edu/jwolfers/Papers/DoesMoneyMatter.pdf.

[26] Jed D. Christiansen, "Prediction Markets: Practical Experiments in Small Markets and Behaviours Observed," *The Journal of Prediction Markets*1 (2007): 30, accessed May 15, 2012, http://inklingmarkets. com/static/jpm_jedchristiansen.pdf.

[27] Hanson, "Combinatorial Information Market Design*,"* 110.

or sell the contract without the need for a willing buyer or seller as the algorithm fills that void and completes the transaction. In addition to providing an advantage in terms of market function and liquidity, an MSR based market also provides a tertiary benefit in the form of simplicity and ease of use.

Following the establishment of a market framework that includes well-defined contracts and a user-friendly interface, a variety of participatory questions must be addressed. The first of which being, *What is the proper size of an effective market?* To answer this question, Jed Christiansen conducted a series of 39 separate prediction markets consisting of 183 individual traders based on a series of rowing races in the UK and utilizing an MSR algorithm rather than a CDA framework.[28] In his comparison of bands of participation within various markets, Christiansen delineates four groups for evaluation consisting of markets with traders numbering 0–10, 11–15, 16–20 and 20 or more. His findings are as surprising as they are informative. The market size with the most calibrated[29] results is the 16–20 trader range [30] with the "20 or more" only slightly less so, indicating that markets with as few as 16 traders can produce well calibrated results.

The second participatory question that must be answered is: *What incentivizes a trader to participate?* While early research indicated that monetary gain was the most prevalent incentive for trader participation (based largely on the accuracy of the markets trading in actual currency, such as www.intrade.com),[31] Christiansen indicates that community, uniqueness of the event, personal stake, and competition are actually more important. Christiansen is not the only researcher to come to this conclusion. Stefan Luckner, compared and contrasted a number of incentive schemes in his 2006 research regarding

[28] Christiansen, "Prediction Markets," 23.

[29] In this case, the term "calibration" refers to the comparison between market prices (reflective of trader judgment) and actual results of the regattas in question.

[30] Christiansen, "Prediction Markets," 29.

[31] Ibid., 32.

the 2006 FIFA World Cup. His findings were a direct challenge to the notion that traders were motivated solely by financial gain.[32] In point of fact, the incentive scheme that provided the most accurate results was one in which each participant was provided a flat rate payment of 50 euro, refuting the claim that each separate trade must provide a tangible or monetary reward for a market to remain effective.

A. BENEFITS AND DISADVANTAGES

While much of the attraction regarding prediction markets has revolved around the notion of successful forecasting accuracy, they also have key supplementary benefits as well. Dynamic feedback, the potential prevention of cognitive errors, and the increased incentive for follow-on research are aspects of prediction markets that have a great deal of utility. In fairness, however, prediction markets are not without their disadvantages; issues such as contract design and a lack of market participation can cripple a market despite the best of intentions.

1. Benefits

Organizations develop and make use of forecasts or estimates in a variety of ways. Quantitative estimates such as a sales forecast or an estimate of new clients gained in the coming quarter are relatively intuitive to understand and compare to actual outcomes. Determining accuracy therefore becomes a relatively straightforward process of juxtaposing assessments versus reality. On the other hand, qualitative forecasts or estimates are much harder to objectively observe and measure. An example of this sort of estimate might be to measure change in customer service or to change the attitudes of employees. In these examples, the use of a prediction market mechanism might be an effective means of objectively measuring these subjective topics.

[32] Stefan, Luckner, “Prediction Markets: How Do Incentive Schemes Affect Prediction Accuracy?” *Negotiations and Market Engineering*, ed. Nick Jennings and Gregory Kersten and Axel Ockenfels and Christof Weinhardt,(Schloss Dagstuhl, Germany, 2007), accessed May 15, 2012, http://drops. dagstuhl.de/opus/volltexte/2007/1002/.

Another benefit to using prediction markets may be to reduce or prevent cognitive errors common to forecasts and estimates. Many studies have shown that collective intelligence offers better decisions than pure deliberating groups and even acknowledged subject matter experts.[33] Putting subjective assessments such as those that might be seen in the intelligence community or within a commander's priority intelligence requirements (PIR) into a prediction market could provide an objective "buy in" of the organization's employees as to the true accuracy and relevance of such assessments.

Also, the use of prediction markets can provide an incentive to conduct additional research and incentivize the release of revelatory information. Participants trade in the market based on a variety of motivations but regardless of their inherent compunctions it is logical to assume that many traders will be motivated to conduct their own research in order to trade more effectively.[34] This in effect, is integrating additional information that may have been heretofore unknown either to the trader, the market at large, or the organization.

2. Disadvantages

As with any method, prediction markets are no panacea to the forecaster. Prediction market implementation comes with a unique set of challenges ranging from design to administration. Establishing a market is not a free proposition, as time, capital, and credibility must be spent. If an organization is then faced with a significant lack of participation this might serve to highlight some form of internal dysfunction within the organization.

While many prediction markets can be created and ready for use very quickly, a rush to implementation will most likely result in less than desirable market design, accuracy and participation. Crafting contracts that are both thoughtful and well-constructed is difficult, requires uncommon expertise, and involves all major stakeholders within the organization. Overly ambiguous or

[33] Sunstein, Cass R., "Deliberating Groups."

[34] Wolfers and Eric, "Prediction Markets," 121.

overly simplistic contracts are generally uninteresting to the trader and can lead to issues with accuracy and participation. Once the market is established, administrators must be responsive to both trader and market needs while taking care not to unduly influence the behavior of the trader. For the organization that chooses to implement a prediction market, finding the right balance between these issues is paramount to market success.

Generally, and in addition to poor contract design, one of the more destructive problems that prediction markets face is a lack of participation. Employees may be reluctant to participate in a prediction market for any number of reasons and barriers. These barriers, inasmuch as they can be mitigated, should be. A severe lack of participation within a market is significant in that it may highlight other problems inside the organization ranging from an underestimation of an employee's time constraints or an employee's perception that the organization is apathetic about their point of view.

B. MARKET EXAMPLES

Prediction markets have been used by many companies for many reasons. Google used prediction markets to forecast demand for their products and timelines for innovation,[35] Hewlett Packard used markets for sales forecasts,[36] and hospitals have used prediction markets to forecast demand for services (doctors, medicine, beds, etc.).[37] These are but a small sample of the successful use of prediction markets as an information aggregation tool. Notably

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[35] Bo Cowgill, Justin Wolfers, and Eric Zitzewitz, "Using Prediction Markets to Track Information Flows: Evidence from Google," *Auctions Market Mechanisms and Their Applications* 14 (2009): 3–3, accessed May 15, 2012, http://namcub.accela-labs.com/stories/pdf/GooglePredictionMarket Paper.pdf.

[36] Charles R. Plott and Kay-Yut Chen, "Information Aggregation Mechanisms: Concept, Design and Implementation for a Sales Forecasting Problem," *Social Science Working Paper 1131* (2002), accessed May 15, 2012, http://www.hpl.hp.com/personal/Kay-Yut_Chen/paper/ms020408.pdf.

[37] David Rajakovich and Vladimir Vladimirov, "Prediction Markets as a Medical Forecasting Tool: Demand for Hospital Services," The Journal of Prediction Markets (2009) 3 2, accessed May 15, 2012, http://web.ebscohost.com.libproxy.nps.edu/ehost/pdfviewer/pdfviewer?sid= 522676a1–94ef-4b66–81a5-d4dbf7343681%40sessionmgr12&vid=2&hid=7.

missing among these examples is a discussion of prediction market use within the U.S. Department of Defense (DoD). In fact, to date there has only been one large-scale experiment with prediction markets inside of DoD. That experiment, known as the Policy Analysis Market (PAM), was cancelled before it ever began.

PAM was officially announced in 2001 and was managed by the Defense Advanced Research Projects Agency (DARPA). The market was designed to cover eight middle east nations and to focus on "five parameters for each nation: its military activity, political instability, economic growth, U.S. military activity, and U.S. financial involvement," with the ultimate goal of forecasting military and political instability.[38] The project was headed by retired Admiral, and former National Security Advisor, John Poindexter. In July 2003, Senators Ron Wyden and Byron Dorgan released an open letter to Poindexter complaining that the PAM would allow terrorists to bet on terrorist attacks, in effect profiting from planning and carrying out attacks. The Senators went on to suggest that "spending millions of dollars on some kind of fantasy league terror game is absurd and, frankly, ought to make every American angry," while also highlighting the involvement of Poindexter who had been convicted for his role in the notorious Iran-Contra scandal.[39] The next day, the PAM project was terminated, with Poindexter resigning days later. As Hanson points out, "the dominant initial reaction to PAM seemed visceral and intuitive rather than analytic."[40] As such, a novel attempt at determining whether "market-generated predictions could improve upon conventional approaches to forecasting"[41] was lost.

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[38] Robin Hanson, "The Policy Analysis Market (A Thwarted Experiment in the Use of Prediction Markets for Public Policy)," *Innovations: Technology, Governance*, *Globalization,* (Summer 2007), vol. 2, no. 3, 77.

[39] Ibid., 79.

[40] Hanson, "The Policy Analysis Market," 80.

[41] Puong Fei Yeh, "Using Prediction Markets to Enhance U.S. Intelligence Capabilities," *Studies in Intelligence* Vol. 50, no. 4 (2006), accessed May 15, 2012, https://www.cia.gov/library/center-for-the-study-of-intelligence/csi-publications/csi-studies/studies/vol50no4/using-prediction-markets-to-enhance-us-intelligence-capabilities.html.

Today, the research arm of the Director of National Intelligence (DNI) is actively pursuing prediction market research in a renewed attempt to improve the way that future events and outcomes are predicted. The Intelligence Advanced Research Projects Agency (IARPA) is currently funding two public prediction markets; Forecasting ACE (Aggregative Contingent Estimation) and Forecasting World Events (FWE). While neither market administrator has been forthcoming with their market statistics, it appears as though both fall within the norms of reported market participant behavior statistics; "20% of the traders conducting 80% of the trades."[42]

The Forecasting ACE market is led by Applied Research Associates (ARA), who manages a team of scientists from ARA and leading universities who hope to move beyond simple averaging of forecasts and into the realm of why some people forecast more precisely than others. The end goal is to improve not only intelligence analysis, but also forecasting in other areas such as economics, business, medicine and logistics.[43] Categories covered in the market include: politics and policy, business and economy, science and technology, military and security, health and society, and sports.

The FWE market shares a similar approach, with an overall objective to "advance the science of forecasting, focusing on methods of prediction that rely heavily on human judgment."[44] The categories covered in the market include: global security, world politics, business and economics, public health, science and technology, and culture and social change. Of note, the FWE market runs on Inkling Markets software.

Both markets began in the summer of 2011 and remain open to new participants. In order to participate in the Forecasting ACE market you must have

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[42] Adam Siegel, phone conversation with author, March 2012.

[43] Forecasting ACE Beta, "About the Forecasting ACE Site," accessed May 15, 2012, http://forecastingace.com/aces/ about.php.

[44] Forecasting World Events (FWE), "Frequently Asked Questions," accessed May 15, 2012, http://forecastwe.org/faq.

a bachelor’s degree or be enrolled in a degree awarding program. The FWE market has no such qualification, though the completion of a lengthy pre-study questionnaire is required.

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III. EXPERIMENTATION / METHODOLOGY

In order to determine whether prediction markets could be effectively employed within a normal military command structure, we set out to design and operate several prediction markets within military units. Given that the accuracy and mechanics of prediction markets have been widely established, this experiment was designed to focus on the implementation of these markets within military commands as they have unique organizational and social constructs that might challenge the ability to run an efficient prediction market.

First and foremost, the organizational structure of nearly every military unit is a strict hierarchy, with a commanding officer at the top with the ultimate power of the final decision in any matters regarding the unit. Second, beyond the commander, most units consist of a staff of mid-level officers with whom the responsibility for planning and organizing the unit lies. As such, the majority of analytical decision-making happens at the top of the hierarchy and involves a minority of the unit. A Marine infantry battalion, for example, has nearly 900 Marines with a staff cadre of just over 20.[45] Because of this structure, it is only natural to question whether or not this methodology would be welcome in military units.

In our efforts to determine if military units could apply these markets to some type of decision-making process, we sought to answer the following questions: to what extent would people participate?; what incentives would be necessary to encourage their participation?; would commanders be comfortable employing this methodology within their commands on issues of importance and further, would they use the quantitative results generated by the market? Additionally, we considered what types of questions we would need to ask in order to maximize participation and how much training would be necessary to fully realize the function of the markets.

[45] Global Security, "USMC Ground Element: Organization Documents," accessed May 15, 2012, http://www. globalsecurity.org/military/library/policy/usmc/to/ground/index.html.

Ultimately, five separate prediction markets were designed and operated for three unique units. Two of these markets were considered training markets, aimed at allowing the participants an opportunity to login to the software and practice making trades and leaving comments. The other three markets were "real" markets and detailed statistics and information were recorded regarding participant activity.

A. PARTICIPATING UNITS

The three units chosen to participate in this research were selected based on a series of factors that included their potential for representing the widest possible application of prediction markets, their willingness to participate, and the feasibility of implementing a market within the limitations of a unit's schedule. These markets involved units from a Naval Postgraduate School (NPS) experimentation project, the Marine Corps Intelligence Activity (MCIA), and the Marine Corps' 2d Intelligence Battalion. The United States Marine Corps (USMC) units represent the strategic/operational level and the operational/tactical level. Additionally, these units were sufficiently large and diverse enough to provide the conditions in order to run a prediction market. Lastly, both of the USMC units are intelligence related. These units are responsible for forecasting and providing assessments as part of their core responsibilities, and it is possible that their use of prediction markets might enhance the quality of their products.

1. JIFX/TSOA/RELIEF

The first market was designed to support the Naval Postgraduate School's (NPS) Joint Interagency Field Experimentation (JIFX) 12–2 project that was held at the end of February 2012 at Camp Roberts, CA. According to NPS, these "field experimentation events have been conducted such that maximum innovation and collaboration are encouraged between DoD, government agencies, industry, universities, and in which SOF, National Guard, and first responder participation and feedback are utilized for effectiveness, affordability,

and feasibility of future capabilities."[46] The design for this market was somewhat unorthodox given a few critical constraints. The first was the difficulty of soliciting volunteers in an environment where potential participants were inundated with a variety of requests and demands. The second issue was ensuring that the market itself referenced each experiment being tested at the event. This was based on the assumption that participation might suffer if a volunteer did not see their particular experiment represented in the market. Finally, and perhaps most significantly, this market would not contain contracts that could be verified by actual outcomes. To this point, contracts of this nature have not been studied to any great extent and in fact, many purveyors of prediction markets dispute whether or not they can be effective in this context. This market would prove to be insightful in this regard.

Ultimately, we ran one prediction market that encompassed experimentation from three separate agencies/projects. They were the Adaptive Red Team Technical Support and Operational Analysis (ART/TSOA) Activity, the Research and Experimentation for Local and International Emergency and First Responders (RELIEF), and the Join Interagency Field Experimentation (JIFX) event. Each of the three groups listed above were responsible for presenting, testing, and evaluating multiple technologies while at Camp Roberts (a detailed list of these technologies can be found in Appendix A, Table 8). The JIFX attendees consisted of contractors, government civilians, academic and military personnel from across the DoD, government agencies, industry, and academia. Since we were experimenters ourselves presenting our research at JIFX 12–2, we solicited participants for our prediction market from amongst the events' attendees. Ultimately, 47 individuals provided their consent to participate and 30 were active traders within the market.

In order to design a prediction market that would work for all three of these groups simultaneously, we decided to combine all three of the projects

[46] Naval Postgraduate School, "What is JIFX?" accessed May 15, 2012, http://www.nps.edu/Academics/Schools/ GSOIS/Departments/IS/Research/FX/JIFX/JIFX.html.

(JIFX/TSOA/RELIEF) into one market with each project the subject of four separate contracts. In total, the market consisted of 12 contracts, each with more than 15 possible answers. Though the overall number of contracts was appropriate for the number of participants, there was concern that the number of possible answers for each contract would ultimately affect liquidity. Put another way, it was possible that traders would become overwhelmed with the number of contracts available, and participation would suffer as a result.

The contracts asked traders to consider various questions such as: which technology would be present in supply systems in 2015, which were the least vulnerable to enemy activity, which deployed with the least amount of gear, and which provided the most immediate capability in its present condition (the full text of the contracts is available in Appendix A, Table 8). Because this market was unique in that the contracts were not exhaustive and exclusive per se, the starting price for each selection began at $50.00, and represented the notion that each outcome was independent of all other outcomes. In essence, a trader buying shares of one technology would not negatively affect the shares of any other technology. At the conclusion of the market, the technologies and their potential utility, from any of the four categories could then be ranked as a function of their final market price.

2. Marine Corps Intelligence Activity (MCIA)

The next two prediction markets were of a less experimental design in that the preponderance of contracts were narrowly defined with binary outcomes. There were however a small number of contracts that were “open ended” and were not tied to verifiable events. The first market was designed for the Marine Corps Intelligence Activity (MCIA) in Quantico, VA.

> MCIA provides tailored intelligence and services to the Marine Corps, other services, and the Intelligence Community based on expeditionary mission profiles in littoral areas. It supports the

development of service doctrine, force structure, training and education, and acquisition.[47]

Additionally, the unit is manned by active duty and reserve Marines, government civilians, and contractors that provide support across the full spectrum of intelligence support to operations.

Support to our prediction market was provided via the Futures Branch of the Production and Analysis (P&A) Company and consisted of representation in the way of participants from across the P&A Company. Four sections within the company provided 10 potential participants as well as five prospective contracts for inclusion in the market. From these prospective volunteers, 36 personnel agreed to participate and 24 of those ultimately became active participants in the market. In addition to the traders, the company also provided eight draft contracts which were also included in the market. The scope of the contracts covered many different areas, including: the possibility of an Israeli attack on Iran, the fate of the Syrian president, the likelihood of a North Korean attack on South Korea, and the future health of Venezuelan President Hugo Chavez among many other subjects (for a complete list of contracts see Appendix A, Table 10). In addition, contracts regarding pop culture (specifically sports and entertainment) were added in order encourage participation. Binary contracts were initially valued at $50.00 and contracts with multiple answers with all answers being equal (e.g., four answers would each start at $25.00 or five would start at $20.00). Finally, this market allowed users to submit their own contracts if they so desired and these were edited for clarity and published by the market administrators.

3. 2d Intelligence Battalion

The final market in our experimentation was conducted at 2d Intelligence Battalion (2d Intel) aboard Camp Lejeune, NC. The mission of 2d Intelligence Battalion "is to plan and direct, collect, process, produce, and disseminate intelligence and provide counterintelligence support to the Marine Expeditionary

[47] Marine Corps Base Quantico, "Marine Corps Intelligence Activity," accessed May 15, 2012, http://www.quantico. usmc.mil/activities/?Section=MCIA.

Force (MEF) Command Element, MEF major subordinate commands, subordinate Marine Air Ground Task Forces (MAGTF), and other commands as directed."[48] The Battalion consists of five subordinate companies consisting of a Headquarters Company, Counterintelligence / Human Intelligence Company, a Production and Analysis Company, a Counterintelligence Support Company, and a Production and Analysis Support Company comprising more than 500 Marines. The 2d Intel prediction market consisted of 53 consenting participants, all of whom were Marines. Of these 53 participants, 42 registered and actively participated. The contracts used for this market were the same base contracts for the MCIA market. User submitted contracts were allowed (and submitted) in this market as well (for a complete list of contracts see Appendix A, Table 12).

B. MARKET DESIGN

Given the physical limitations of this research, a software based prediction market is without question the most feasible and most efficient method of creating the markets proposed above. While there are a variety of potential options available to consumers and researchers, one in particular provided the greatest accessibility and ease of use. Inkling Markets, based in Chicago, IL, and created by CEO Adam Siegel, was "founded in 2006 to offer collective intelligence solutions to help organizations decrease operational and strategic risk."[49] Since 2006, both civilian industry and government institutions have used Inkling Markets, including: Mitre, RAND, Procter and Gamble, Lockheed Martin, Ford and many others. Inkling Markets' software is particularly alluring given its ease of use and intuitive design. Utilizing Hanson's market scoring rules (MSR) model, this software is user friendly for both the market creator and market participants. Mr. Siegel and Inkling Markets provided the software and necessary support pro bono.

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[48] II Marine Expeditionary Force, "2d Intelligence Battalion Mission," accessed May 15, 2012, http://www.marines. mil/unit/iimef/hq/Pages/2dIntelBN/Mission/default.aspx.

[49] Inkling, "We Enable Inklings to Happen," accessed May 15, 2012, http://inklingmarkets. com/ homes/company.

1. Software Accounts

Each market was created with the Inkling Markets software and made available to participants through their website, www.inklingmarkets.com. Each market was created separately in order to partition each unit's market and to ensure the reliability and consistency of the data. Participants were invited to the market via the e-mail invite mechanism built into the software. The invite consisted of a link to the market where each participant was then prompted to create their own user account consisting of a unique (self-made) user ID and password. Once they gained access to the website, they were free to begin trading. Each trader was granted an initial balance of $5,000.00 play dollars with which to buy and sell positions on contracts.

2. Contracts

The contracts were a variety of both short term and long term questions ranging in lifespan from three days to several months. As a result, some contracts would be resolved in a matter of days (e.g., Who will win the baseball game between the San Francisco Giants and the Arizona Diamondbacks on 9 April 2012?), but others might last many months (Will President Obama be reelected in November 2012?). In addition, contracts with binary outcomes were juxtaposed with those that were open-ended and contained multiple long-term possibilities. For example, a binary question might ask "If North Korea will successfully launch a satellite by 16 April 2012?" This contract will obviously have a "yes" or "no" answer as one or the other has to happen. This contract is said to be mutually exclusive and collectively exhaustive, as all possibilities are available for purchase. An open ended contract would be phrased: "North Korea will conduct a provocative attack on U.S. or South Korean interests within: 0–6 months, 6–12 months, 12–18 months, North Korea will not commit any attacks." In this case there are multiple answers and any one may be correct. This type of question contains an inherent challenge in that the length of the market itself may be limited to a timeframe well short of any of the options available. Current prediction market research does not address whether or not a participant's

actions will be affected by such a constraint. By designing the market to be a contrasting mixture of short-term, long-term, binary, and open-ended contracts, one can compare and contrast the trading volume between the various types.

The type of contract was not the only consideration, however. The number of contracts that participants are exposed to can be a critical factor in their participation. Our markets were limited to 8–12 contracts in order to encourage trading, as a result. In some cases that number was exceeded slightly as a result of user submitted contracts.

3. Market Duration

Each market was limited in duration based on several factors. The first was simply a function of how much time the participating units were willing to donate. Understandably, both 2nd Intelligence Battalion and MCIA had a desire to limit the market's timeframe in order to prevent the experiment from adversely affecting day-to-day operations within the unit. In addition, evidence suggests that one week is ample time for a market to function properly.[50] The confluence of both of these factors indicated that a market lasting between 7–10 days would be the optimal choice.

4. Training and Test Markets

The level of training received was also a function of time limitations. In the case of the JIFX/TSOA/RELIEF market, on-site training was not possible given the participants' experimental requirements during the week. In many cases, participants were conducting very time and energy intensive experiments that did not allow for any type of collective training. So participants in this market received an overview of the prediction market concept and the software they would be interacting with as part of the event's in-briefing. 2d Intelligence Battalion and MCIA, however, did receive a formalized introduction to prediction markets as well as a short block of training regarding the use of the software. In these two

[50] Plott and Chen, "Information Aggregation Mechanisms: Concept, Design and Implementation for a Sales Forecasting Problem," 19.

cases, participants were exposed to the actual interface and were encouraged to ask questions regarding its use. In addition, these two units were encouraged to participate in a test-market prior to the actual experimental market. This allowed the participant to further acclimatize themselves to the software and ask any questions they felt necessary.

5. Market Incentives

Conversations with Inkling Markets CEO Adam Siegel revealed that effective incentives should go beyond those individuals with the highest account balance at the conclusion of the market.[51] His opinion, based on observations of many different markets, is that rewarding only the wealthiest trader may actually de-incentivize those participants who have lost money on various transactions. The notion is that once a trader believes they have little to no chance of becoming the top trader they limit their participation or quit altogether. As a result, this limited participation would have powerful consequences for a market that seeks to aggregate information. To combat this, Inkling Markets has developed unique mechanisms to reward those that see their account balances dwindling. To wit, they have developed "Karma" points that reward users for making comments inside the market or for "liking" other traders' comments. In this manner, participants are incentivized to add value to the market despite a low portfolio balance. Therefore, we offered prizes in multiple categories: Highest Portfolio Balance, Most Trades, and Most Karma Points, believing that the "winner" of the market was more than just the participant with the highest portfolio value at the end of the day.

C. POST-MARKET SURVEY

In an effort to capture the thoughts and opinions of the market participants, a short survey was conducted at the completion of each market. The survey was designed and operated through free web-based software provided by www.surveymonkey.com. Market participants were invited to complete a short

[51] Adam Siegel, phone conversation with author, March 2012.

survey via an e-mail invite. As such, each survey was anonymous and no information was recorded regarding who had, or had not completed the survey.

The survey consisted of ten questions regarding general demographic data and basic market behavior questions.[52] The demographic data requested was “Rank/Pay Grade” and “Education Level.” This data was sought in an effort to understand the basic attributes of the average participant and potentially highlight a variable that would indicate whether or not experience or education had any effect on market participation. Market behavior questions were asked in order to determine the number of times an individual logged into the market and the extent to which a participant traded during each visit. Additionally, the survey attempted to clearly define and catalog a volunteer’s logic for participating, or choosing not to participate at a given time, and whether or not they felt compelled to conduct additional research to aid in their trading efforts. Finally, the survey posed questions regarding the respondent’s desire to participate in another such market, and queried them for potential future applications of prediction markets within the military.

[52] See Appendix B for a copy of the survey and results.

IV. RESULTS AND ANALYSIS

A. OVERALL

We conducted five prediction markets over the course of two months. Two of the markets were training markets, designed to familiarize the participant with the market software, while the other three were the experimental markets that functioned as the basis of our research. Site visits and command briefings were conducted in late February and early March 2012 and were intended to inform the command of our processes and procedures, as well as to solicit additional support. The markets were initiated during the second week of March and were concluded 21 days later. The initial design and implementation of all three markets were conducted on site with the participating unit, while the actual market administration was performed remotely from the Naval Postgraduate School (NPS) via the Internet. The entire experimentation phase consisted of 136 participants who made more than 1200 trades consisting of more than 18,000 shares and nearly $800,000 in play money over 23 days (see Table 1).

Market	Traders	Trades	Contracts	Shares Traded	Total Liquidity
JIFX	47	381	13	3553	$189,487.90
MCIA	36	342	13	2414	$93,466.73
2d Intel	53	660	19	12576	$514,599.97
Totals	**136**	**1383**	**45**	**18,543**	**$797,554.60**

Table 1. Combined market statistics

B. MARKET DESIGN

Each experimental market was initially intended to include ten contracts that would each run for five to seven days. However, as each market was designed, care was taken to ensure that the content of the market and focus of the contracts was valuable and relevant to the participating unit. As such, the Joint Interagency Field Experimentation (JIFX) project market focused solely on content relevant to the JIFX. The Marine Corps Intelligence Activity (MCIA) and 2d Intelligence Battalion markets also included other contracts outside the normal interest of military units at the behest of both the market administrators and the experimenting units. These other contracts related to sports, entertainment and politics were included to determine whether or not traders would invest in these contracts more heavily and thereby "prime the pump" for trading in more occupation-relevant contracts. We believed that some may not be immediately interested in the prediction market concept or the questions being asked. Therefore, offering other general knowledge questions as contracts might serve to pique the interest of these traders and encourage them to participate in the main market contracts.

1. Length of Contracts

Each market conducted during the experimentation phase consisted of 13–19 contracts and lasted between five and nine days (see Table 2). These contracts were a mix of unit-created, market-administrator created, and user-created, and covered a wide range of topics related to each market.[53] The JIFX market contracts focused primarily on the viability of various experiments and technologies that were viewed by market participants during JIFX 12–2. The constrained timeline of this market was a function of the sponsoring event and as a result the market was opened to traders for only one week.

[53] See Appendix A for detailed contracts and market statistics.

	JIFX	MCIA	2d Intel
Number of Participants	47	36	53
Number of Contracts	13	13	19
Length of Market	5 Days	8 Days	9 Days

Table 2. Basic market data

The MCIA market contracts consisted largely of questions related to current and future world events, foreign policy questions, and included two "pop culture" questions.[54] After some discussion with unit participants, we determined that a familiarization market would be conducted prior to the establishment of the experimental market so as to condition traders to the market framework and the functionality of the software. Therefore, the length of the familiarization market and MCIA experimental market was three and eight days, respectively.

The 2d Intelligence Battalion market contained the most contracts at 19 and also covered the most ground topically, with seven sports and entertainment related contracts, ten world events contracts, and two political contracts.[55] Like the MCIA market, a three day familiarization market was established prior to the nine day experimental market.

2. Participants

Across all three markets, there was a 71% participation level among consenting participants. Put another way, of 136 users who consented to participate and were subsequently invited, 96 users actually registered for a user account. Of the three markets, the 2d Intelligence Battalion market had the highest level of user participation at 79% registered, while the JIFX market had the least at 64% (see Figure 1). Of note though, both the 2d Intelligence Battalion and MCIA markets were homogenous units while the JIFX market consisted primarily of users who were independent of the JIFX event. In essence, few of

[54] See Appendix A, Table 10.

[55] See Appendix A, Table 12.

the JIFX market participants had any real stake in the outcome of the market, though 64% of invited users still registered for an account and conducted trades.

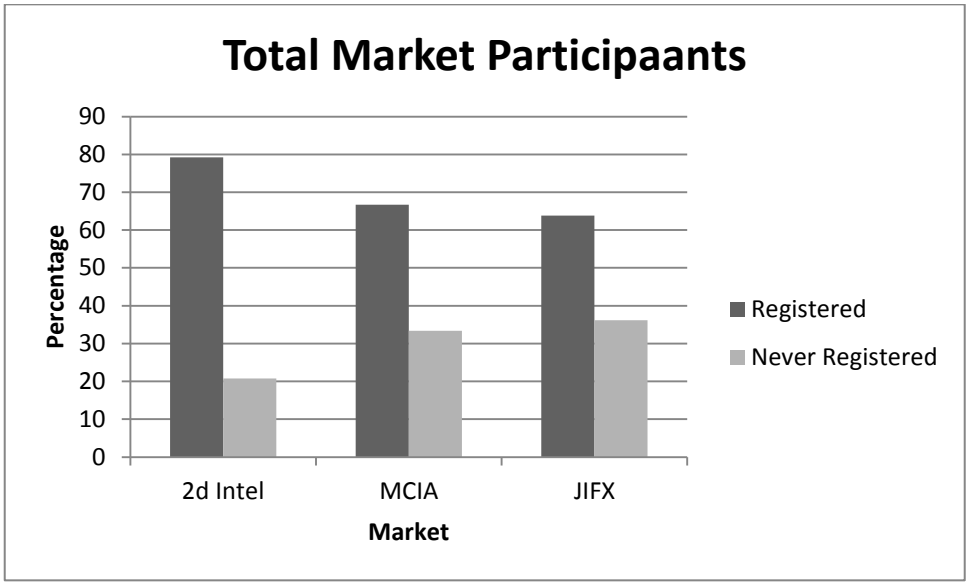

Figure 1. Total account registration rate by market

3. Participant Demographics

The demographic data of market participants across the three units varied widely, ranging from independent and government contractors, to enlisted and officer service members (see Figure 2). As might be expected, the majority of the contractors came from the JIFX market, while the bulk of the enlisted service members came from 2d Intelligence Battalion.

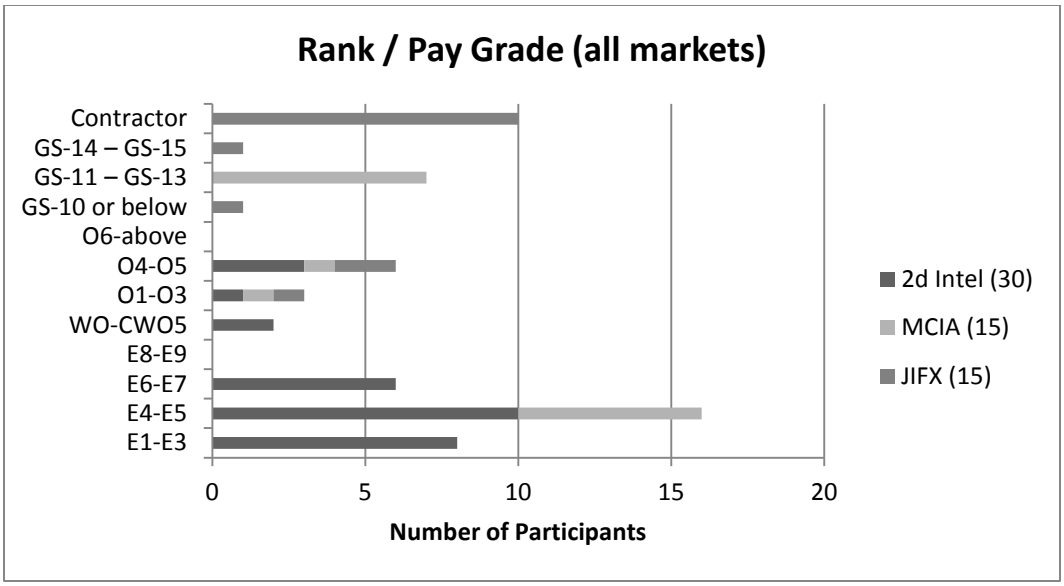

Figure 2. Rank/Pay Grade of market participants, all markets

This demographic divide can also be seen on the educational side as the majority of college graduates were represented in the JIFX and MCIA markets. Additionally, the JIFX market also reflected the highest number of users with advanced degrees. Overall, survey respondents overwhelmingly reported some level of college completed.

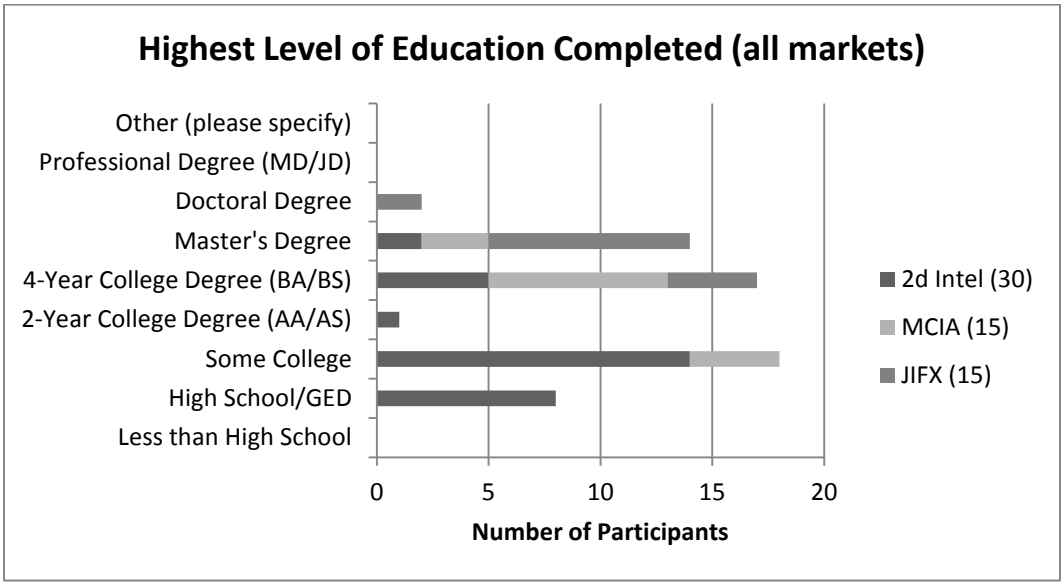

Figure 3. Education level of participants, all markets

4. Incentives Offered

For each market, incentives were offered in order to entice people to participate. These incentives were materially insignificant in nature, ranging from a $20 gift card to a 72-hour liberty pass for the market winners.[56] The gift cards were awarded by the market administrators, while the liberty passes were unit specific to 2d Intelligence Battalion. As discussed in the previous chapter, we felt that incentives were a necessary condition in order to ensure maximum participation and so market winners were defined in multiple categories: overall highest portfolio value, highest number of trades, and most karma points.

5. Participant Behavior

Across the three prediction markets, 45% of traders logged on less than five times during the course of the market (see Figure 4). This number is somewhat skewed though as 80% of the JIFX market participants logged on less than five times (see Table 3). The reason for the high percentage of low logins in the JIFX market is likely due to the nature of the contracts. As designed, these contracts did not necessarily lend themselves to support a large volume of trades as they asked about an outcome that was attributed to a one-time event. Regardless of this statistic, 78% of all market participants logged on less than ten times.

[56] A 72-hour liberty pass is an incentive used by military commanders at the unit level to reward their soldiers/Marines. A 72-hour liberty pass is normally a 3-day weekend with travel limited to the local area.

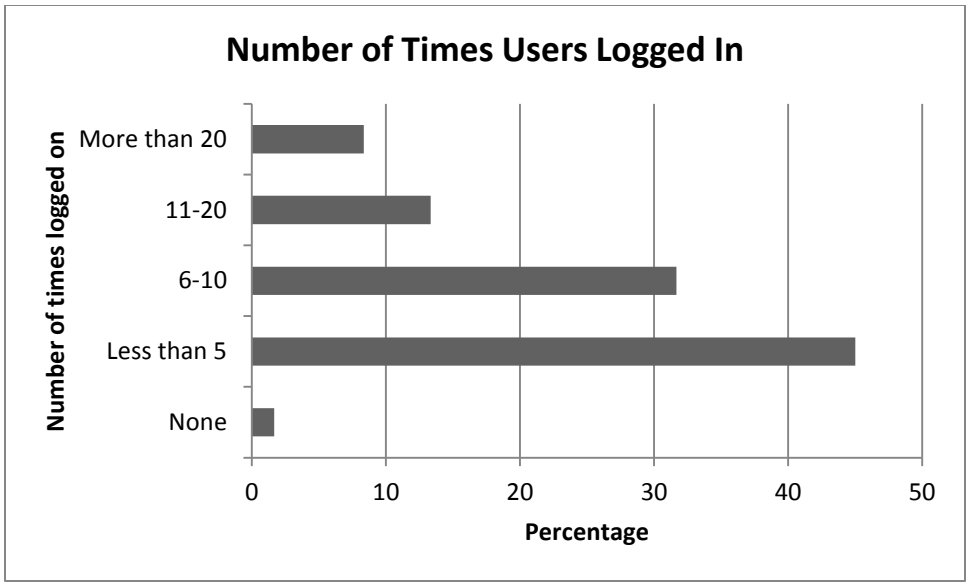

Figure 4. Total amount of market visits, all markets

		Prediction Market		
		2d Intel	**MCIA**	**JIFX**
Number of times logged on	**None**	0%	0%	7%
	Less than 5	40%	20%	80%
	6–10	33%	60%	0%
	11–20	17%	13%	7%
	More than 20	10%	7%	7%

Table 3. Logins by market

In terms of total amount of time spent per trader-login, the majority of participants spent three to five minutes per visit, with 75% of total participants spending less than 10 minutes per site visit (see Figure 5). Interestingly, when examined by market, all three exhibited similar behavior regarding the ratio of participants to the time that they spent per visit (see Table 4).

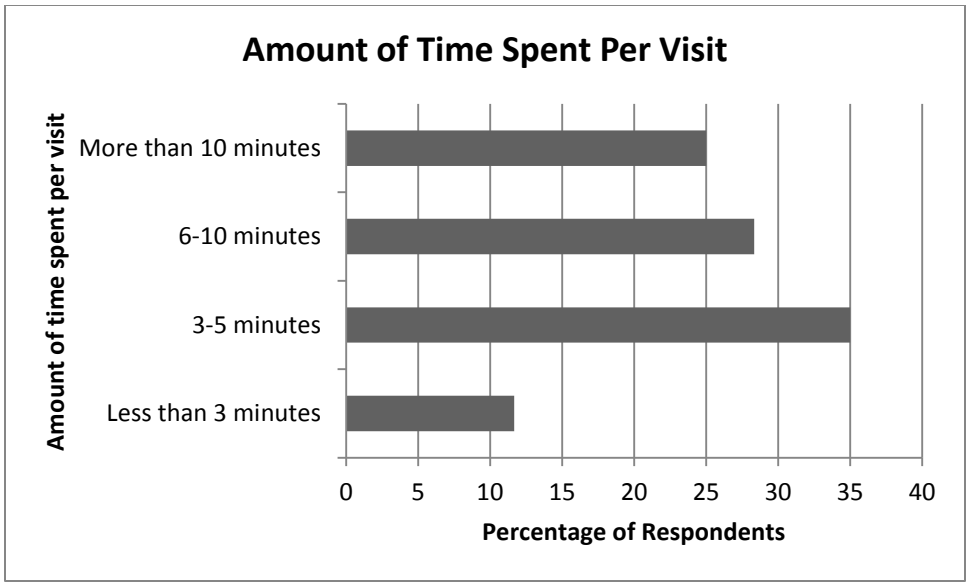

Figure 5. Total amount of time spent per visit, all markets

		Prediction Market		
		2d Intel	**MCIA**	**JIFX**
Time spent during each login	**Less than 3 minutes**	10%	7%	20%
	3–5 minutes	30%	40%	40%
	6–10 minutes	30%	27%	27%
	More than 10 minutes	30%	27%	13%

Table 4. Time spent per visit

All three markets exhibited the highest volume of trading during the first four days and afterwards exhibited a precipitous downward trend, with none of the markets demonstrating any significant trading activity after day five (see Figure 6). Of note, the decreased trading in the MCIA market during days two and three is likely explained by a command-wide Internet outage during this period. Also telling is Figure 7, which shows that 66% of market participants made less than 10 trades and 88% made less than 30 total trades.

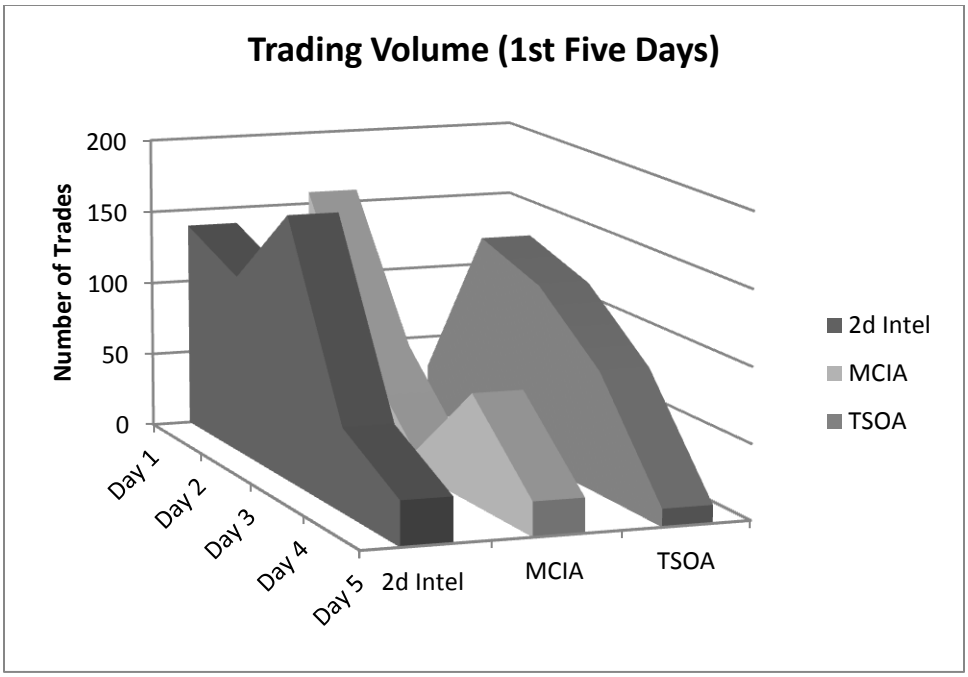

Figure 6. Total volume of trading for the first five days of the market, all markets

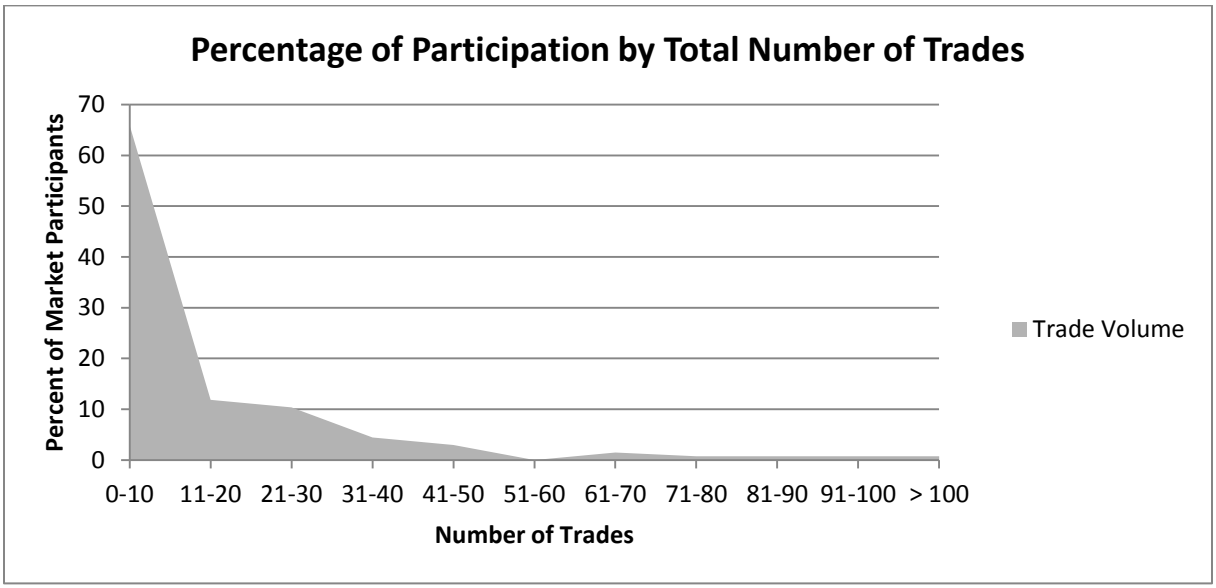

Figure 7. Participation percentage based on the number of trades completed, all markets

To better understand the individual reasoning behind participant behavior, every market trader was invited to participate in a post-market survey where they were queried about their experience while a participant. Respondents to the question, “What was the biggest factor in your decision not to participate at a given moment?” predominantly answered, “lack of time” (see Figure 8). Additionally, several of the comments posted to the “Other” category could also be classified as belonging to the “lack of time” category. Other major reasons cited for not participating was due to a lack of knowledge, or interest in the questions being asked.

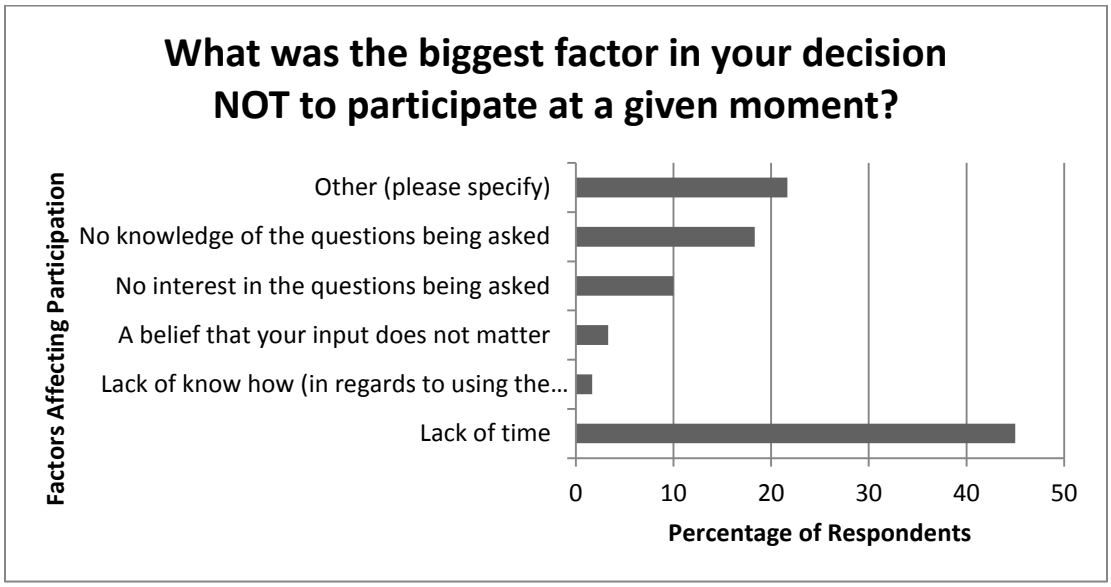

Figure 8. Reasons for not participating, all markets

Reasons for not participating by market can be further expounded by the makeup of the unit and their responses. For example, MCIA shows that 27% of respondents had no knowledge of the questions being asked (see Table 5). This is likely due to the specificity involved in the contract design at the behest of the unit. MCIA is broken down into functional areas, so respondents from a functional area that falls outside the subject matter of the contract would likely not feel that they had the expertise to offer a response to that contract. The same is true of

the JIFX market where unless the participant was available for all three phases of the JIFX exercise, they would most likely not have any valuable input to the other contract areas (TSOA or RELIEF).

		Prediction Market		
		2d Intel	**MCIA**	**JIFX**
Reason for not participating	**Lack of time**	37%	47%	60%
	Lack of know how (in regards to using the market)	3%	0%	0%
	A belief that your input does not matter	7%	0%	0%
	No interest in the questions being asked	13%	13%	0%
	No knowledge of the questions being asked	13%	27%	20%
	Other (please specify)	27%	13%	20%

Table 5. Reasons for not participating, all markets

When asked what the major factor was in their decision to participate, 57% of all survey respondents answered “intrigue in prediction markets.” Only 20% of the total respondents answered that incentives, or the chance to win prizes, was the major factor, with the majority of that 20% belonging to the 2d Intelligence Battalion market (see Figure 9). However, in the 2d Intelligence Battalion market, incentives were cited by 33% of the respondents as being important, suggesting that while incentives don’t seem to matter across the board, they may be important to certain demographics or commands.

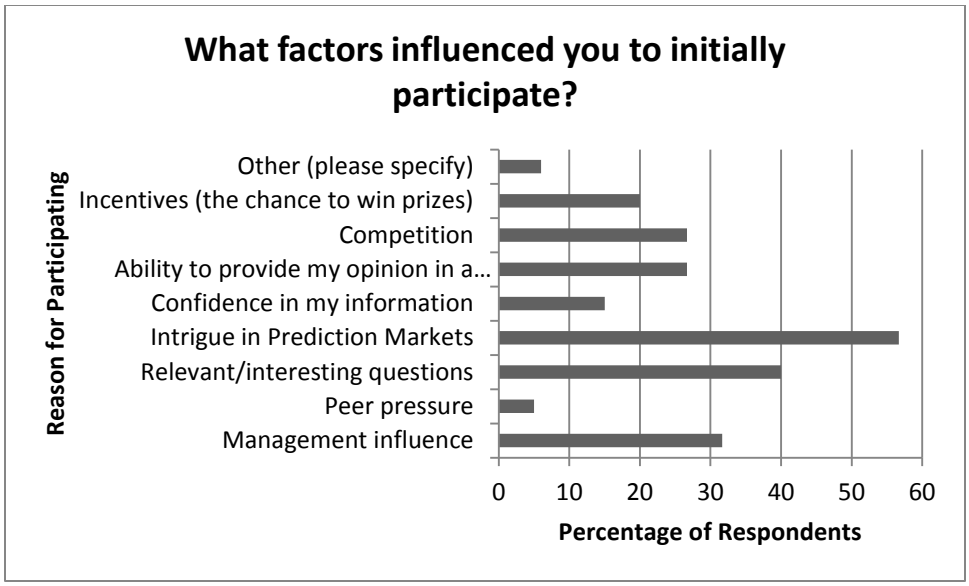

Figure 9. Factors that influenced participation, all markets

6. Command Involvement

Finally, the level of command involvement seen in the three prediction markets covered the spectrum from fully interested and involved, to tacit approval with no direct participation. Interestingly, command involvement seemed to have little overall influence in regards to market activity; however, it did seem to factor into individual reasoning for participating. For example, the JIFX market had no command involvement to speak of and survey respondents noted this, with only 7% citing management influence as a reason for participating. On the other hand, 33% cited management influence in the 2d Intelligence Battalion market which had the most direct command involvement with the Commanding Officer participating and personally providing incentives in the form of a 72 hour liberty pass to the market winner. MCIA had indirect command involvement with the Commanding Officer aware of the market, but not participating, though 27% still noted management influence as a reason for participating.

C. RESULTS BY MARKET

1. JIFX/TSOA/RELIEF

This market was set up to gauge the overall utility and usability of experiments presented at JIFX 12–2 in their use to the U.S. military, specifically U.S. Special Operations Command. The JIFX organization has long used a checklist for evaluators to judge the applicability, utility and usefulness of experiments presented. While adequate for their purposes, we proposed that a prediction market might provide a more objective approach to this historically subjective process. Over the course of five days, the market resulted in 381 trades by 30 active traders consisting of 3,553 shares and nearly $190,000 in "play" money.

a. Market Design

The JIFX market is undeniably unique in its design. As the field experiment actually consisted of three separate areas of research, we determined that the market must contain contracts that not only represented each of these areas, but each individual experiment as well. With this construct in mind, the JIFX market was based on four core questions that related well to each area of experimentation and would elicit the type of information that the JIFX administrators were interested in collecting. Subsequently, each of these four questions was assigned to one of three areas of experimentation resulting in 12 core market questions (four TSOA, four JIFX and four RELIEF) in total. Each experiment was then added as a potential answer for each contract meaning that each had up to 19 different answers (see Figure 10).

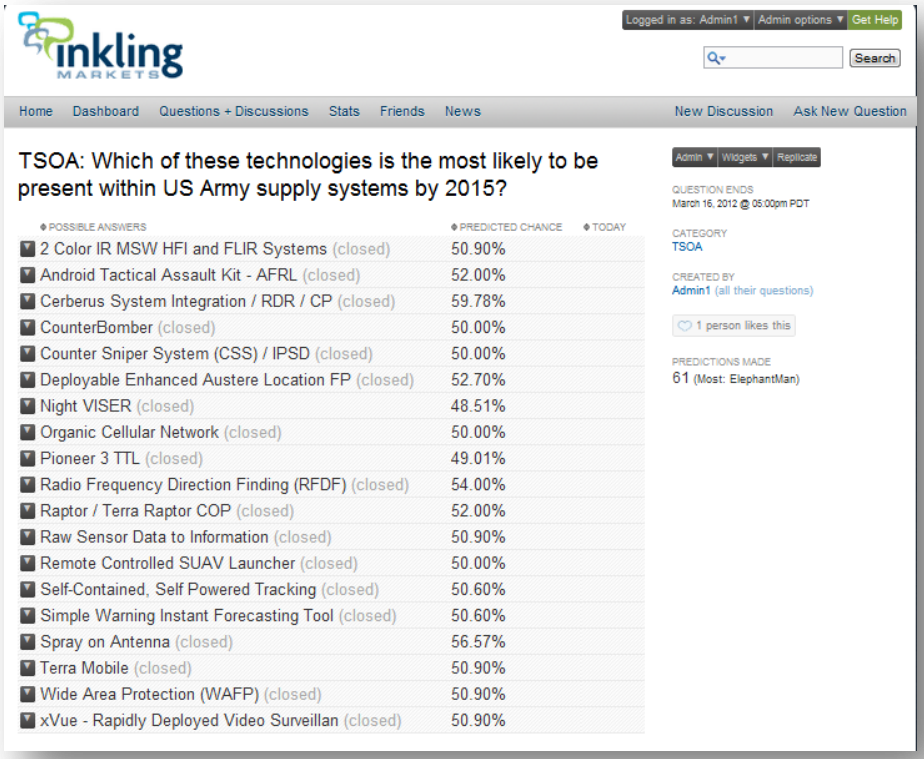

Figure 10. Example of a JIFX market contract. This picture shows the multiple sub-answers available to the trader

Pragmatically, the unorthodox design of this market posed serious challenges in terms of generating adequate market liquidity. Stated more simply, the participants might find themselves overwhelmed by the choices available and become reluctant to trade. In actuality, this concern was not without merit in the JIFX and RELIEF contracts where there were fewer traders; however, the TSOA contracts were subject to a much higher trading volume, suggesting that a contract with a number of “sub-answers” is viable if supported by adequate participation. Additionally, prediction markets have not been adequately tested in this context and this experiment represents an entirely new application. In point of fact, our expectations for the success of this market were decidedly low and we approached this particular market with guarded optimism knowing that stagnant market (representing total failure) was entirely possible, if not likely.

b. Length of Contracts

The nature of the exercise and the operational tempo of the participants limited the market duration to one-week. Additionally, it was determined that one-week was adequate to garner the participation necessary without becoming overly burdensome to the participants.

	Averages (per contract)	Totals
Number of Traders	6.92	47
Number of Trades	29.31	381
Number of Contracts	--	13

Table 6. JIFX/TSOA/RELIEF basic market statistics

c. Participants

Participation in the market was sought via face-to-face solicitation with an e-mail that included links to register and create a user account. Overall, 271 individuals were contacted and invited, with 47 consenting to participate and 30 ultimately registering for an account. This result far succeeded initial expectations.

At the conclusion of the market, the 47 consenting participants were also sent a request to participate in a post-market survey regarding their experiences as a trader. Of those invited, 32% completed the survey. Sixty-seven percent of the survey respondents were civilian contractors whose business is research and design, hence their inclusion and participation in the JIFX event.[57] Additionally, many of the market participants were academics or involved with academia, which likely justifies their willingness to participate in such a market. In terms of education, all market participants reported that they had a bachelor's degree or higher, with 73% reporting that they had a master's degree or higher.[58]

[57] See Appendix B, Figure 43.

[58] See Appendix B, Figure 44.

d. Incentives Offered

The only incentive offered to market participants was a gift certificate to the outright market winner, suggesting that since the experimentation occurred in California wine country, perhaps they could purchase a fine case of wine. According to the post-market survey, only 3% responded that they were influenced by incentives as a reason for participating. Most participated due to an intrigue in prediction markets (37%), while others noted an interest in the ability to provide opinions in a non-confrontational forum (23%).[59]

e. Participant Behavior

According to survey results, 80% of the market participants logged on less than five times during the course of the week, and the majority spent 3–5 minutes on average inside the market per visit.[60] When asked about "the biggest factor in your decision NOT to participate at a given moment," survey respondents overwhelmingly noted that a "lack of time" was the largest inhibitor. The next most common response was a "lack of knowledge regarding the questions being asked."[61]

Trading patterns across the market reflected participants' inclination to trade within markets that they had personal experience with and to avoid the markets that were outside of their professional purview. The majority of trades were conducted on the second day of the market and trading dropped off significantly after the fourth day of the market (see Figure 11).

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[59] See Appendix B, Figure 49.

[60] See Appendix B, Figures 45 and 46.

[61] See Appendix B, Figure 47.

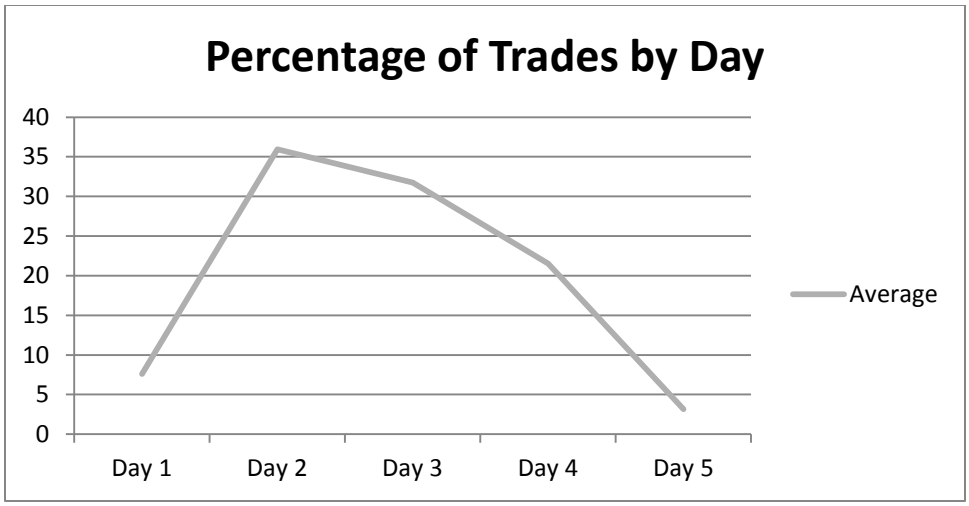

Figure 11. Total trades by day, JIFX market

It also appears from the data that generally, participants only traded once per contract and did not totally take advantage of the market mechanism (meaning trades were never revisited to judge true value of the answer chosen). Another interesting and encouraging part of this market was the amount and quality of comments inside the market. On average, each contract had six comments, with one TSOA contract regarding which "technology provided the most immediate capability for force protection," having 40 comments amongst 13 traders.[62] In total, 79% of the market participants made less than 10 trades, with 17% of the traders accounting for 80% of the trades (see Figure 12).

[62] See Appendix A, Table 9.

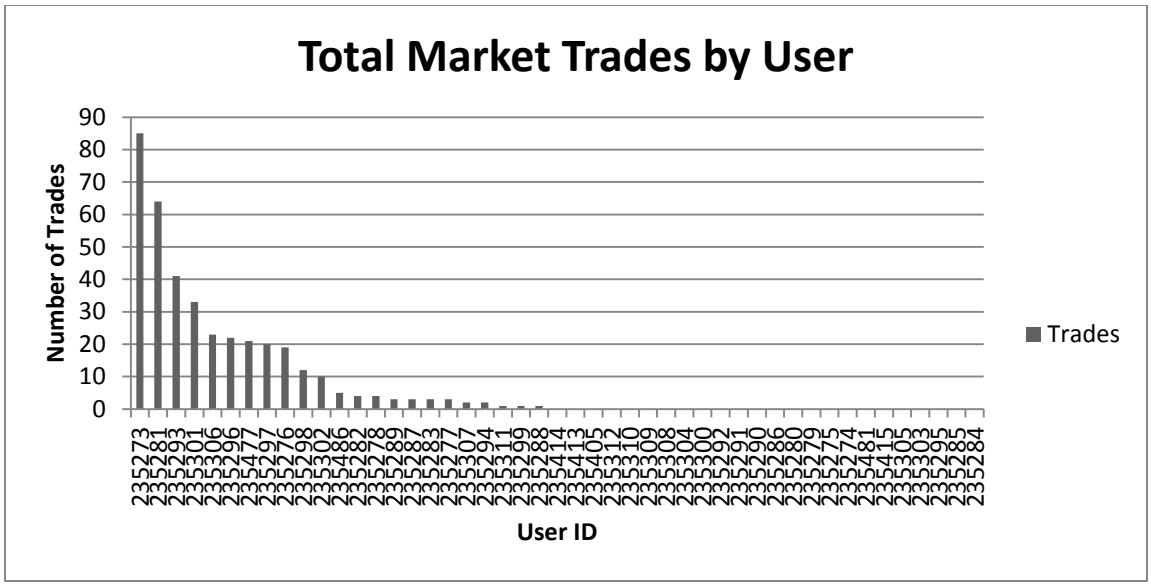

Figure 12. JIFX market trades by user

f. Command Involvement

Per se, there was no real command involvement for this market. The permission to participate was given by the head of the JIFX team as a result of the program's relationship with NPS. While the project head was not involved directly, the head of the TSOA team did support and encourage his personnel (the evaluators) to participate in the market.

2. MCIA

The MCIA market was designed to test the implementation of a prediction market as a potential intelligence forecasting tool. The market participants were all members of the command and consisted of uniformed military and civilians. Our purpose was to evaluate whether or not military intelligence professionals are capable of implementing this methodology in their forecasts and whether or not the information garnered was practical or desired by decision makers. Over the course of eight days, the market resulted in 342 trades by 24 active traders consisting of 2414 shares and $93,000 in "play" money.

a. Market Design

The design of the MCIA market was undertaken in close coordination with the Futures Branch of the Production and Analysis (P&A) Company. The desire of both the researcher and the experimenting unit was to ensure that the market contracts were interesting and useful to the command and by extension, the market participants. To that end, MCIA requested that each interested section within the command submit questions that they would like to see considered for inclusion in the market. This solicitation resulted in ten contracts which were then refined and included in the market. Additionally, the researchers added two sports related questions and a participant submitted one contract for inclusion.

b. Length of Contracts

The MCIA market was originally projected to run for one week; however, due to an unscheduled Internet outage at the command during the first five days, the market was extended into the next week to allow those that wanted to trade an opportunity to do so. The market was also preceded by a three-day familiarization market to allow the prospective participants an opportunity to "test drive" the software before actual market began.

	Averages (per contract)	**Totals**
Number of Traders	13	36
Number of Trades	26.31	342
Number of Contracts	--	13

Table 7. MCIA basic market statistics

c. Participants

The initial solicitation for participants was done by the command prior to the initial command in-brief by the researchers. Those who desired to participate were then asked to attend a briefing that covered the basics of prediction markets and the scope of our research, as well as a brief overview of

the Inkling Markets software. At the conclusion of this briefing, participants signed an informed consent and provided their contact information so that they could receive their formal market invitation. Ultimately, 36 individuals consented to participate, with 24 registering for an account.

Forty-two percent of the market participants also participated in a post-market survey. Of those that completed the survey questionnaire, 53% were uniformed military and 43% were government civilians.[63] Educationally, all market participants reported that they had some college, with 53% reporting that they had a bachelor's degree, and 20% reporting a master's degree.[64]

d. Incentives Offered

Incentives in the way of gift cards were offered to the market winners. For this market, participants were informed that there would be three winners; one each for "highest portfolio value," "most number of trades," and "most karma points." According to the post-market survey, only 3% responded that they participated due to the chance to win prizes. Most participated due to an "intrigue in prediction markets" (27%) or due to the "interesting or relevant" questions (23%).[65] Another 27% noted that they felt some "management influence" to participate. This influence is likely due to the command's request for each section to provide both potential contracts and interested participants.

e. Participant Behavior

According to survey results, 60% of the market participants logged on six to ten times during the course of the week, and the majority spent 3–5 minutes on average inside the market per visit.[66] When asked about, "the biggest factor in your decision NOT to participate at a given moment," 47%

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[63] See Appendix B, Figure 53.

[64] See Appendix B, Figure 54.

[65] See Appendix B, Figure 59.

[66] See Appendix B, Figures 55 and 56.

responded that a “lack of time” was the largest inhibitor, while 27% noted a “lack of knowledge regarding the questions being asked.”[67]

As with the JIFX market, the trading patterns across the market reflected that participants mainly traded widely on the contracts with which they were most familiar, and that on average, they only bought one position per contract. The majority of trades were conducted on the fourth day of the market as trading days two and three were statistically irrelevant given a command-wide Internet outage. (see Figure 13). Also like the JIFX market, the volume of trades dropped significantly after the fourth day.

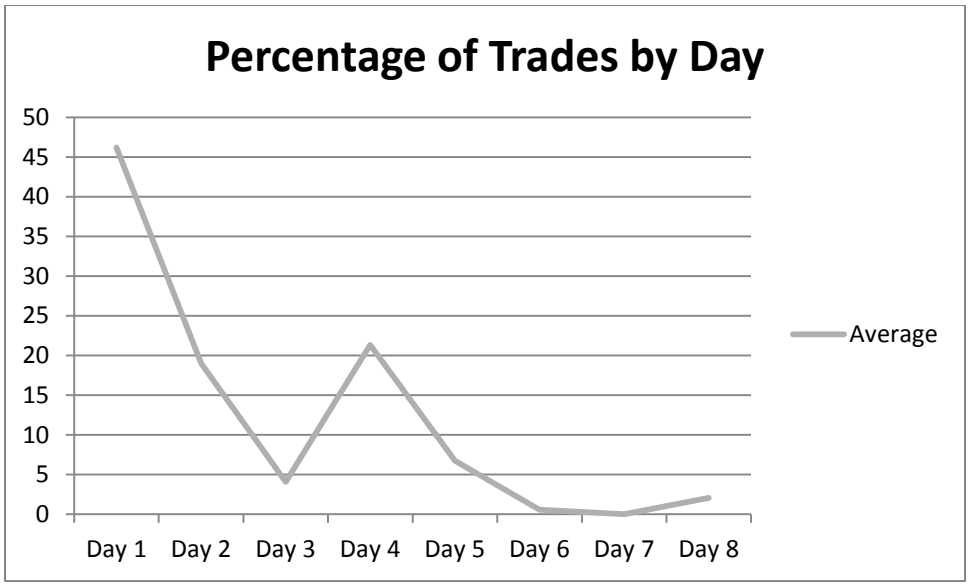

Figure 13. MCIA total trades by contract

Comments throughout the market were sparse. We did not anticipate this result, as one of the anticipated benefits for analysts using prediction markets is the ability to use the forums to generate dialogue concerning forecasts or assessments. The most widely traded contracts were ones concerning the likelihood of an Israeli attack on Iran or a North Korean attack on South Korea which resulted in 47 and 51 trades, respectively.[68] It is

[67] See Appendix B, figure 57.

[68] See Appendix A, Table 11.

also apparent from the market data that questions that involved little expert knowledge or might be perceived as normal “common knowledge” received the most activity. This result is in keeping with the lack of time response above, as specialized questions would likely require some degree of research if the trader is not a subject matter expert. Overall, 64% of the market participants made less than 10 trades, with 28% of the traders accounting for 78% of the trades (see Figure 14).

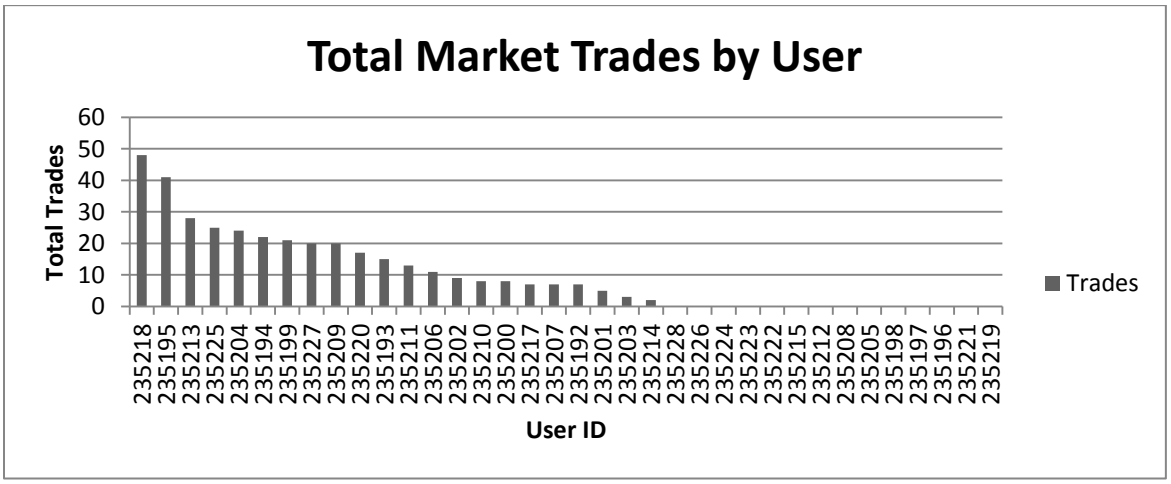

Figure 14. MCIA trades by user

f. Command Involvement

The MCIA Commander gave tacit approval for this market, but was not himself an active participant. Instead, the Production and Analysis Company Commander was given overall cognizance of the project, with his Futures Branch Officer in Charge managing the hands-on setup and implementation of the market. As such, MCIA unit members were encouraged to participate but were not required to participate.

3. 2d Intelligence Battalion

The 2d Intelligence Battalion market was the only completely military market that we ran during our experimentation. Further, this market was the only one with the direct knowledge and participation of the unit Commanding Officer.

2d Intelligence Battalion focuses its intelligence support at the operational level of command and had recently returned from a yearlong deployment to Afghanistan. After discussions with the command Operations Officer, it was determined that the 2d Intelligence Market would mirror the MCIA market contracts with only a few exceptions. Another unique aspect of this market was the makeup of the participants, with nearly 60% of the participants enlisted service members below the rank of Sergeant (E-5). Over the course of nine days, the market resulted in 660 trades by 42 active traders consisting of more than 12,000 shares and $515,000 in “play” money.

a. Market Design

As stated above, the design of the 2d Intelligence Battalion market was based on the MCIA market discussed previously, with three notable exceptions. First, some of the very specific contracts, such as the drug trade in South America or the Islamist movement Boko Haram in Nigeria were dropped since they had little relevance to the mission of 2d Intelligence Battalion. Second, the battalion commander asked for the inclusion of certain contracts as a way to discern the opinions of his Marines on local issues such as local gas prices. Finally, given that the demographics of the market were heavily weighted toward the junior enlisted, we felt that more pop-culture contracts would be needed in order to stimulate trading on the more operationally relevant contracts. One of the unintended consequences of this was that users focused a great deal of attention on these contracts instead of those that would be of actual interest to the command. This also led to minor saturation of the market with contracts that were not necessarily command focused.

b. Length of Contracts

Similar to the MCIA market, the 2d Intelligence market was projected to run for one week following a three-day familiarization market. While trading volume was the highest on day three, the registration rate was not. One potential explanation for the initial lull in registration was the high turnover rate

facing the unit due to planned separations and the granting of leave requests given their recent return from their deployment to Afghanistan. In light of this, the decision was made to extend the market past the weekend to allow extra time for those who desired to participate but had not yet had an opportunity to do so. Also, since several of the contracts were user-submitted, some were not created and able to be traded until later in the week, reducing the likelihood of a high volume of trading. Ultimately, the entire market was capped at nine days in keeping with our initial desire to keep the markets short in overall duration.

	Averages (per contract)	**Totals**
Number of Traders	14.16	53
Number of Trades	34.74	660
Number of Contracts	--	19

Table 8. 2d Intelligence Battalion basic market statistics

c. Participants

To garner participation in the market, we traveled to Camp Lejeune to brief unit leadership and command personnel on our research goals and proposed market framework. We briefed our project three times; once to the Commanding Officer and his Staff, and twice to separate groups of unit analysts. Through these face-to-face iterations, we were able to gain the consent of 53 individuals to participate. Of those 53, 42 registered for an account and made at least one trade.

Of the 53 participants, 57% also completed the post market survey. Of the surveyed participants, 60% were enlisted service members in the grade of E-5 or below.[69] In total, 80% of the participants were enlisted, while 39% of survey respondents would be classified as serving in a leadership role (E-6 or

[69] See Appendix B, Figure 63.

higher). Seventy-three percent of those surveyed reported that they had "some college," with 17% having a bachelor's degree and 7% with a master's degree.[70]

d. Incentives Offered

Initially, our projections for participation levels within this market were very optimistic and based on two lines of reasoning. The first is that this type of technology appeals to a younger demographic in its design and function, and generally ignites a spirit of competition. The second is that anecdotal discussions with participants indicated a desire to provide input and opinion in a non-confrontational and non-attributable manner. Additionally, we felt that incentives might further their desire to contribute, so the Battalion Commanding Officer personally offered the winner of the market a 72-hour liberty pass. As with the MCIA market, winners were determined by overall portfolio worth, most trades made, and most karma points.

While post market survey data for the JIFX and MCIA markets revealed that only 3% of those who completed the post-market survey participated for the chance to win prizes (incentives), 33% of the 2d Intelligence Battalion traders who were surveyed participated for incentives.[71] Admittedly however, the chance to win time off from work may be more valued than the chance for a gift card or case of wine.

e. Participant Behavior

Across the nine-day market, survey results indicate that 40% logged on less than five times, with 73% ultimately logging on less than 10 times. A participants' time per visit was evenly divided across the choices, with 30% falling to 3–5 minutes, 6–10 minutes and more than 10 minutes respectively, and 10% reporting that they spent less than five minutes per visit. Similar to the JIFX and MCIA markets, the 2d Intelligence Battalion survey respondents cited a lack

[70] See Appendix B, Figure 64.

[71] See Appendix B, Figure 69.

of time as their number one reason for not participating “at a given moment.” This is significant, as in this market, the Commanding Officer gave his explicit permission for participants to trade in the market during working hours. The next most common responses were a “lack of knowledge” or a “lack of interest in the question.”[72]

The highest volume of trading in the market occurred on days three and eight (see Figure 15). As discussed above, registration was slow initially as many unit personnel had been granted a long weekend prior to market initiation. The higher volume of trading on day eight is likely a function of participants returning from block leave. Participants in this market appeared reticent to trade a contract more than once or twice. Additionally, since the traders were only granted $5,000 with which to begin trading, many appeared to spread their money out across several contracts.

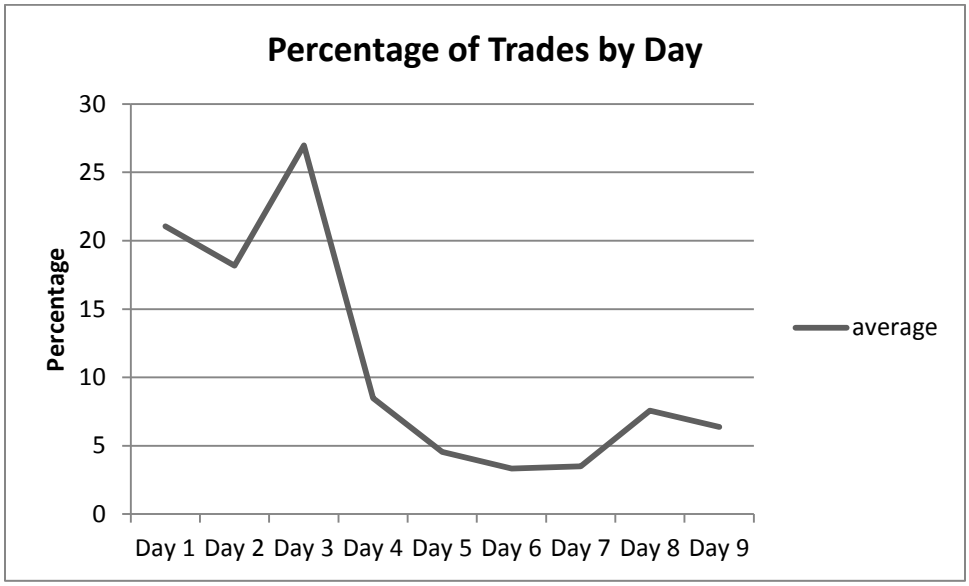

Figure 15. Total trades by contract, by day

[72] See Appendix B, Figure 67.

On average, each trader made just over two trades per contract and each contract averaged about 14 traders per. The two most popular contracts by number of traders both had to do with politics, one regarding the Louisiana Republican Presidential Primary and the other concerning the likelihood of President Obama being reelected. The most heavily traded contract in the market asked about the team that was the most likely to win the 2012 Division I NCAA Men's Basketball Championship (March Madness). In total, 58% of the market participants made less than 10 trades, with 26% of the traders accounting for 79% of the trades (see Figure 16).

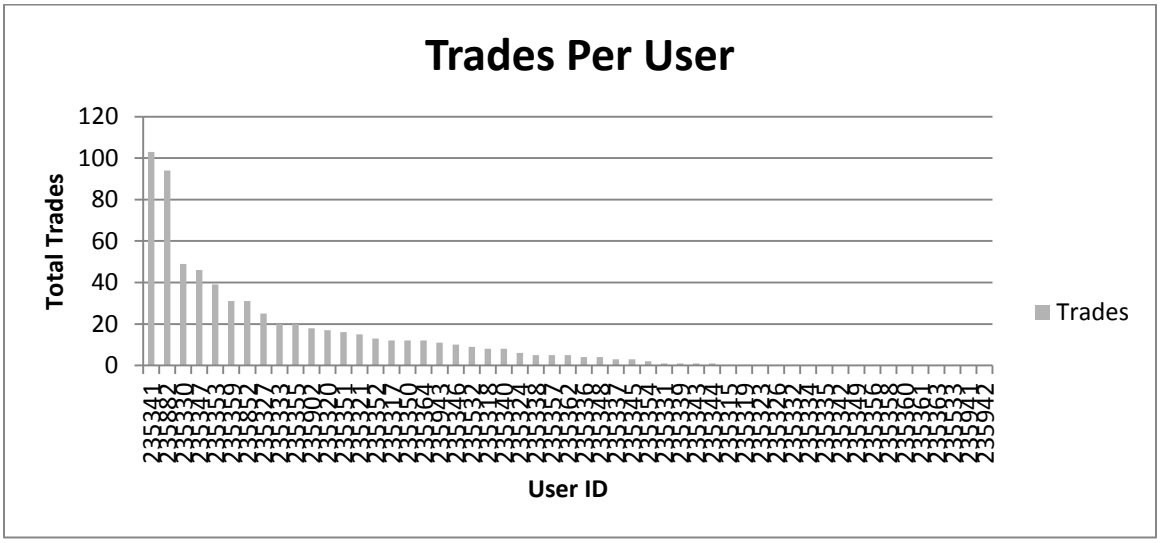

Figure 16. 2d Intelligence Battalion market trades by user

f. Command Involvement

This market had the most command involvement of the three commands. The Battalion Commander was personally involved and highly interested in the results of the experiment as he felt that his analysts could employ prediction markets as an analytic tool.[73] From the planning stages, through market design, and into implementation, the Commander was an active participant and vocal supporter, even going so far as to personally guarantee

[73] Conversation with LtCol Joe Gross, Commanding Officer of 2d Intelligence Battalion, March 8, 2012.

incentives to the winners of his market. The most obvious results of command involvement seems to be a high participation rate at 79% and 1/3 of survey respondents who answered that “management influence” was one of their main reasons for participating in the market.[74] This management influence is not necessarily a pejorative concept however as the 2d Intelligence Battalion market boasted the most participants, the highest registration rate, and the second highest trade per user rate. This is significant in that it clearly illustrates the notion that market success is dependent upon the active attention and participation of command leadership.

[74] See Appendix B, Figure 69.

V. CONCLUSIONS

In totality, the data gathered not only serves to answer the research questions posed, but it also provides a number of potential recommendations for prediction market implementation in military commands as well as a foundation for future research. The conclusions drawn serve as a valid point of departure for designing future markets to be both relevant and useful for the unit that chooses to employ them. By analyzing the trading activity of the three markets and the post-market survey responses detailed in the previous chapter, we were able to draw a fair number of conclusions and provide answers to our research questions.

A. ANSWERING THE RESEARCH QUESTIONS

1. What are the Features of Market Design that Might Encourage Participation in/from Military Units/Individuals?

Participation is without question the single most important factor in determining the utility of any given prediction market, because a prediction market simply will not work without participation from traders. The intuitive nature of this statement does not detract from its importance. As such, our research provided a wide variety of incentives, while also evaluating their efficacy. While it is generally agreed upon that there must be an incentive structure to encourage trading, there has been a dearth of research that compared the tangible incentives of money or prizes to the intangible motivation of personal interest and prestige. Our findings indicate that tangible incentives play far less of a role than previously thought.

In addition to specifying evidence of the aforementioned uninteresting factors, the answers that the survey respondents provided also allow onte to see what factors encourage participation amongst traders. While the primary reason of “Intrique in Prediction Markets” has already been mentioned, the survery

confirms that “competition,” “relevant/interesting questions,” and the “ability to provide an opinion in a non-confrontational forum” also play an enormous role in a trader’s participation calculus.

The three markets employed two different types of incentive prizes in the same three categories. The JIFX and MCIA markets rewarded selected participants with a twenty-dollar gift card, while the 2d Intelligence Battalion market used free vacation days as an incentive. The decision to use liberty passes in lieu of gift cards was suggested by the Battalion Commander. This was fortuitous as it created the opportunity to test the efficacy of a socially acceptable, legal reward within a military system, and it also established the precedence for an incentive that could be continued post-experiment should the unit decide to continue using prediction markets as an analytic tool.

From an anecdotal perspective, it seemed clear during the initial briefings to the participants that the incentives provided were going to play a major role in the individuals’ decision to participate. Participants’ body language (consisting of approving smiles, head nods and chatter about how to spend the money) when the gift cards and liberty passes were mentioned seemed to indicate that a greater than normal rate of participation would be likely. However, the rates of participation in these three prediction markets were not significantly higher than what is typical for a market of this size (i.e., 20 percent of the traders making 80 percent of the trades). Furthermore the preponderance of the evidence provided by the survey indicates that in each market, “Intrigue in the Market” was the primary reason for initial participation.[75] In point of fact, “Incentives (the chance to win prizes)” was one of the least selected responses, accounting for only 20% of the total, though 17% of those were from the 2d Intelligence Battalion market.[76]

[75] See Appendix B, Figure 39.

[76] See Appendix B, Figures 39 and 69.

This finding is especially important to military units, since the concern regarding military use of prediction markets has been heretofore articulated as a "disdain for gambling." In addition, conversations with some commanders have indicated concern that they cannot legally provide tangible incentives such as gift cards. Our findings essentially remove both of these issues from debate given that tangible prizes were a relatively uninteresting factor for most participants.

2. What Market Attributes are Useful for Military Decision (Prediction) Markets (Number and Type of Contracts, Length of Market)?

In addition to answering questions of incentives, the three experimental markets also provided a great deal of insight into type of contracts that traders were most interested in and the duration of such interest. Both the 2d Intelligence Battalion and MCIA markets were designed to include general interest contracts that allowed the participants to make predictions on sports and pop-culture. This was done to encourage a greater degree of liquidity in the market and to "prime the pump" of trader interest in the market. The JIFX market served as a control for this variable as their market did not have any contracts that were not directly related to the experiments conducted at the field exercise. A comparison of the three markets with regards to the type of contracts is telling.

In both the MCIA and 2d Intelligence Battalion markets, the average number of trades per participant were 2.03 and 2.29, respectively.[77] However, in the JIFX market, which did not include "priming" questions of any kind, the average number of trades per participant was 3.35, representing a 40% increase in trading activity. This increase, taken with the survey responses that indicate the importance of "relevant/interesting questions" is powerful evidence that a critically important factor in the success of a contract is the relevance to the user. Put another way, using easy to grasp, general knowledge questions does not appear to serve as a pathway for participants to trade on more complex

[77] The slightly higher average of the 2d Intel market is likely the result of the enormous amount of trading that resulted from a contract regarding the winner of the 2012 NCAA Men's Basketball tournament.

contracts. Overall, the evidence indicates that the single most effective method of inducing trading activity on a particular contract is to craft questions that will be relevant to the market participants.

The interest of a particular user however only seems to run so far. Despite the difference in demographics among the three markets there was one very clear constant between them: each one of the markets saw a substantial decrease in activity after the fourth day of trading. Furthermore, participation was almost entirely absent after the fifth day of trading (see Figure 17).

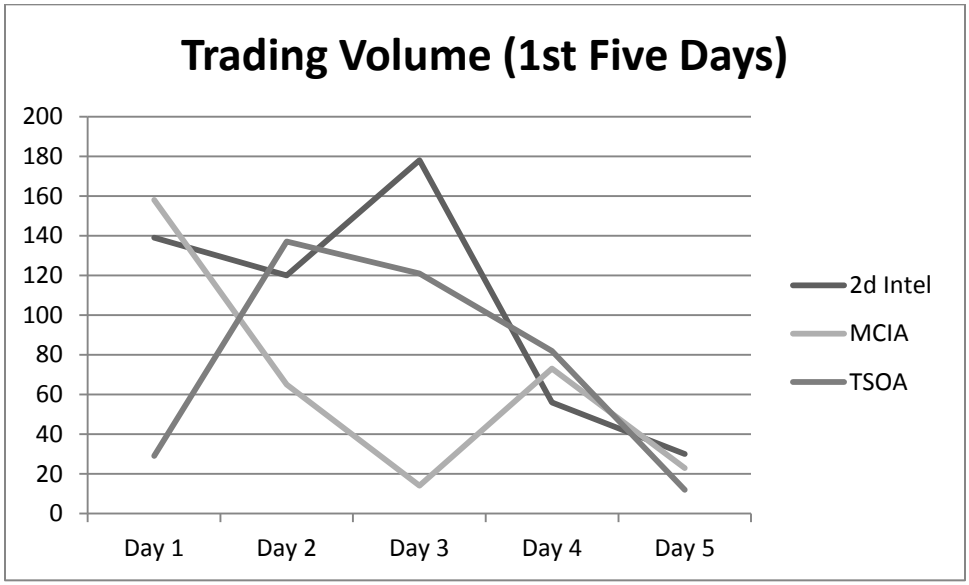

Figure 17. Trading volume across all markets (first five days)

This finding is noteworthy in two respects. The first is that it supports Slamka et al.'s claim that second-generation payoff mechanisms such as final stock price do not induce massive herding or manipulative behavior towards the end of a known trading period.[78] The second is that it suggests a point of diminishing returns on trading volume for markets of this type. Taken together, these points suggest an appropriate timeframe and payoff mechanism for a military market creator. A market with clearly defined contracts that last no more

[78] Slamka, Jank, and Skiera, "Second-Generation Prediction Markets," 29.

than a week appear to be just as effective as those that last much longer. Additionally, our research shows that even if traders know when a contract will end, it has little to no effect on the ultimate contract price, suggesting that at least in these markets, herding was not a factor.

3. How Might a Military Unit Employ Prediction Markets and what Types of Units Might Find Prediction Markets Useful?

In order to answer this two-part question appropriately, one must first discuss the attributes of the three separate test markets. With this in mind, the 2d Intelligence Battalion and MCIA test markets were essentially forecast markets, which, if employed in an actual scenario, would create a series of quantitative forecasts regarding future events. In an entirely different application, the JIFX market functioned as "an idea market"[79] designed to evaluate new product ideas. Understanding the division between these markets is an essential part of understanding what types of units might stand to benefit the most from the employment of a prediction market.

In the case of a forecast market, the intelligence units that participated in the experiment would be an intriguing place to employ a series of markets. Forecasts are a critical part of the intelligence process but are generally the product of a single mind or perhaps a consensus from self-proclaimed subject matter experts. Additionally, well over half of the participants from these two markets indicated that they conducted additional research as a result of their participation in the market.[80] This fact, along with the responses that indicated a desire to "provide information in a non-confrontational forum" is strong evidence that an intelligence organization of a similar type could stand to benefit a great deal both in terms of refined forecasting and increased incentive for the participant to increase their base of knowledge regarding potential analytic judgments.

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[79] Slamka, Jank, and Skiera, "Second-Generation Prediction Markets," 1.

[80] See Appendix B, Figures 58 and 68.

Alternatively, the JIFX market functioned effectively in an entirely different way. Despite the lack of actual event payoffs, this market did not see a substantial drop in trading activity and was actually very successful in terms of its participation rates. Both the trading activity and survey responses supported the notion that traders were not discouraged from participating despite the fact that their contracts would not be settled on the basis of actual future events. In short, traders felt free to express their evaluation without regard to some kind of guaranteed payoff. In terms of potential applications, this could lead one to see the JIFX market as an analogue for a military acquisition unit designed to evaluate equipment for future employment.

Extrapolating from this, there are a variety of units that could stand to benefit a great deal from employing a market of this type. For instance, the 2nd Brigade Combat Team (2BCT), 1st Armored Division at Fort Bliss, Texas, which took over the role of the Army Evaluation Task Force in late 2010 and which has been asked to test and evaluate equipment for future employment on the battlefield[81], could find a prediction market both useful and efficient. As an example, 2BCT could establish a prediction market post-training event, ask a series of questions regarding the tested equipment and aggregate the opinions of the entire Brigade in relatively short order, while gathering results in an objective and quantifiable manner rather than as a subjective assessment.

4. What are the Challenges Associated with the use of Prediction Markets in Military Decision-Making?

Whenever an attempt is made to introduce and integrate a new tool into a military unit there are always challenges. Prediction markets are unlikely to be immune from such challenges. The impediments to implementation are various, ranging from the logistical to the intangible, but the major barriers are not impossible to overcome.

[81] John Hall, "Fort Bliss Unit Changes Command, Takes on Systems-Testing Mission," *El Paso Times*, November 17, 2010, accessed May 31, 2012, http://www.elpasotimes.com/news/ci_16631304?IADID=Search-www.elpasotimes.com-www.elpasotimes.com.

First and foremost prediction markets are largely a software-based application. It is not outside the realm of possibility that a member of the unit could create an application of their own volition, but this is extremely unlikely. Therefore, a unit would need to purchase the license for a software application from a company such as Inklingmarkets.com, as well as provide traders with a means of access to the trading instrument, e.g., a computer terminal. Though an analysis of this cost compared with the cost of current evaluation methods is beyond the scope of this thesis, it is conceivable that the use of prediction markets could represent a more efficient use of the unit's time and energy in terms of man hours spent evaluating and aggregating information.

Time not only represents one of the largest barriers to participation and implementation but also the most rectifiable. According to survey respondents, the single largest barrier to participation was a perceived lack of time, cited as a reason for reducing trading activity by 45% of total respondents.[82] The solution to this problem does not require a great deal of elaboration or sophisticated problem solving. In fact, the simplest of solutions might be the most effective. A unit that chooses to employ a prediction market should not do so as an additional requirement. At least initially, a unit should provide a sanctioned block of time to allow for market participation that does not impinge on a participant's current responsibilities. It would be naïve to assume that the above is all that is needed to solve the problem, but at a minimum, the survey responses represent a fairly clear description of one of the challenges facing military market creators.

B. RECOMMENDATIONS FOR IMPLEMENTATION

The experimental markets conducted highlight a number of key issues that should be taken seriously if a prediction market is to be implemented in the context of military decision-making. Additionally, there are more than a few reasons to be optimistic about the potential scale-ability of prediction markets in the military. In general terms, the survey evidence indicates that respondents

[82] See Appendix B, Figure 37.

believe that prediction markets have application in a wide variety of military contexts that is only limited by one's imagination. Additionally, with the bulk of the evidence provided by the three experimental markets suggesting that prediction markets are feasible for use within a military organization, there is a great deal of motivation to search for areas of potential application.

After identifying areas in which prediction markets might prove useful, the implementer or market maker must pay special attention to two key concepts: purpose and participation. Questions of purpose refer to what the market creator is attempting to achieve by initiating the market. For instance, the creator must decide whether or not the market will serve as an idea market designed to evaluate the utility of a particular piece of equipment or the potential efficacy of a particular strategy. The desired effect of the market will therefore drive the type of payoff mechanisms used. In addition, evaluating purpose also influences the type of contracts to be traded and the liquidity needed to drive the market. For instance, the JIFX market required a contract representing each experiment presented during the exercise. Had the number of participants dropped below a certain level, there might not have been enough liquidity to drive prices to equilibrium. Clearly this is speculation, but care should be taken to stay as close to the optimal number of contracts (8–12) as possible.

Questions of participation relate to the aforementioned issues of time and incentives. The idea that tangible incentives are necessary can be discounted based on the available evidence from our experimental markets, which is a positive outcome for military units on a limited budget or those weary of encouraging the perception of "gambling." The military market creator should seek to focus on the major driving force of participation as indicated by the survey responses: relevant and interesting questions. As such, an investment of intellectual capital in the craftsmanship of clear, interesting and germane contracts are likely to see a substantial return in terms of participation. Furthermore, and as mentioned previously, allowing adequate time for such participation is a key requirement from the participant's perspective. Simply

stated, the most interesting questions available can easily go unanswered if a trader feels as though their daily duties will suffer by participating.

C. LESSONS LEARNED DURING EXPERIMENTATION

Throughout our research and experimentation, we encountered several areas that deserve specific mention for those undertaking this sort of research in the future. The first, is that pop-culture or general knowledge type contracts are unnecessary to encourage participation. In point of fact, these types of questions can siphon attention away from contracts that the market administrator is truly interested in.

Another area of lost focus is generated by user-initiated contracts. Our initial hypothesis was that allowing users to submit their own contracts to the market would be another way to encourage participation. In practice however, what we found was that the users submitting contracts were already prolific traders and had a great desire to participate and succeed in the market. Quickly, we realized that these user-defined contracts could easily shift the focus from relevant and interesting contracts to the entire market to contracts that were only interesting to certain niches of the market.

Finally, we anticipated that the software's comment system would be a key component of interest for military units, especially intelligence units. Our hypothesis in this regard was that the user created dialogue concerning each contract would not only increase the overall knowledge base of the market participants and encourage better trading, but that the dialogue created would lead to improved communication throughout the unit on issues of analysis, forecasting, and the subject matter of the contract. While we were not able to specifically determine whether or not this phenomena actually occurred, it was clear that comments on a trade or a contract could drive future trading action both positively and negatively. This is especially important in regards to senior-subordinate relationships and user concerns over anonymity inside the marketplace.

D. RECOMMENDATIONS FOR FUTURE RESEARCH

The experimental markets tested in this research provide a great deal of insight regarding implementation, but due to limitations in research scope, do not provide evidence of accuracy when used by a military unit for decision-making purposes. Nor do they measure whether or not, or how often, military decision makers (especially Commanders) would utilize prediction market outcomes. Therefore, one logical step of research would be to implement the best practices recommended here for implementation in an effort to test the accuracy of the predictive markets and the efficacy of the idea markets.

Some other areas of future research in this area of military prediction markets might focus on larger markets containing more participants, and longer markets consisting of contracts with a high rate of turnover.

One area that we were able to test indirectly, and definitely an area of future interest, is that of binary contracts versus open-ended contracts. As we conducted our research, few, if any, prediction markets that we encountered asked open-ended questions. Our interactions with the units involved in our research have informed our opinion that while binary contracts are easy to trade on and pay off, open-ended questions are of great importance and utility to the military in general, and intelligence units in particular. Our experimentation shows that traders are willing to participate in contracts where an answer cannot be known, or will not be known until sometime later in the future.

Finally, given the demographics of our markets and the nature of the military, it might be informative to test all-volunteer markets versus assigned-personnel markets. While we believe that markets work best when those interested parties are given the ability to participate at their leisure, the military has a unique structure that might allow markets to flourish when individuals are assigned to participate as part of their normal duties. If nothing else, this would alleviate their concerns over their perceived time constraints.

APPENDIX A: PREDICTION MARKET EXPERIMENTATION DATA

A. COMBINED MARKETS

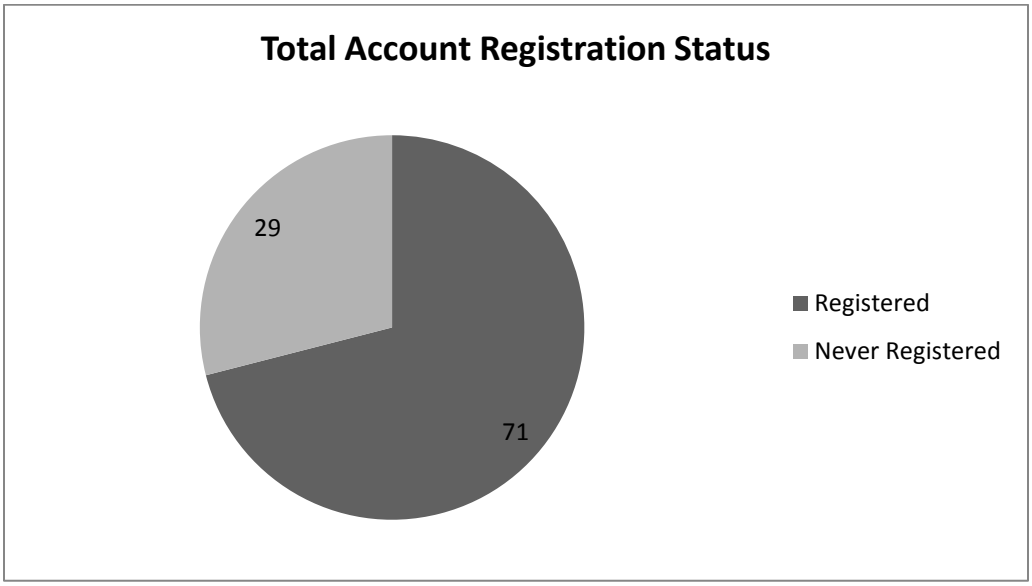

Figure 18. Total registration status in percentage

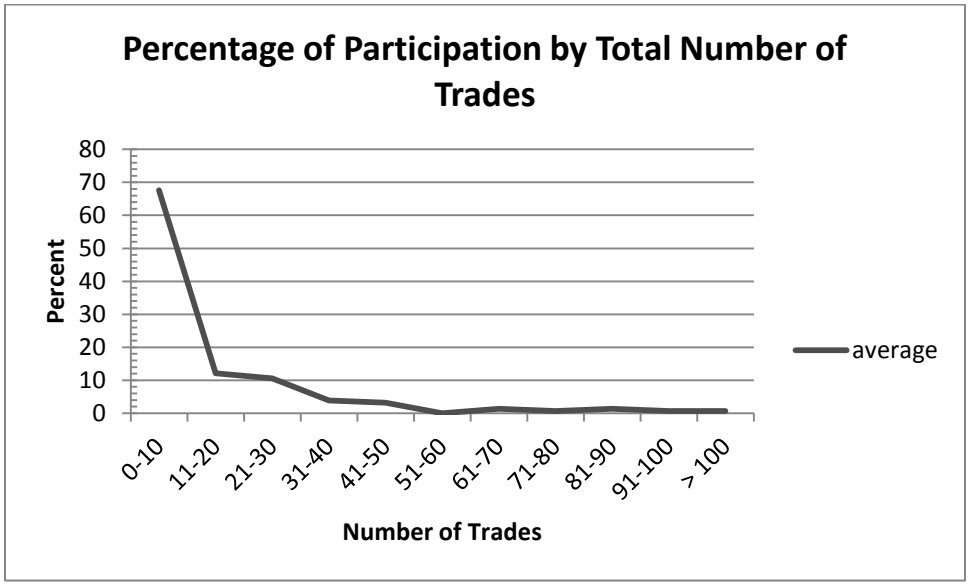

Figure 19. Total participation in all markets as determined by the total number of trades made

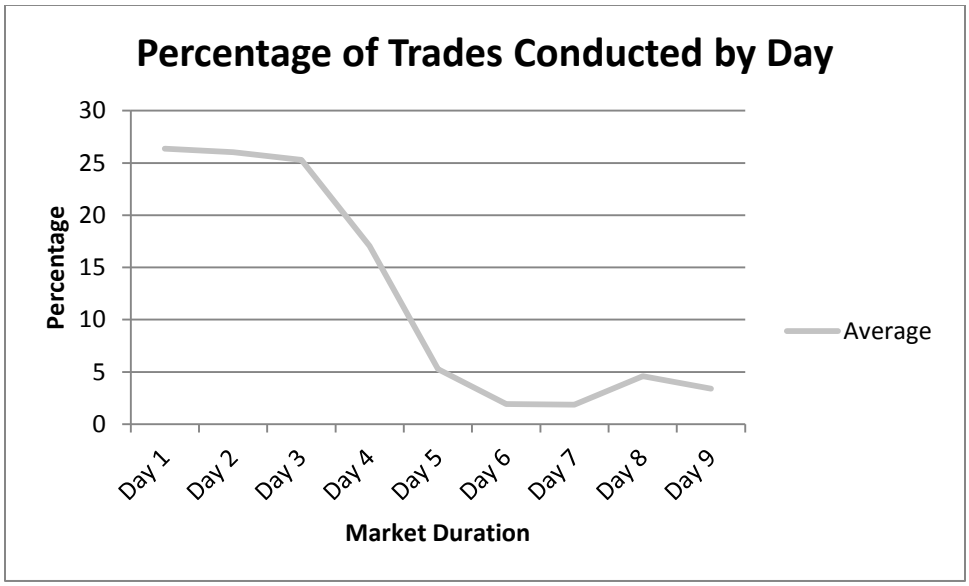

Figure 20. Percentage of trades conducted across all markets by day

B. JIFX/TSOA/RELIEF MARKET DATA

1. Contracts

Contract	# of traders	# of trades	Avg # of trades
JIFX: Which of these technologies deploys with the smallest overall footprint (size of gear, amount of personnel needed to operate/maintain, etc…)?	2	5	2.50
JIFX: Which of these technologies is the least vulnerable to adversary activity (jamming, interception, deception, denial, spoofing, etc…)?	3	11	3.67
JIFX: Which of these technologies is the most likely to be present within US Army supply systems by 2015?	4	10	2.50
JIFX: Which one of these technologies provides the most immediate capability to units for use in Force Protection (tech that is mature and available for immediate employment)?	2	6	3.00
RELIEF: Which of these technologies deploys with the smallest footprint (size of gear, amount of personnel needed to operate/maintain it, etc…)?	2	5	2.50
RELIEF: Which of these technologies is the least vulnerable to adversary activity (jamming, interception, deception, denial, spoofing, etc…)?	2	3	1.50
RELIEF: Which of these technologies is the most likely to be present within US Army supply systems by 2015?	3	5	1.67
RELIEF: Which of these technologies provides the most immediate capability to units for use in Force Protection (tech is mature and available for immediate employment)?	5	11	2.20
TSOA: Which of these technologies deploys with the smallest footprint (size of gear, amount of personnel needed to operate/maintain it, etc…)?	22	55	2.50
TSOA: Which of these technologies is the least vulnerable to adversary activity (jamming, interception, deception, denial, spoofing, etc…)?	10	34	3.40
TSOA: Which of these technologies is the most likely to be present within US Army supply systems by 2015?	15	61	4.07
TSOA: Which of these technologies provides the most immediate capability to units for use in Force Protection (tech is mature and available for immediate employment)?	13	166	12.77
Will the planned draw-down in Military Manpower numbers make Deployable Force Protection Technologies for protecting small (<300 people) command posts more important?	7	9	1.29
Averages	6.92	29.31	3.35
Totals	46	381	8.28

Table 9. All contracts for the JIFX market with basic statistics

Contract	# of trades per day					# of days on market	# of shares traded per contract	Liquidity	# of comments
	Day 1	Day 2	Day 3	Day 4	Day 5				
JIFX: Which of these technologies deploys with the smallest overall footprint (size of gear, amount of personnel needed to operate/maintain, etc...)?	0	3	2	0	0	5	33	$1,654.05	3
JIFX: Which of these technologies is the least vulnerable to adversary activity (jamming, interception, deception, denial, spoofing, etc...)?	0	1	5	5	0	5	69	$3,472.07	5
JIFX: Which of these technologies is the most likely to be present within US Army supply systems by 2015?	0	6	3	0	1	5	62	$3,118.21	5
JIFX: Which one of these technologies provides the most immediate capability to units for use in Force Protection (tech that is mature and available for immediate employment)?	1	5	0	0	0	5	33	$1,661.24	3
RELIEF: Which of these technologies deploys with the smallest footprint (size of gear, amount of personnel needed to operate/maintain it, etc...)?	1	4	0	0	0	5	31	$1,568.85	4
RELIEF: Which of these technologies is the least vulnerable to adversary activity (jamming, interception, deception, denial, spoofing, etc...)?	1	2	0	0	0	5	25	$1,241.25	2
RELIEF: Which of these technologies is the most likely to be present within US Army supply systems by 2015?	1	3	1	0	0	5	24	$1,210.79	2
RELIEF: Which of these technologies provides the most immediate capability to units for use in Force Protection (tech is mature and available for immediate employment)?	6	2	3	0	0	5	86	$4,358.61	2
TSOA: Which of these technologies deploys with the smallest footprint (size of gear, amount of personnel needed to operate/maintain it, etc...)?	3	16	22	11	3	5	550	$29,948.57	6
TSOA: Which of these technologies is the least vulnerable to adversary activity (jamming, interception, deception, denial, spoofing, etc...)?	1	10	19	3	1	5	252	$12,985.55	6
TSOA: Which of these technologies is the most likely to be present within US Army supply systems by 2015?	3	18	17	22	1	5	636	$34,210.91	5
TSOA: Which of these technologies provides the most immediate capability to units for use in Force Protection (tech is mature and available for immediate employment)?	12	67	49	36	2	5	1629	$87,270.76	40
Will the planned draw-down in Military Manpower numbers make Deployable Force Protection Technologies for protecting small (<300 people) command posts more important?	0	0	0	5	4	2	123	$6,787.04	1
Averages	2.23	10.54	9.31	6.31	0.92	4.77	273.31	$14,575.99	6.46
Totals	29	137	121	82	12		3553	$189,487.90	84

Table 10. Detailed statistics for JIFX market contracts

2. Registration and Trading Statistics

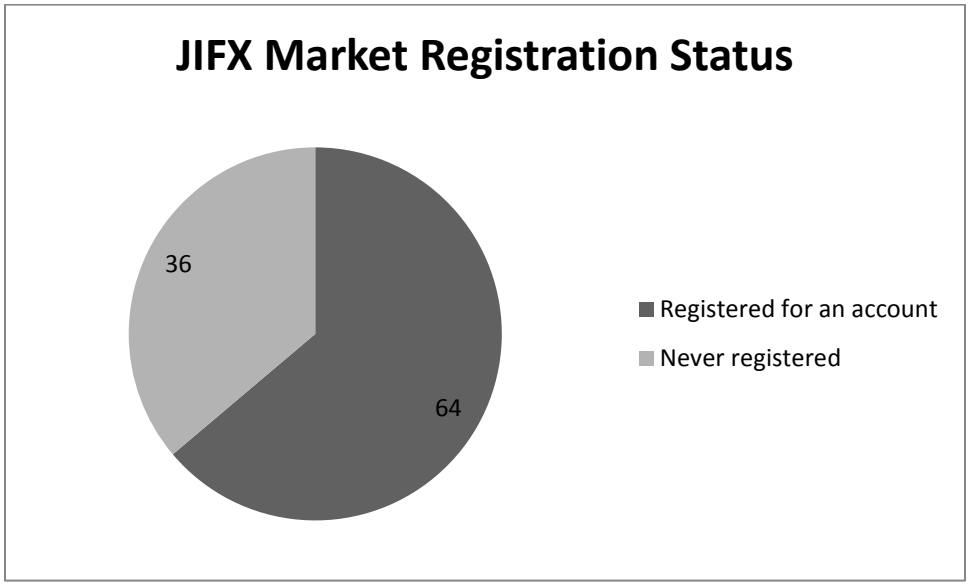

Figure 21. JIFX market registration status

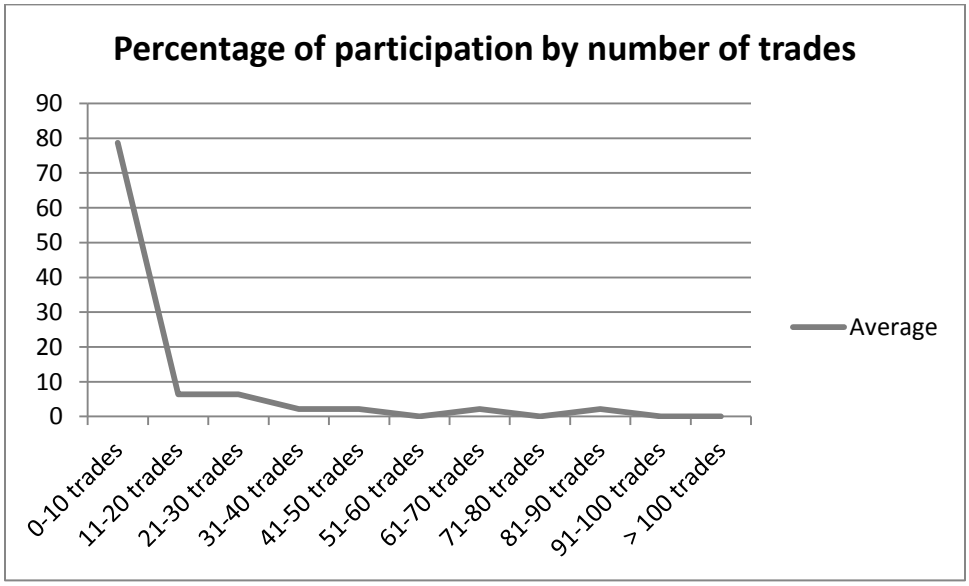

Figure 22. Total participation in the JIFX market as determined by the total number of trades made

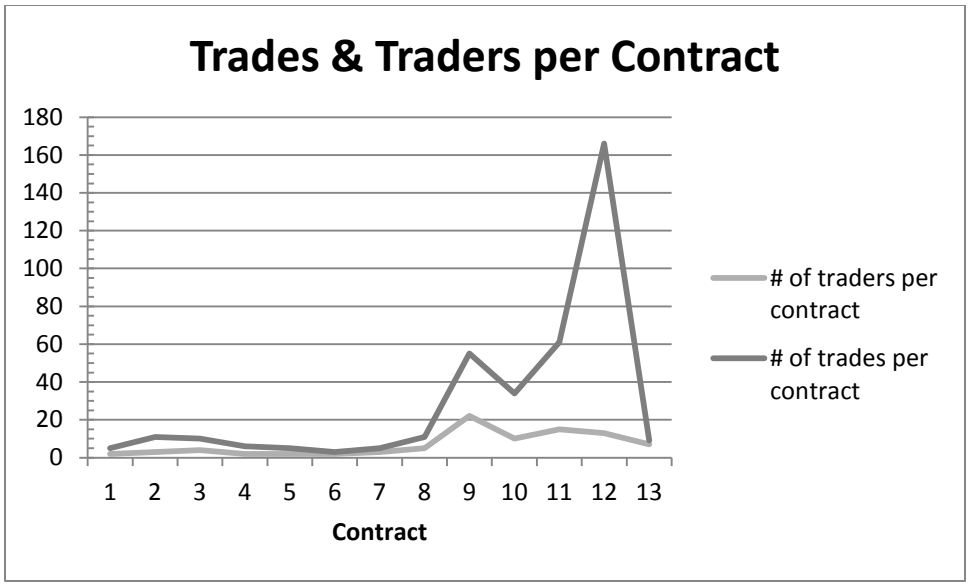

Figure 23. JIFX trades and traders by contract

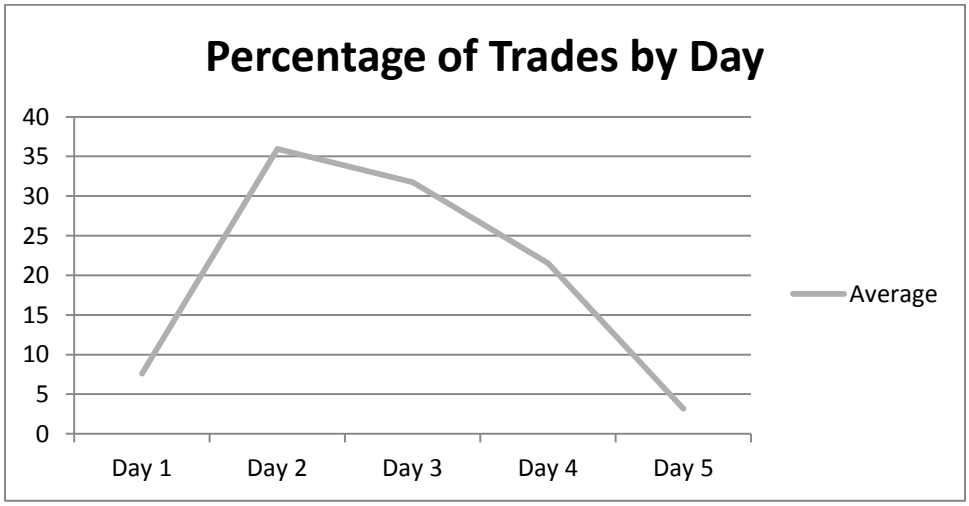

Figure 24. JIFX percentage of trades by market day

C. MCIA

1. Contracts

Contract	# of traders per contract	# of trades per contract	Avg # of trades per user
How will President Chavez's health issue affect stability in Venezuela over the next 12 months?	17	32	1.88
How will the drug trade in Central America evolve in response to increased US counter-narcotics efforts over the next 5 years?	14	23	1.64
Nonstate actors can cheaply put an EFP or explosive on a semiautonomous(SA) UAV and aim it at a high impact target. What is the likelihood of the following occurring by 1/20/2013?	9	17	1.89
North Korea will commit a provocative attack on US or South Korean interests within:	21	51	2.43
Which NFL team will sign former Indianapolis Colts quarterback Peyton Manning?	11	31	2.82
Which of the Men's NCAA Tournament #1 seeded teams will lose first?	7	22	3.14
Will another blue on green attack(Afghan National Security Forces attack on ISAF forces) occur in Afghanistan in the next two weeks?	6	13	2.17
Will Boko Haram's (Nigerian Islamist movement) increase in attacks against western influence ignite religious conflict throughout Nigeria in the next 12 months?	10	14	1.40
Will Israel conduct a military attack on Iran prior to the US presidential elections in November 2012?	19	47	2.47
Will Libya devolve into civil war before March 2013?	12	20	1.67
Will Syrian President Bashar al-Assad remain in power through September 2012?	20	37	1.85
Will the US be involved in a NEO or humanitarian mission in Syria (or along the Syrian border) before the US presidential election?	12	21	1.75
Will Yemen experience a military coup before 31 December 2012?	11	14	1.27
Averages	13.00	26.31	2.03
Totals	36	342	

Table 11. MCIA market contracts and basic statistics

Contract	# of trades per day								# of days on market	# of shares traded per contract	Liquidity	# of comments
	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8				
How will President Chavez's health issue affect stability in Venezuela over the next 12 months?	15	3	4	5	4	0	0	1	8	210	$4,751.63	2
How will the drug trade in Central America evolve in response to increased US counter-narcotics efforts over the next 5 years?	8	5	2	5	2	0	0	1	8	159	$3,963.39	1
Nonstate actors can cheaply put an EFP or explosive on a semiautonomous(SA) UAV and aim it at a high impact target. What is the likelihood of the following occurring by 1/20/2013?	5	8	0	0	4	0	0	0	8	77	$3,884.25	3
North Korea will commit a provocative attack on US or South Korean interests within:	27	12	0	9	1	0	0	2	8	370	$7,814.81	5
Which NFL team will sign former Indianapolis Colts quarterback Peyton Manning?	13	4	2	4	6	2	0	0	8	316	$6,842.39	0
Which of the Men's NCAA Tournament #1 seeded teams will lose first?	7	5	4	2	2	0	0	2	8	148	$3,845.86	0
Will another blue on green attack(Afghan National Security Forces attack on ISAF forces) occur in Afghanistan in the next two weeks?	0	0	0	11	2	0	0	0	5	82	$4,406.00	1
Will Boko Haram's (Nigerian Islamist movement) increase in attacks against western influence ignite religious conflict throughout Nigeria in the next 12 months?	6	1	0	7	0	0	0	0	8	88	$4,449.10	1
Will Israel conduct a military attack on Iran prior to the US presidential elections in November 2012?	33	6	0	7	0	0	0	1	8	427	$25,792.62	1
Will Libya devolve into civil war before March 2013?	11	4	1	4	0	0	0	0	8	105	$4,915.90	0
Will Syrian President Bashar al-Assad remain in power through September 2012?	21	5	0	10	1	0	0	0	8	249	$13,947.20	4
Will the US be involved in a NEO or humanitarian mission in Syria (or along the Syrian border) before the US presidential election?	2	10	1	7	1	0	0	0	8	112	$5,389.09	2
Will Yemen experience a military coup before 31 December 2012?	10	2	0	2	0	0	0	0	8	71	$3,464.49	0
Averages	12.15	5.00	1.08	5.62	1.77	0.15	0.00	0.54	7.77	185.69	$7,189.75	1.54
Totals	158	65	14	73	23	2	0	7		2414	$93,466.73	20

Table 12. Detailed statistics for MCIA market contracts

2. Registration and Trading Statistics

Figure 25. MCIA market registration status

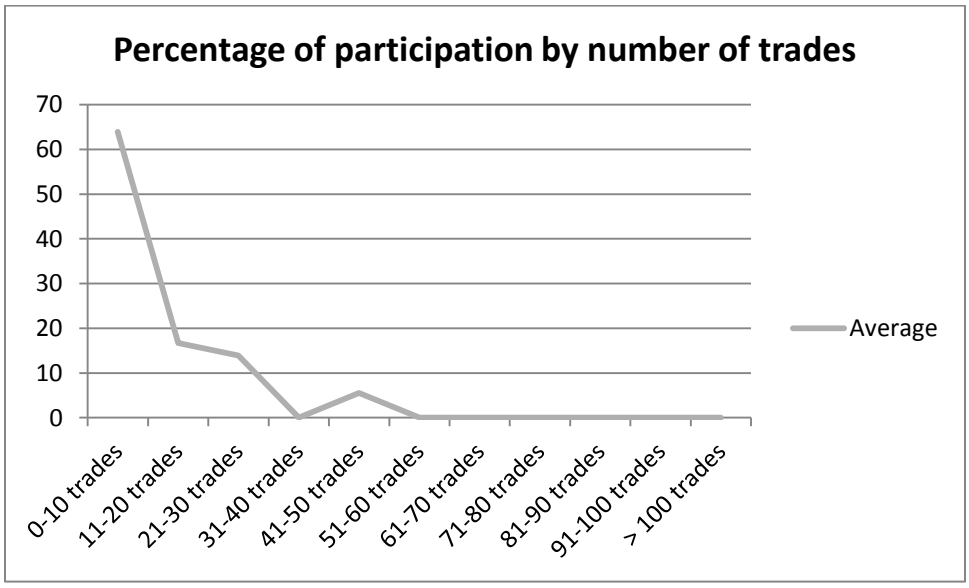

Figure 26. Total participation in the MCIA market as determined by the total number of trades made

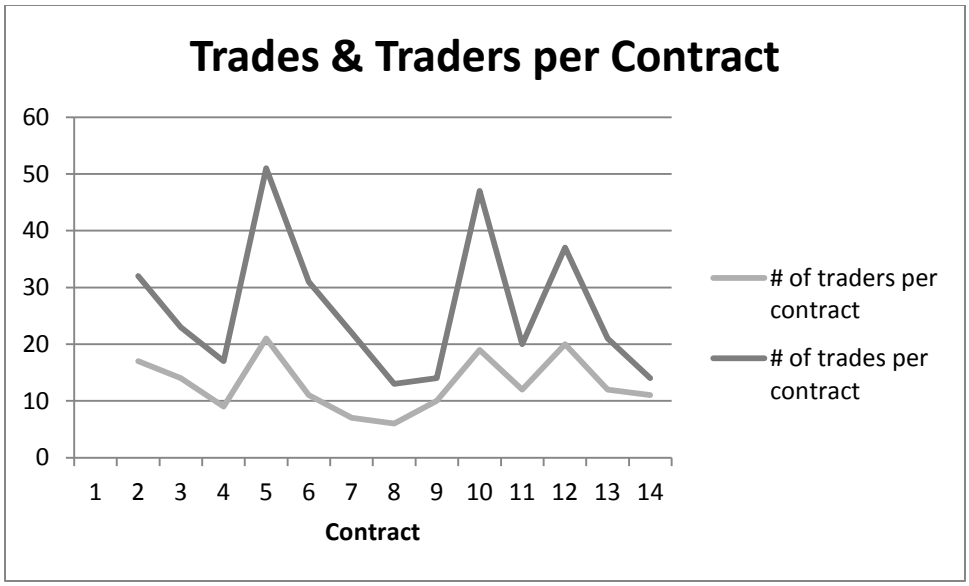

Figure 27. MCIA trades and traders by contract

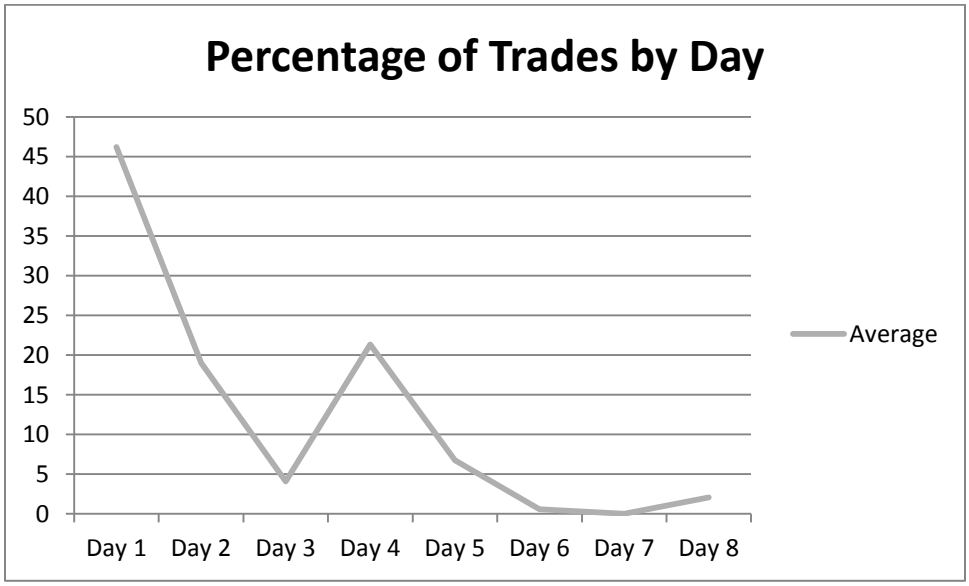

Figure 28. MCIA percentage of trades by market day

D. 2D INTELLIGENCE BATTALION

1. Contracts

Contract	# of traders per contract	# of trades per contract	Avg # of trades per user
According to GasBuddy.com, what will the average price for a gallon of unleaded gasoline be on Saturday, 24 March 2012, for the city of Jacksonville, NC?	19	45	2.37
What will the combined score of the Syracuse versus Ohio State Men's NCAA Basketball Elite 8 game be on Saturday March 24th?	2	2	1.00
Which of these teams will win the NCAA Men's Basketball Championship?	19	71	3.74
Which republican presidential candidate will win the Louisiana GOP primary on Saturday, 24 March 2012?	20	61	3.05
Who will be drafted first overall in the 2012 NFL Draft?	18	59	3.28
Who will start at Quarterback for the NY Jets first regular season game?	9	14	1.56
Will "The Hunger Games" bring in more than $120 million in its opening weekend?	7	13	1.86
Will a "green on blue" attack (ANSF attack against U.S./ISAF forces) occur in Afghanistan before 31 March 2012?	14	36	2.57
Will a foreign or multinational military force fire on, invade, or enter Iran before 1 September 2012?	13	33	2.54
Will a foreign or multinational military force fire on, invade, or enter Syria between 19 March 2012 and 31 December 2012?	15	32	2.13
Will a North Korean or multinational military force fire on, invade, or enter South Korea before 1 June 2012?	19	43	2.26
Will at least one official Taliban representative be appointed to serve as a minister in the Afghan government before 1 January 2013?	14	35	2.50
Will Iran successfully detonate a nuclear device, either atmospherically, underground, or underwater before 1 January 2013?	19	42	2.21
Will North Korea successfully launch a satellite before 30 April 2012?	8	14	1.75
Will Syrian President Bashar al-Assad remain in power through 30 September 2012?	12	28	2.33
Will the New York Knicks beat the Toronto Raptors on Tuesday, March 20th?	11	15	1.36
Will the U.S. be involved in a NEO or HA mission in Syria (or along the Syrian border) before the 2012 U.S. presidential election?	16	41	2.56
Will U.S. President Barack Obama be re-elected?	25	56	2.24
Will Yemen experience a military coup before 31 December 2012?	9	20	2.22
Averages	14.16	34.74	2.29
Totals	53	660	

Table 13. 2d Intel market contracts and basic statistics

Contract	# of trades per day									# of days on market	# of shares traded per contract	Liquidity	# of comments
	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9				
According to GasBuddy.com, what will the average price for a gallon of unleaded gasoline be on Saturday, 24 March 2012, for the city of Jacksonville, NC?	10	6	14	9	6	-	-	-	-	6	522	$20,642.30	2
What will the combined score of the Syracuse versus Ohio State Men's NCAA Basketball Elite 8 game be on Saturday March 24th?	1	1	-	-	-	-	-	-	-	2	26	$3,866.20	0
Which of these teams will win the NCAA Men's Basketball Championship?	26	12	9	1	6	1	0	10	6	9	4145	$65,414.84	0
Which republican presidential candidate will win the Louisana GOP primary on Saturday, 24 March 2012?	11	6	27	12	3	2	0	0	0	6	1130	$59,843.16	3
Who will be drafted first overall in the 2012 NFL Draft?		22	22	4	0	0	3	5	3	8	623	$34,485.68	3
Who will start at Quarterback for the NY Jets first regular season game?	-	-	-	-	-	-	-	5	9	2	300	$11,784.80	1
Will "The Hunger Games" bring in more than $120 million in its opening weekend?	-	-	-	-	2	10	1	-	-	3	807	$52,442.46	1
Will a "green on blue" attack (ANSF attack against US/ISAF forces) occur in Afghanistan before 31 March 2012?	7	10	8	3	1	0	2	5	0	9	520	$31,809.86	0
Will a foreign or multinational military force fire on, invade, or enter Iran before 1 September 2012?	6	8	8	3	2	0	0	2	4	9	314	$14,208.44	0
Will a foreign or multinational military force fire on, invade, or enter Syria between 19 March 2012 and 31 December 2012?	4	3	13	2	1	0	1	4	4	9	530	$30,007.99	1
Will a North Korean or multinational military force fire on, invade, or enter South Korea before 1 June 2012?Â	10	12	9	2	2	2	1	3	2	9	623	$26,115.79	1
Will at least one official Taliban representative be appointed to serve as a minister in the Afghan government before 1 January 2013?	11	6	6	3	2	1	2	2	2	9	396	$23,453.42	4
Will Iran successfully detonate a nuclear device, either atmospherically, underground, or underwater before 1 January 2013?	13	9	8	5	0	0	0	3	4	9	364	$16,145.73	1
Will North Korea successfully launch a satellite before 30 April 2012?	-	-	-	-	-	5	6	2	1	4	95	$4,964.96	0
Will Syrian President Bashar al-Assad remain in power through 30 September 2012?	4	5	9	3	0	0	2	3	2	9	488	$28,679.03	1
Will the New York Knicks beat the Toronto Raptors on Tuesday, March 20th?	11	4	-	-	-	-	-	-	-	2	389	$26,166.63	1
Will the US be involved in a NEO or HA mission in Syria (or along the Syrian border) before the 2012 US presidential election?	8	8	13	2	4	0	1	2	3	9	311	$14,107.70	1
Will U.S. President Barack Obama be re-elected?	13	7	25	3	1	1	2	3	1	9	513	$24,850.53	4
Will Yemen experience a military coup before 31 December 2012?	4	1	7	4	0	0	2	1	1	9	480	$25,610.45	0
Averages	9.27	7.50	12.71	4.00	2.00	1.47	1.53	3.33	2.80	6.95	661.89	$27,084.21	1.26
Totals	139	120	178	56	30	22	23	50	42		12576	$514,599.97	24

Table 14. 2d Intel detailed statistics

2. Registration and Trading Statistics

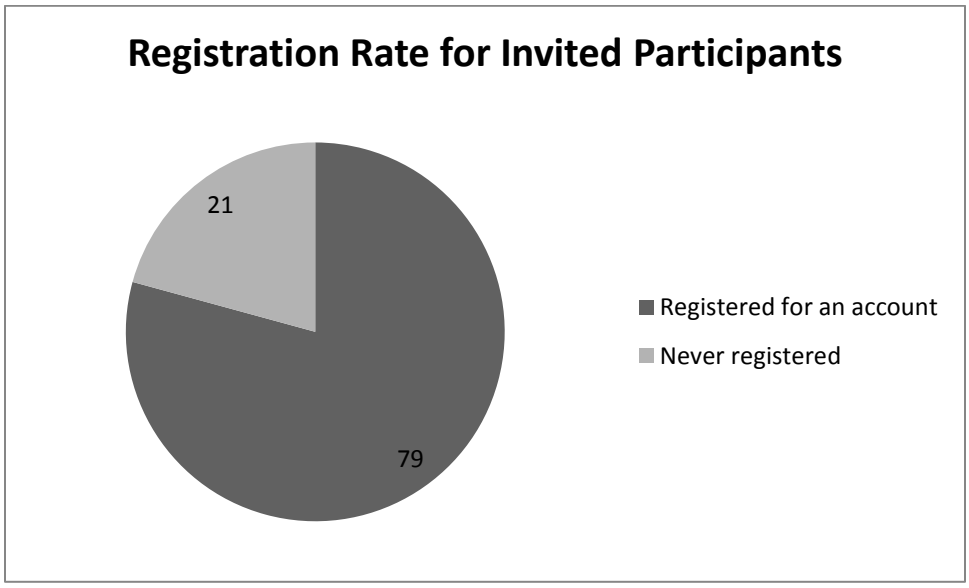

Figure 29. 2d Intel market registration status

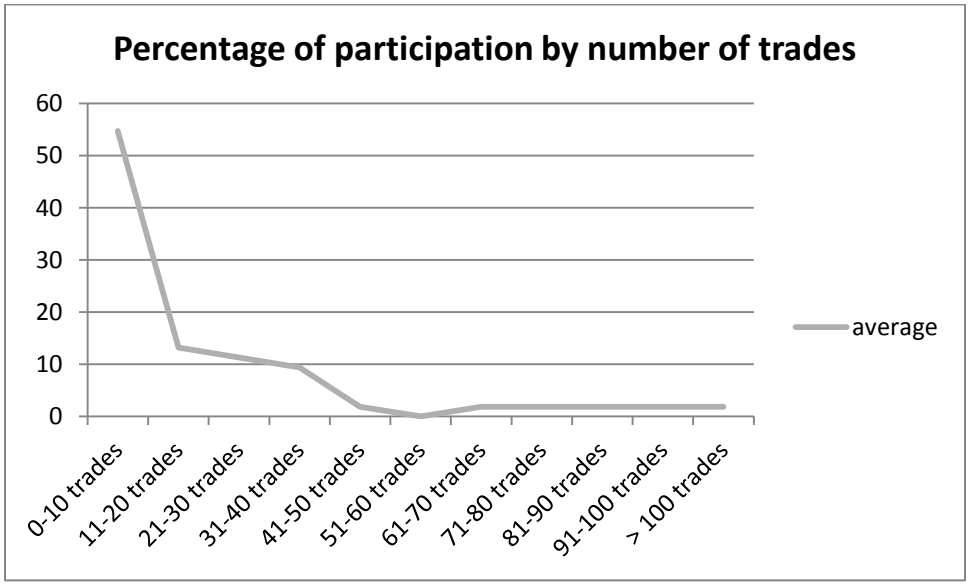

Figure 30. Total participation in the 2d Intel market as determined by the total number of trades made

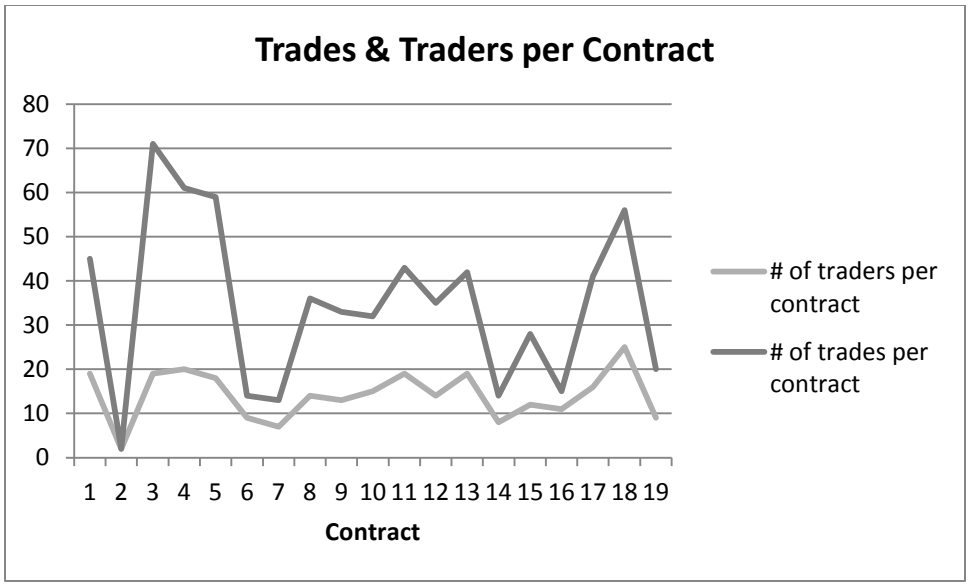

Figure 31. 2d Intel trades and traders by contract

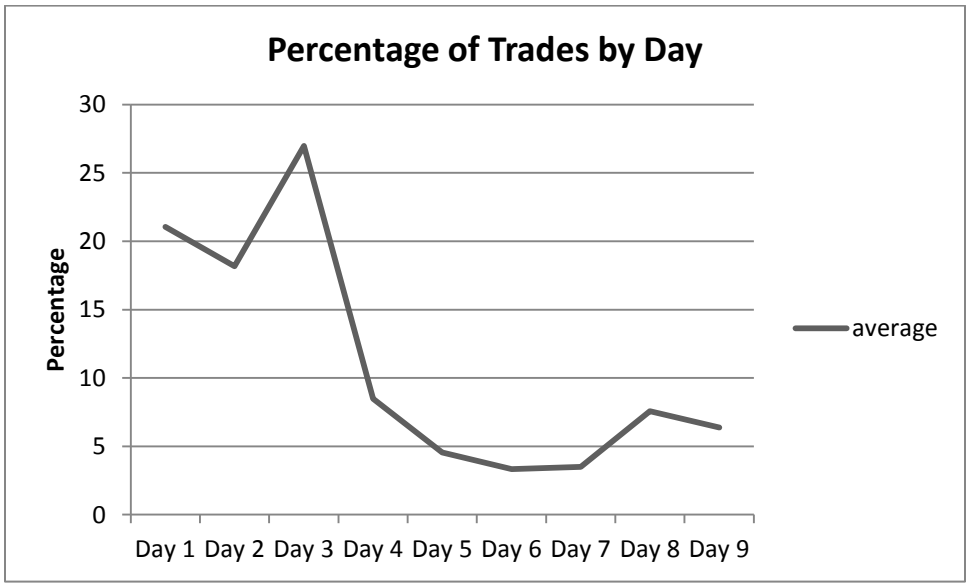

Figure 32. 2d Intel percentage of trades by market day

APPENDIX B: PREDICTION MARKET SURVEY DATA

A. COMBINED SURVEY DATA

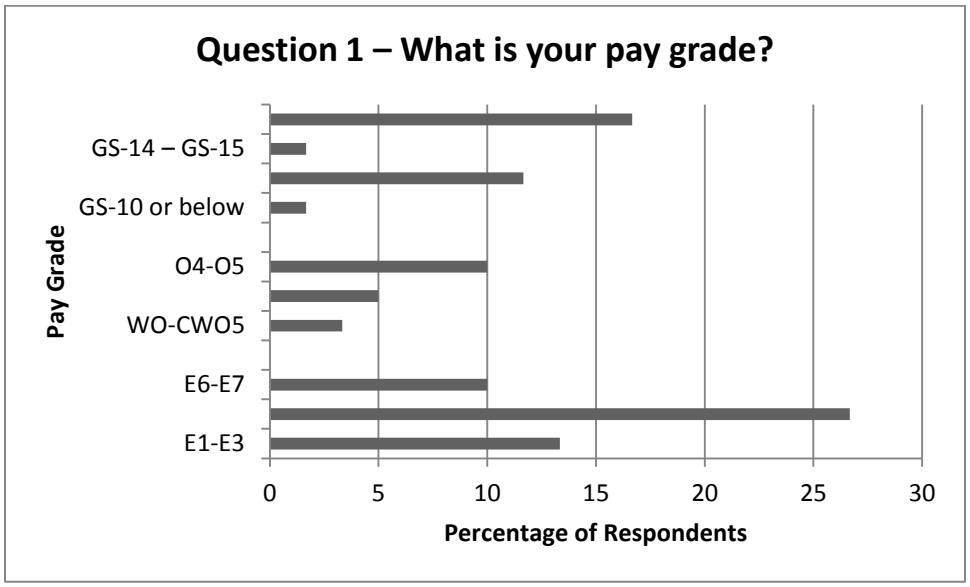

Figure 33. Rank/Pay grades of market participants (combined market survey data)

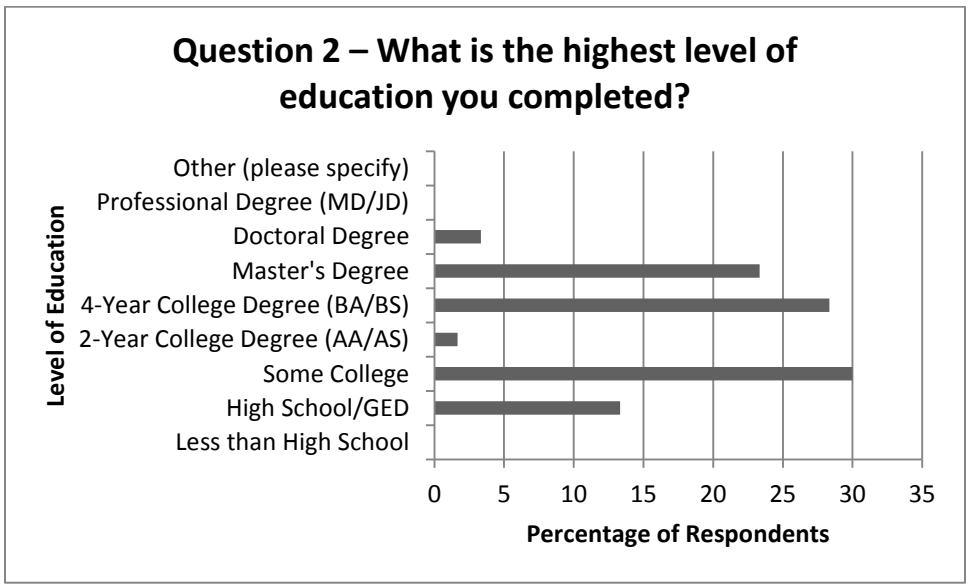

Figure 34. Education Level of market participants (combined market survey data)

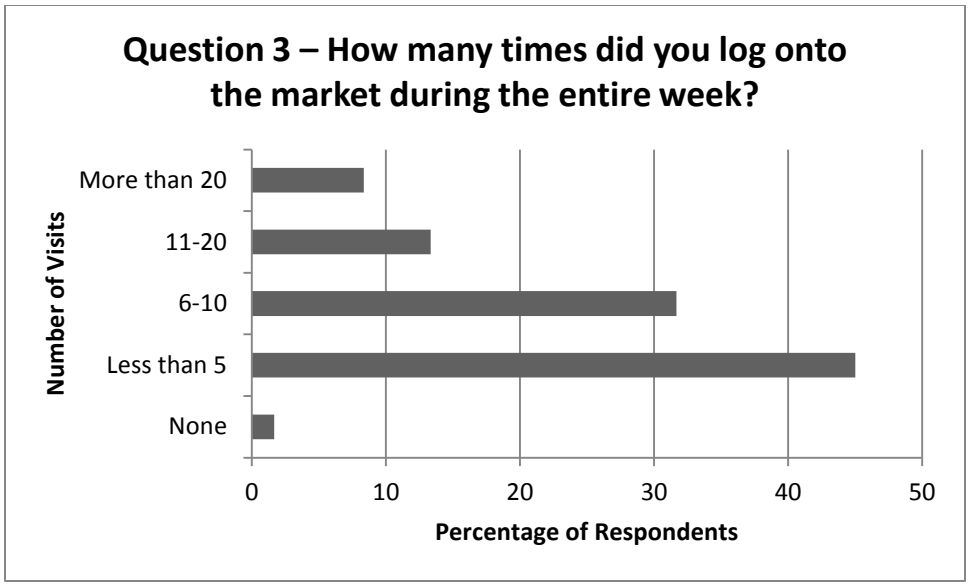

Figure 35. Total market visits (combined market survey data)

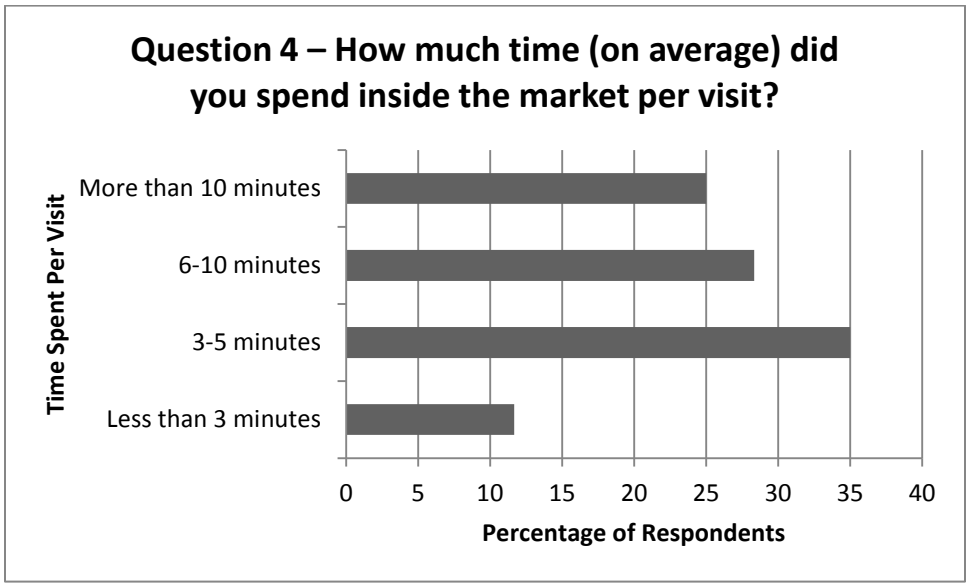

Figure 36. Amount of time spent in the market per visit (combined market survey data)

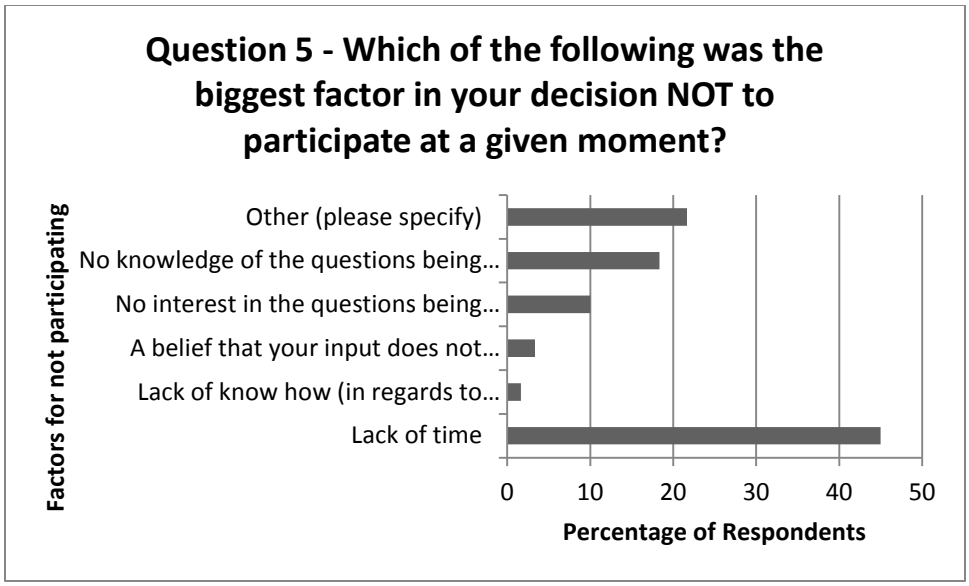

Figure 37. Factors that negatively affected participation (combined market survey data)

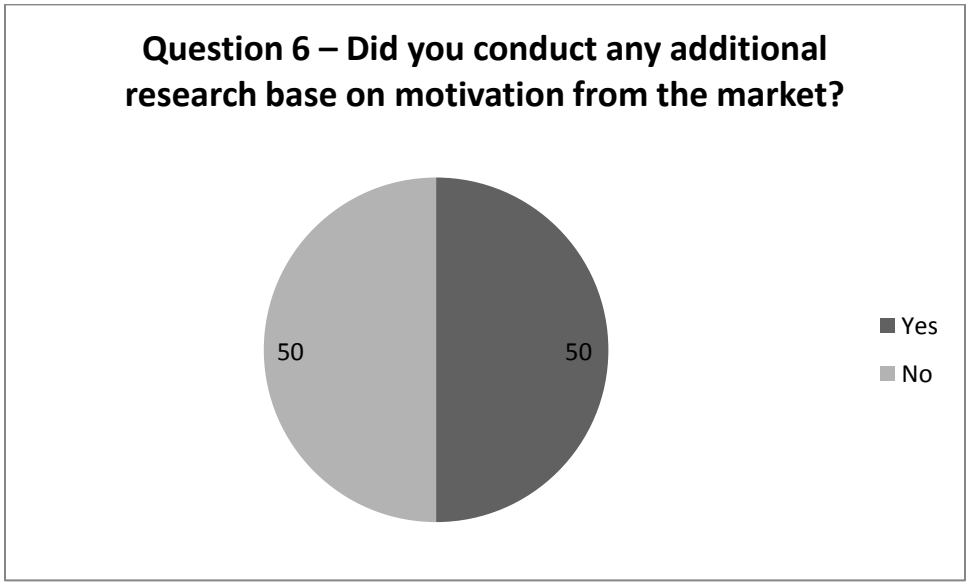

Figure 38. Percentage of those who conducted additional research in order to participate in the market (combined market survey data)

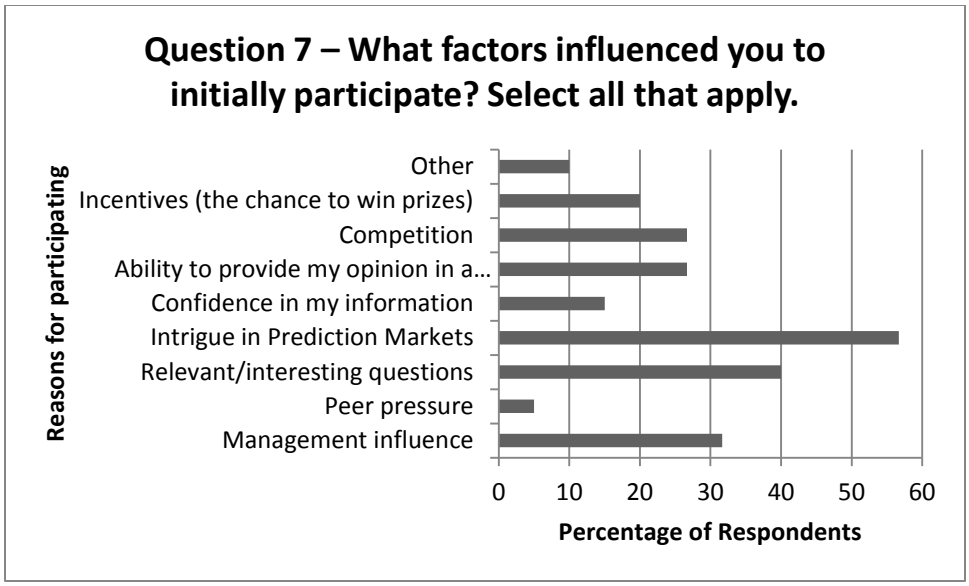

Figure 39. Factors that positively influenced participation (combined market survey data)

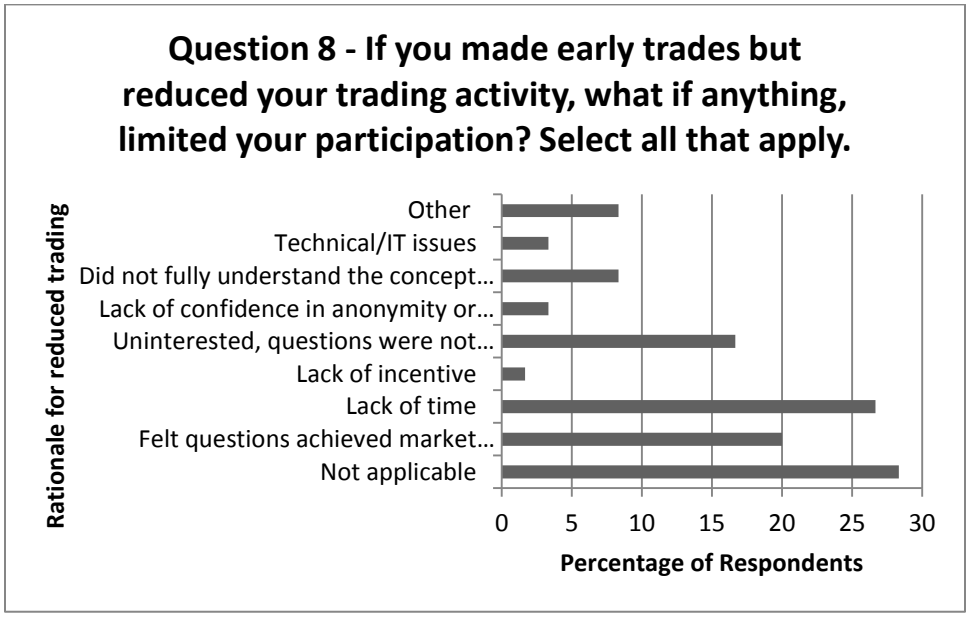

Figure 40. Reasons for reducing participation after initial trades were conducted (combined market survey data)

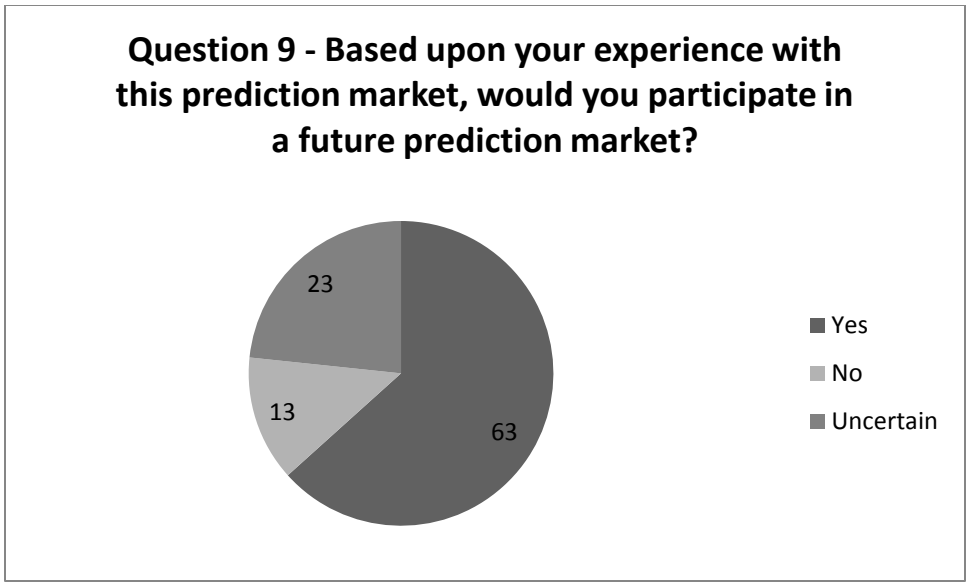

Figure 41. Likelihood for future participation in a prediction market (combined market survey data)

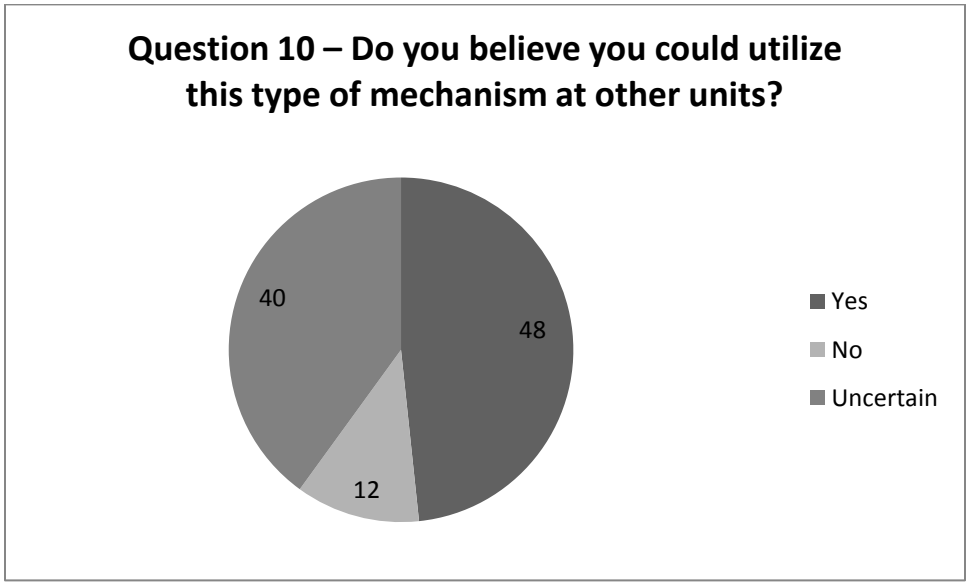

Figure 42. Likelihood of prediction market success at other units (combined market survey data)

B. JIFX/TSOA/RELIEF SURVEY DATA

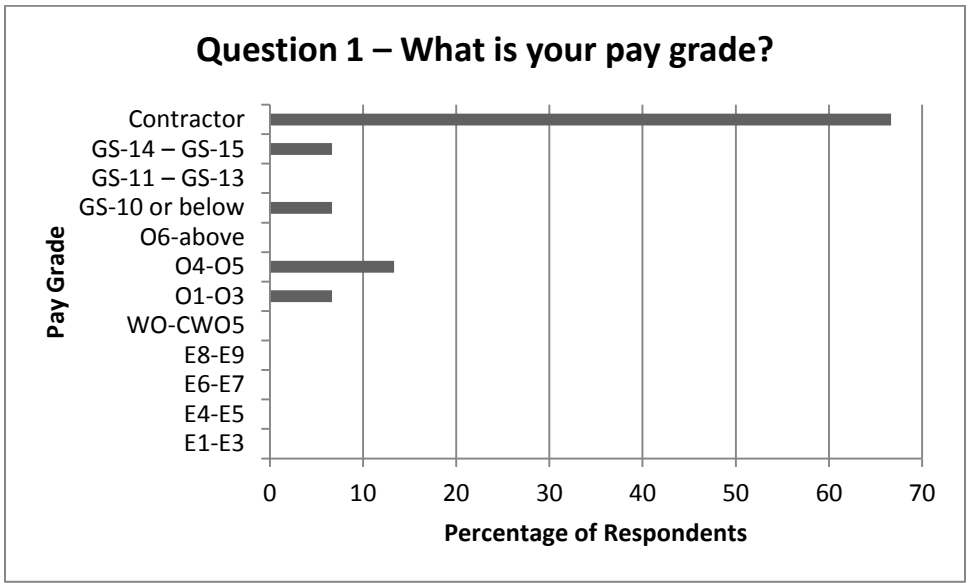

Figure 43. Rank/Pay grade of market participants (JIFX market)

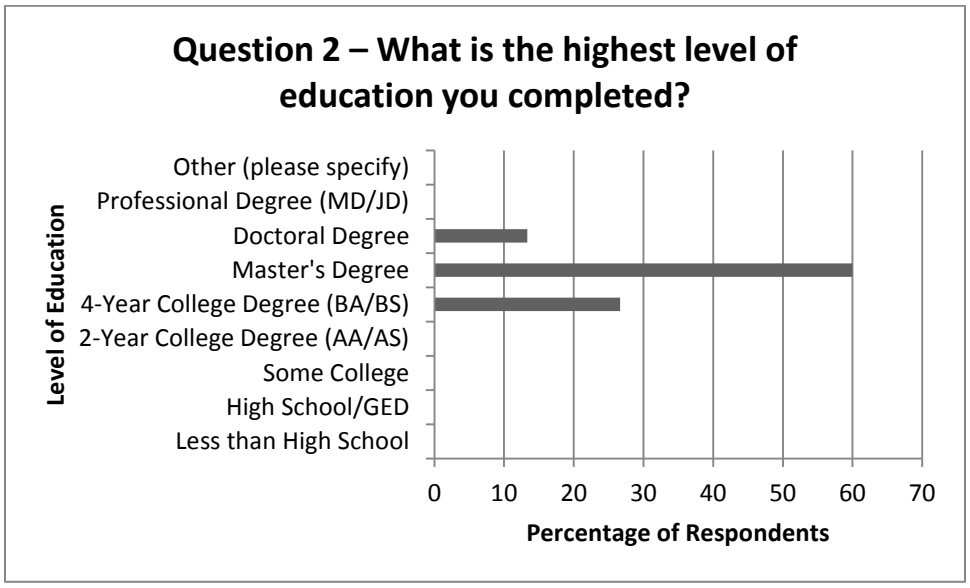

Figure 44. Education level of market participants (JIFX market)

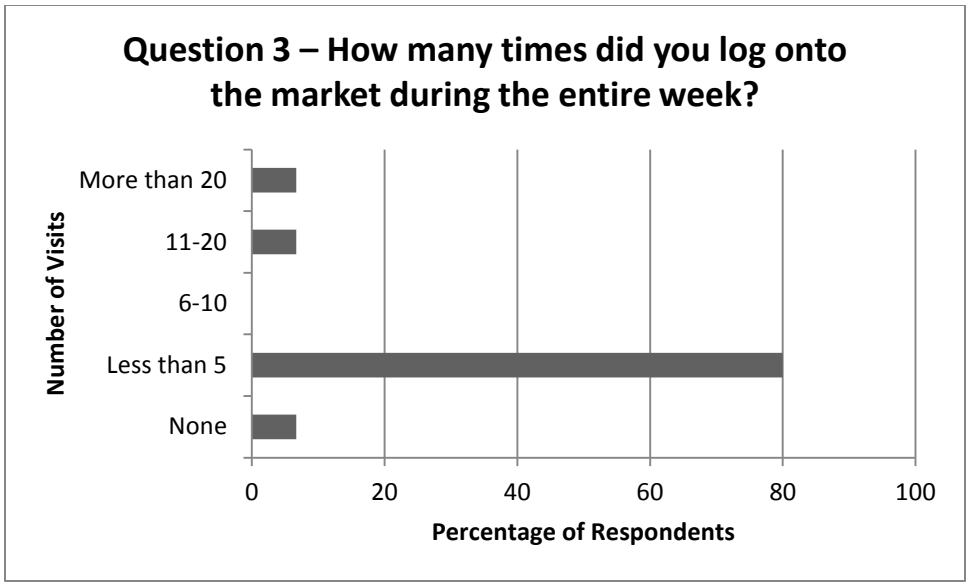

Figure 45. Total market visits (JIFX market)

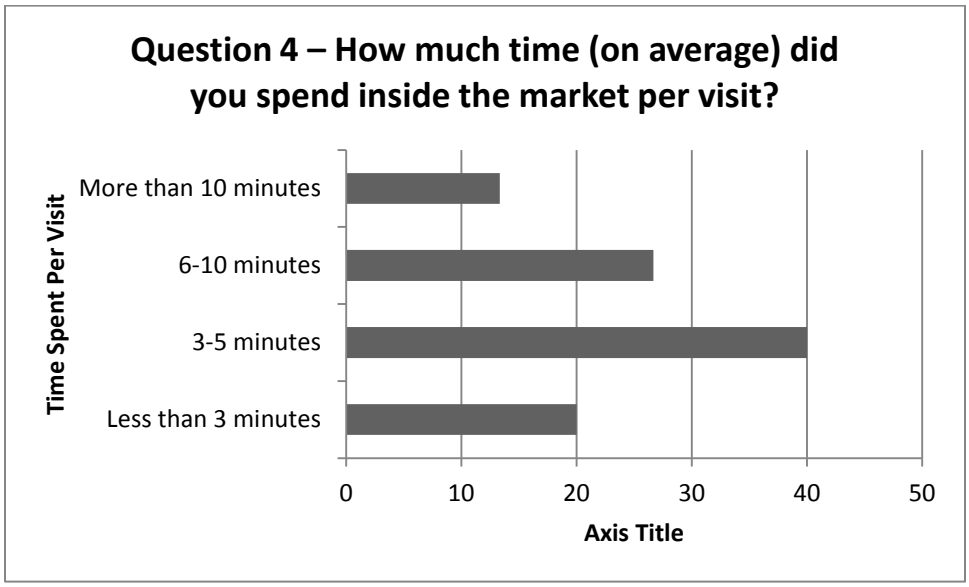

Figure 46. Average time spent per market visit (JIFX market)

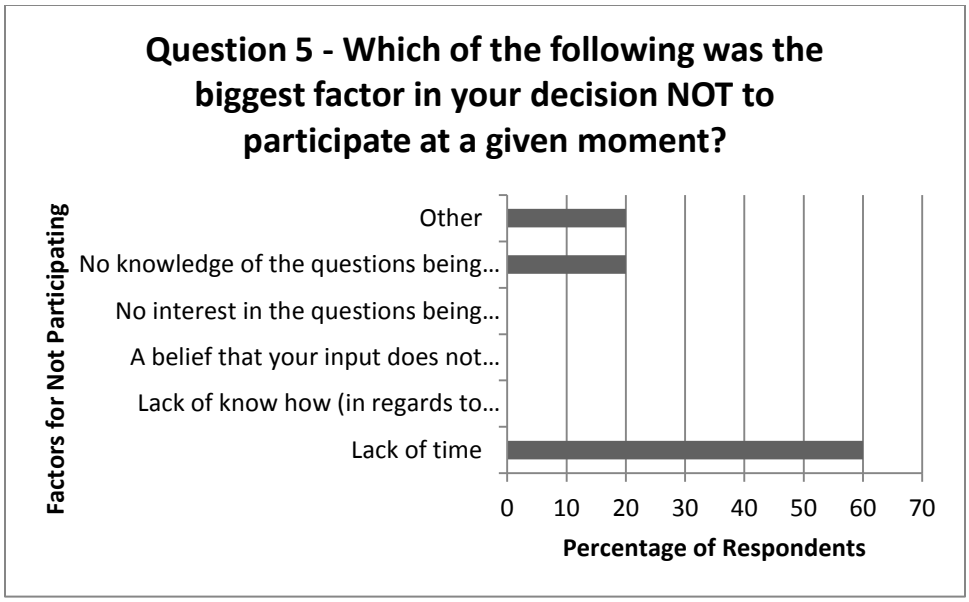

Figure 47. Factors for not participating (JIFX market)

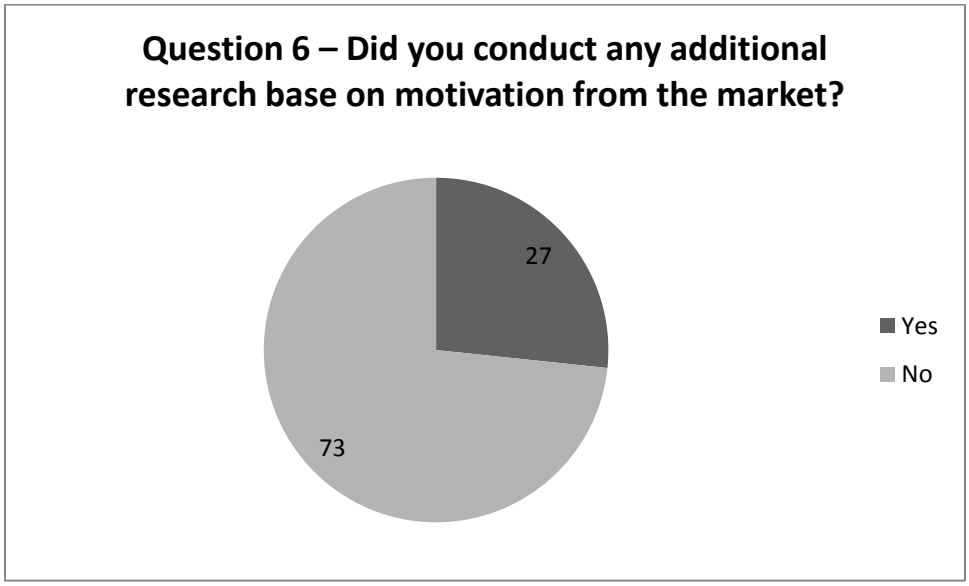

Figure 48. Percentage of those who conducted additional research in order to participate (JIFX market)

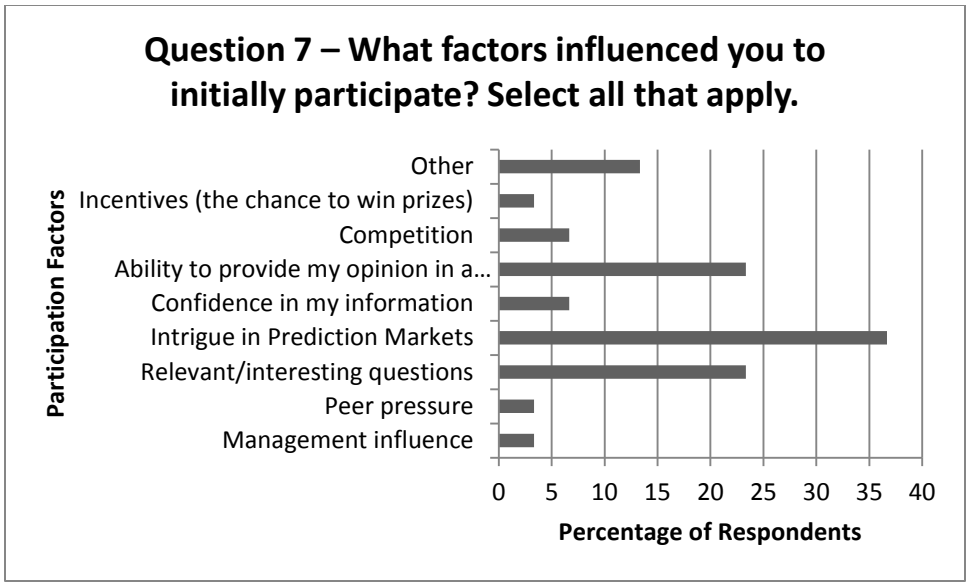

Figure 49. Factors that positively influenced participation (JIFX market)

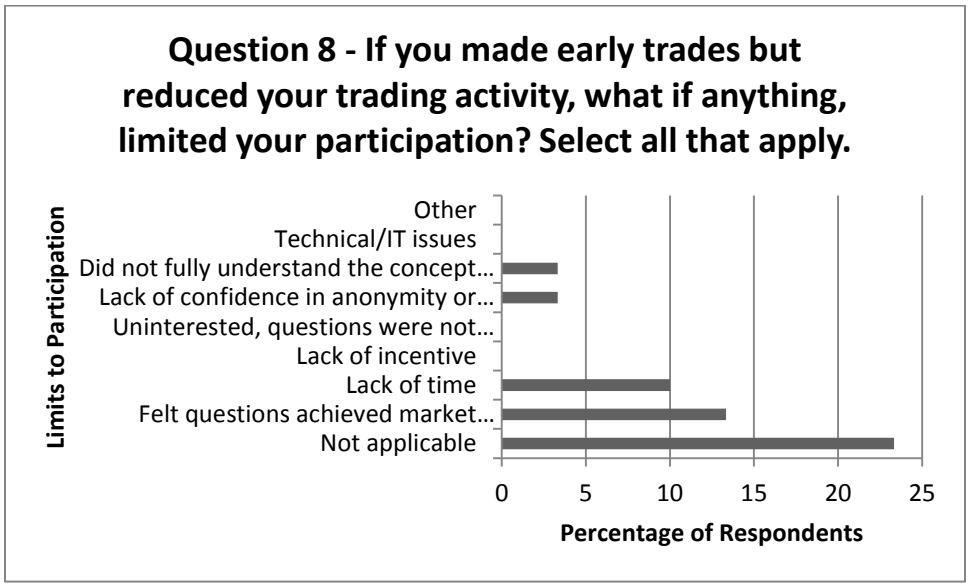

Figure 50. Factors that reduced participation after initial trades were conducted (JIFX market)

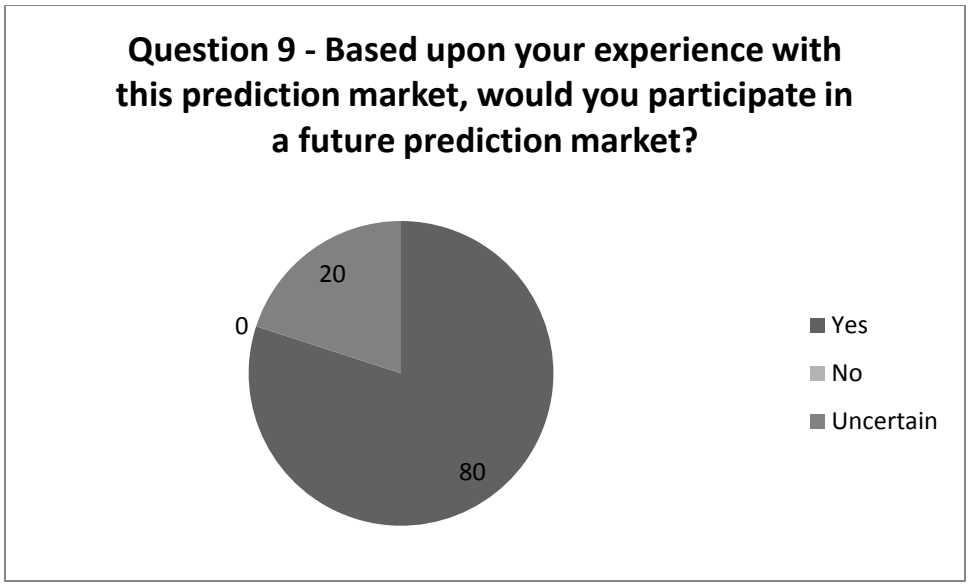

Figure 51. Likelihood of future participation in a prediction market (JIFX market)

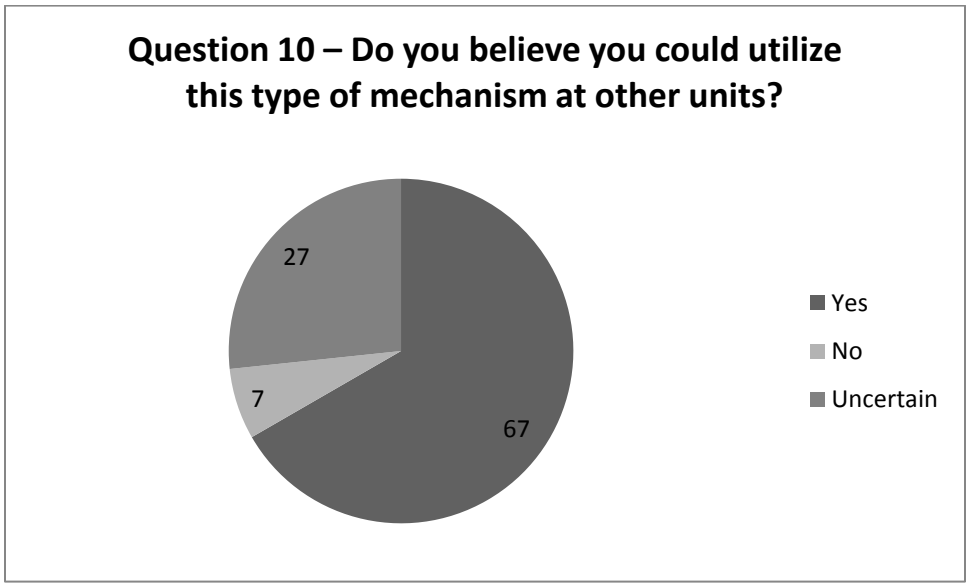

Figure 52. Likelihood of prediction market utility at other units (JIFX market)

C. MCIA SURVEY DATA

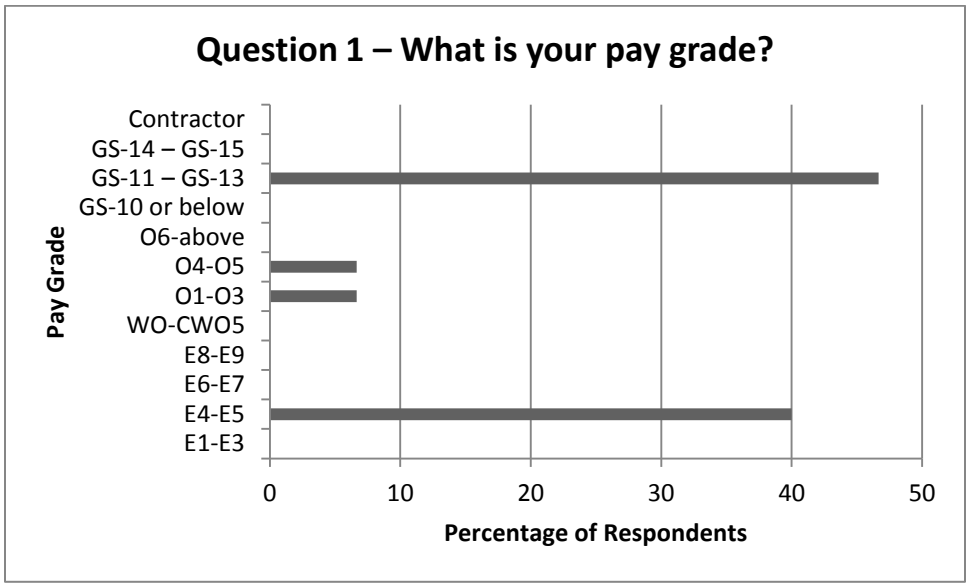

Figure 53. Rank/Pay grade of market participants (MCIA market)

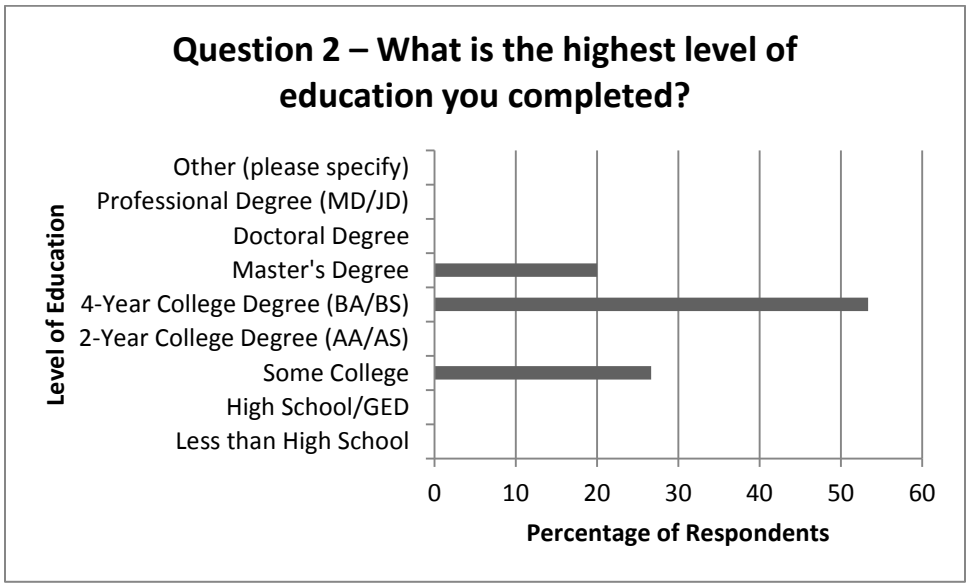

Figure 54. Education level of market participants (MCIA market)

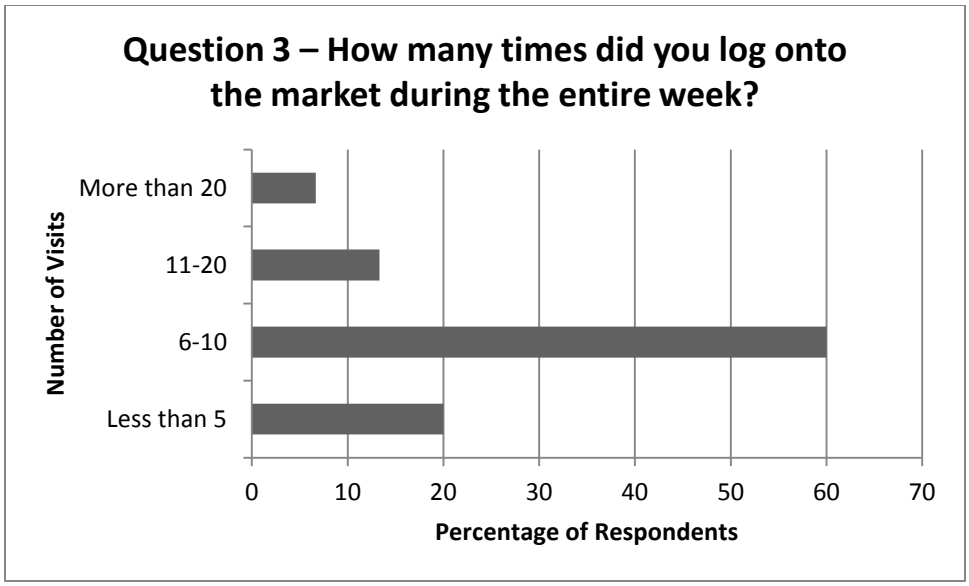

Figure 55. Total market visits (MCIA market)

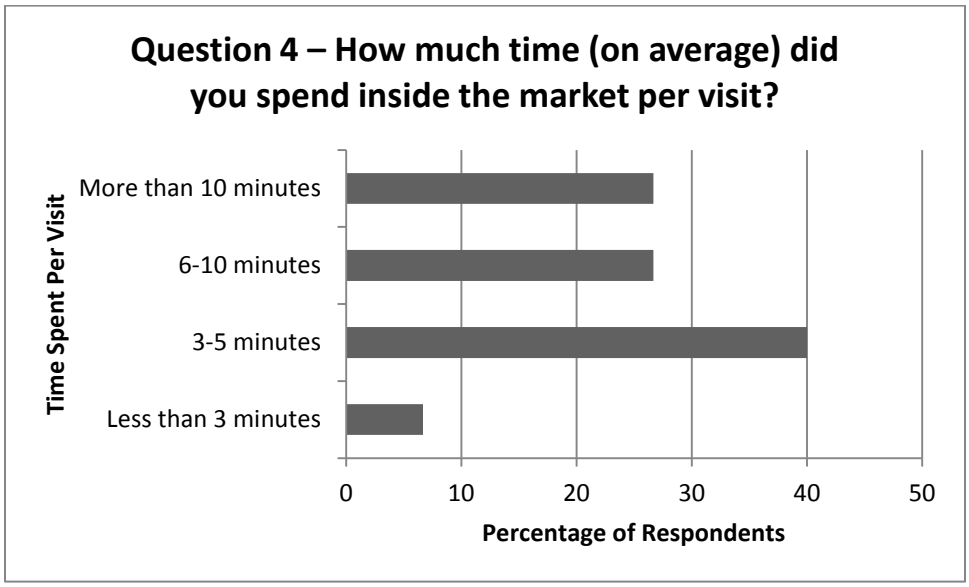

Figure 56. Average time spent per market visit (MCIA market)

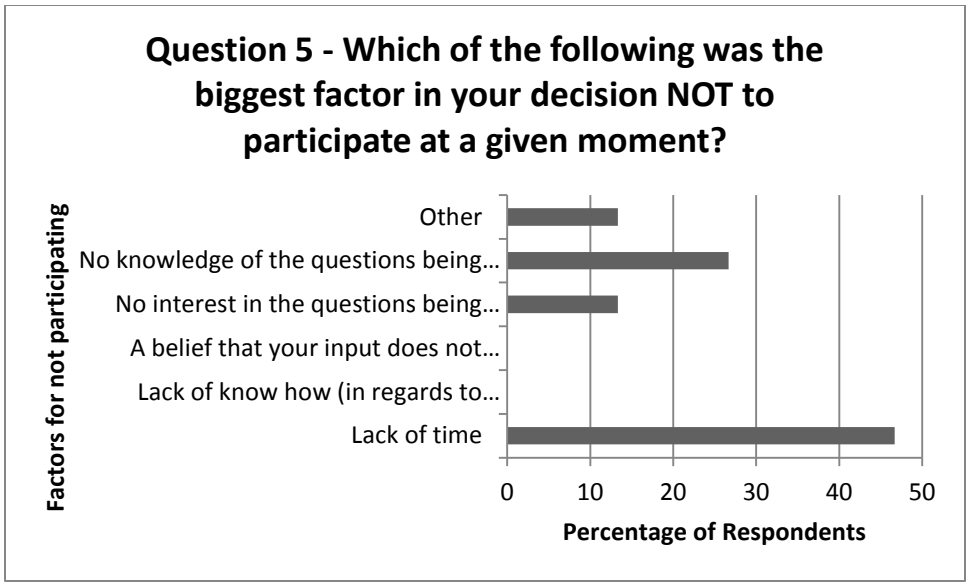

Figure 57. Factors for not participating (MCIA market)

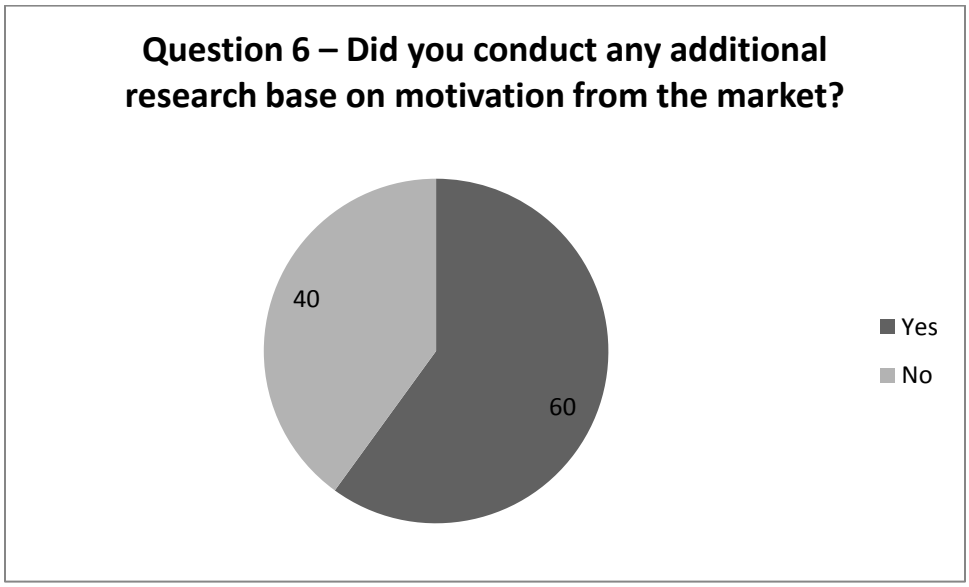

Figure 58. Participants that conducted additional research in order to participate (MCIA market)

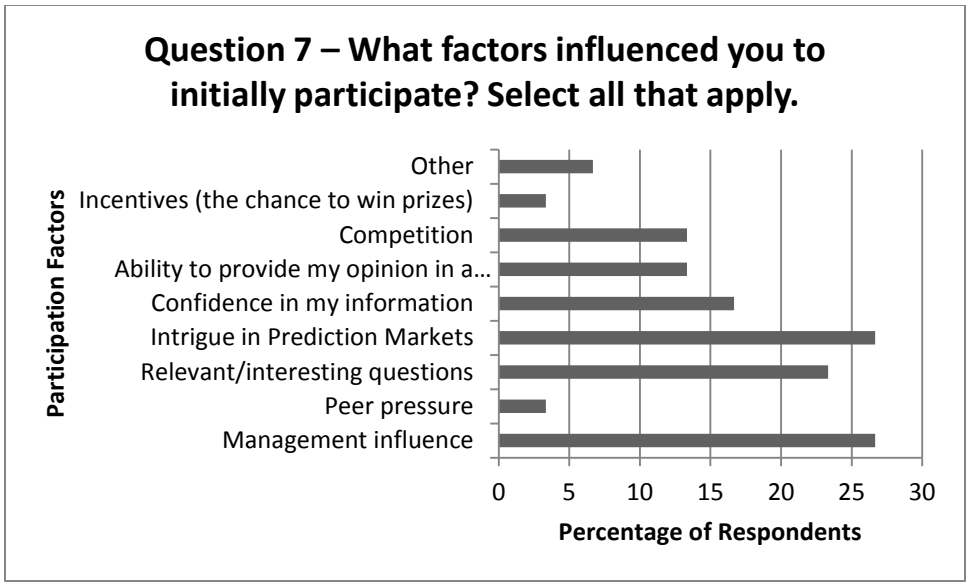

Figure 59. Factors that positively influenced participation (MCIA market)

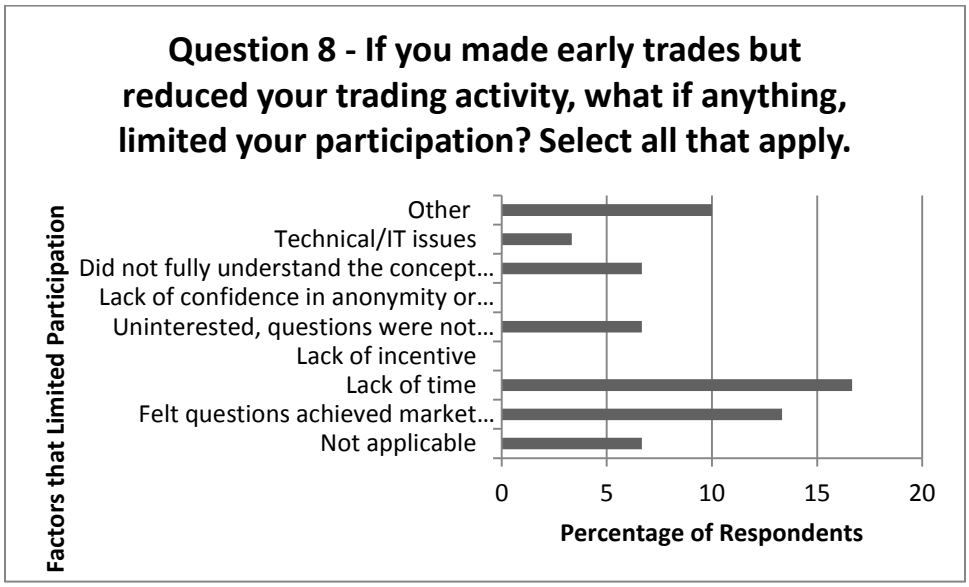

Figure 60. Factors that reduced participation after initial trades were conducted (MCIA market)

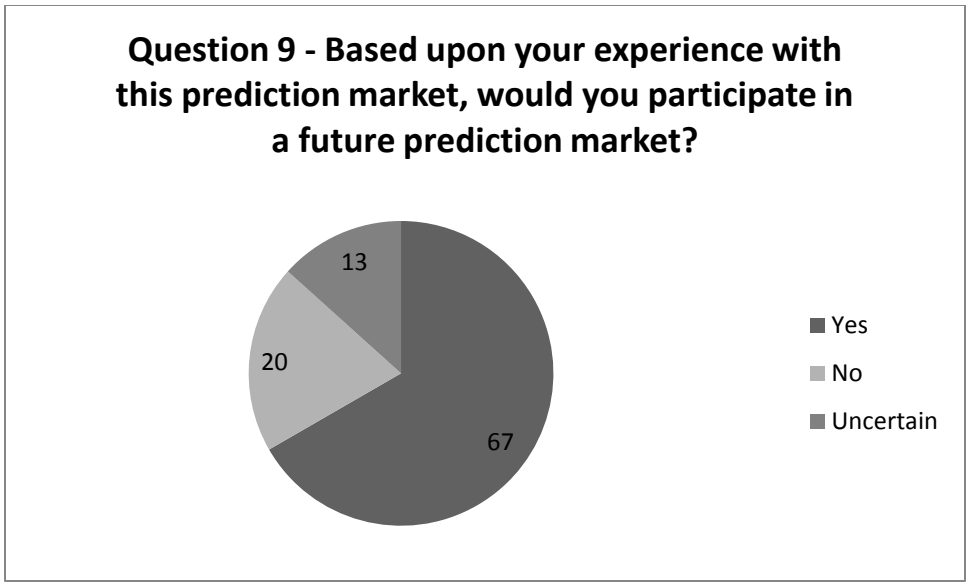

Figure 61. Likelihood of future participation in a prediction market (MCIA market)

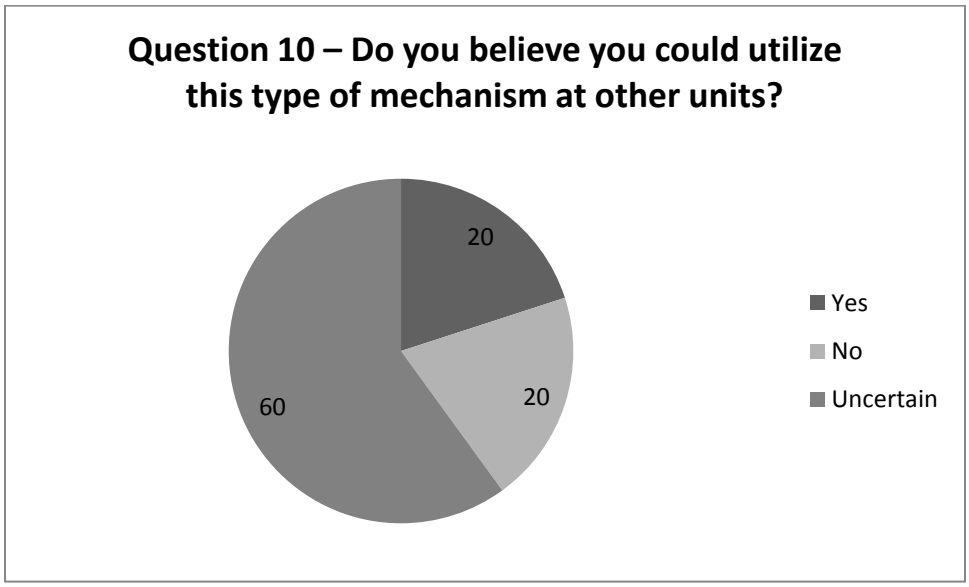

Figure 62. Likelihood of prediction market utility in other units (MCIA market)

D. 2D INTELLIGENCE BATTALION SURVEY DATA

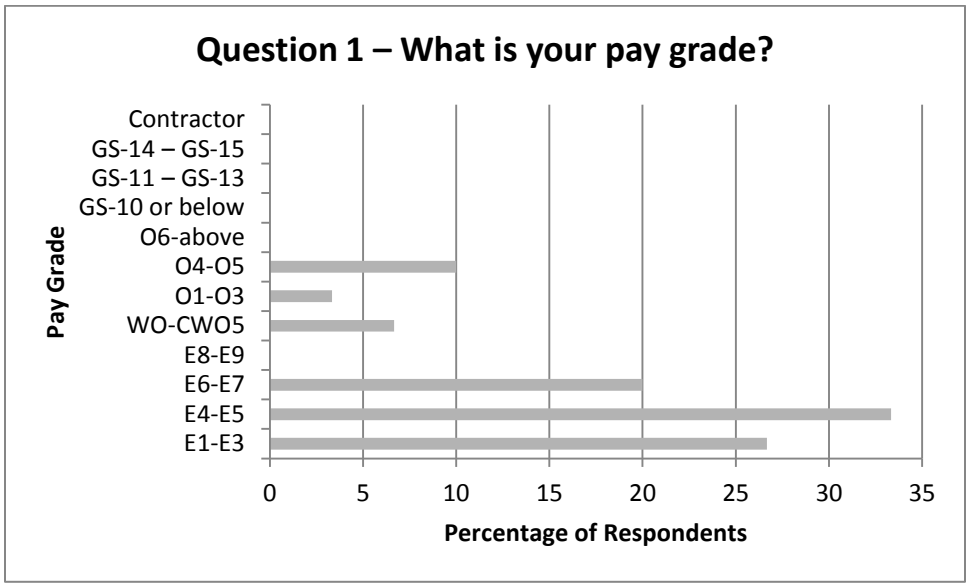

Figure 63. Rank/Pay grade of market participants (2d Intel market)

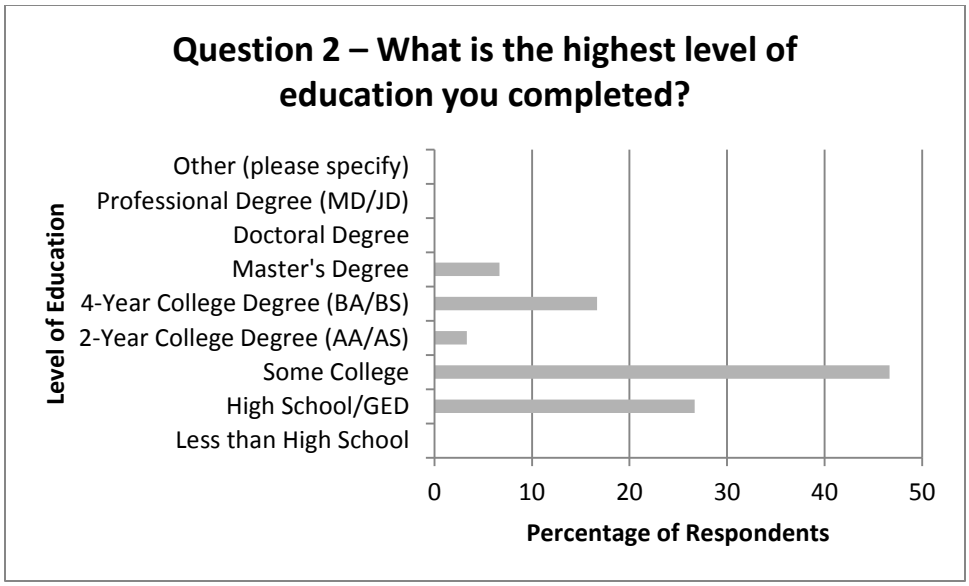

Figure 64. Education level of market participants (2d Intel market)

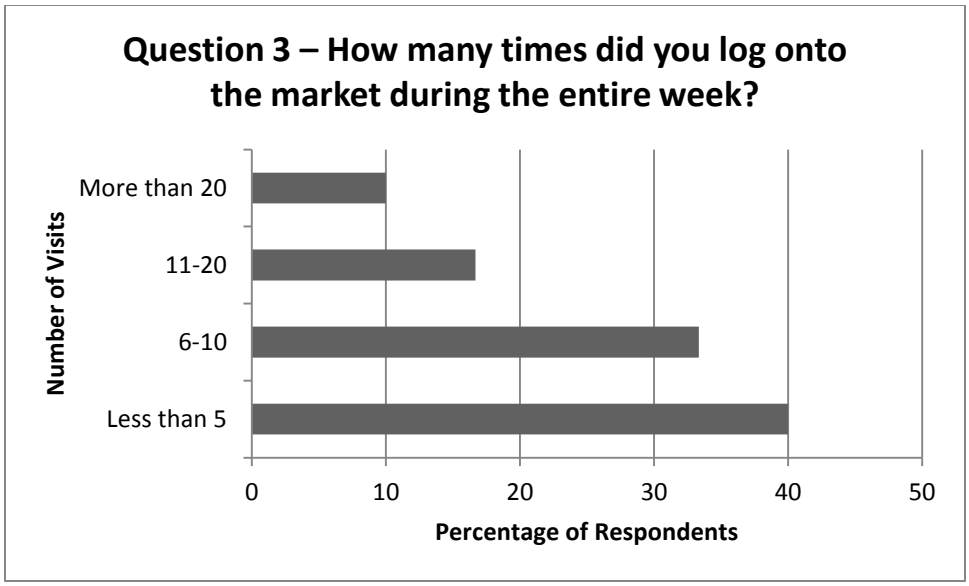

Figure 65. Total market visits (2d Intel market)

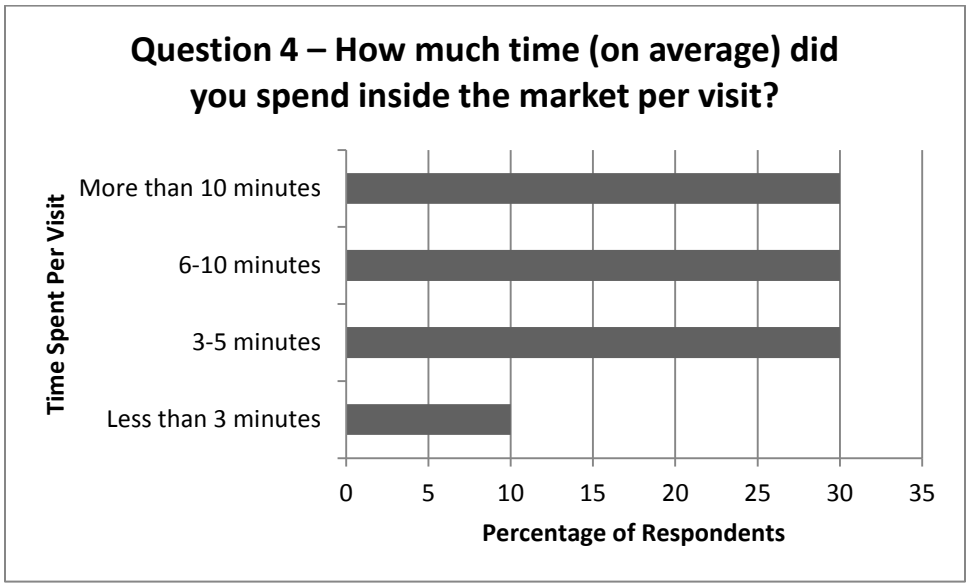

Figure 66. Average amount of time spent per visit (2d Intel market)

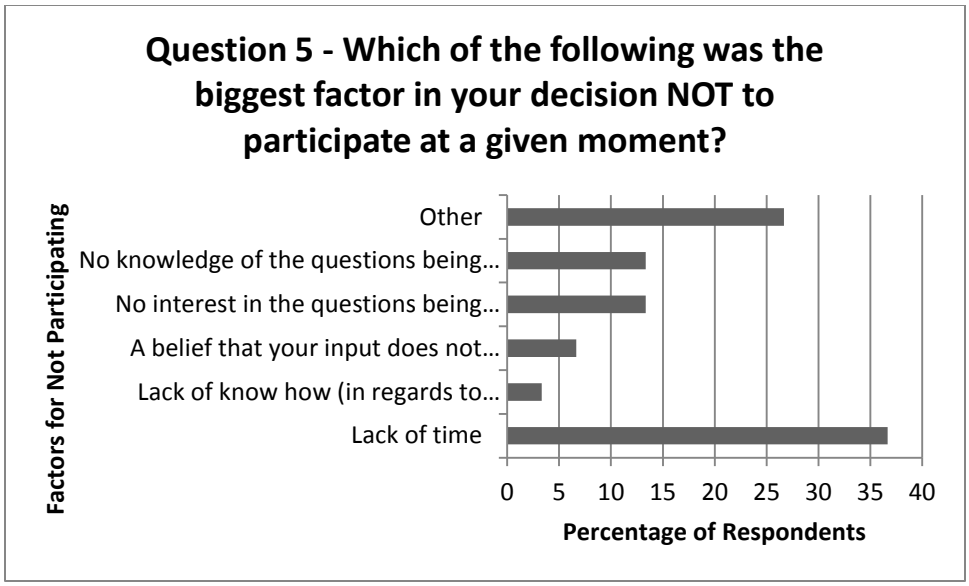

Figure 67. Factors for not participating in the market (2d Intel market)

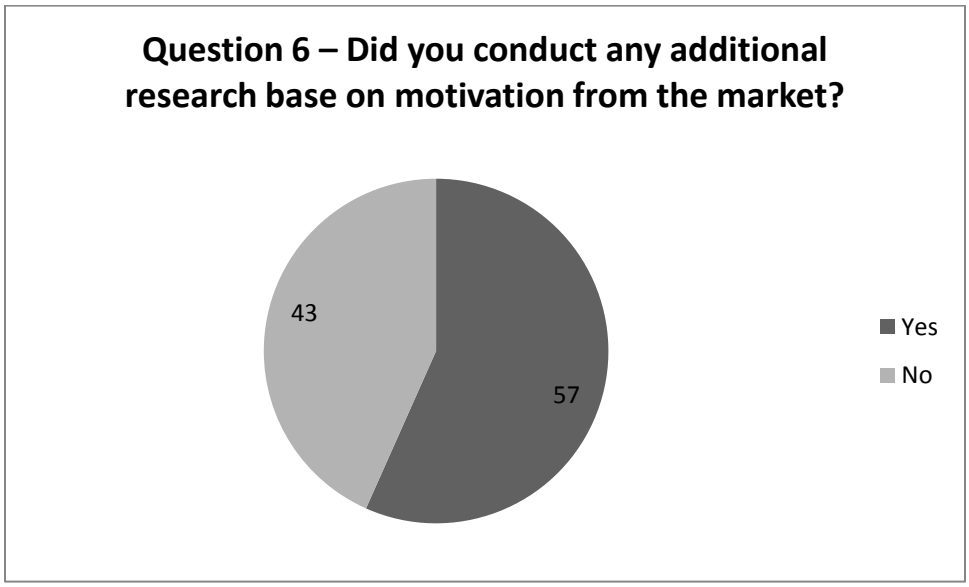

Figure 68. Participants that conducted additional research in order to participate in the market (2d Intel market)

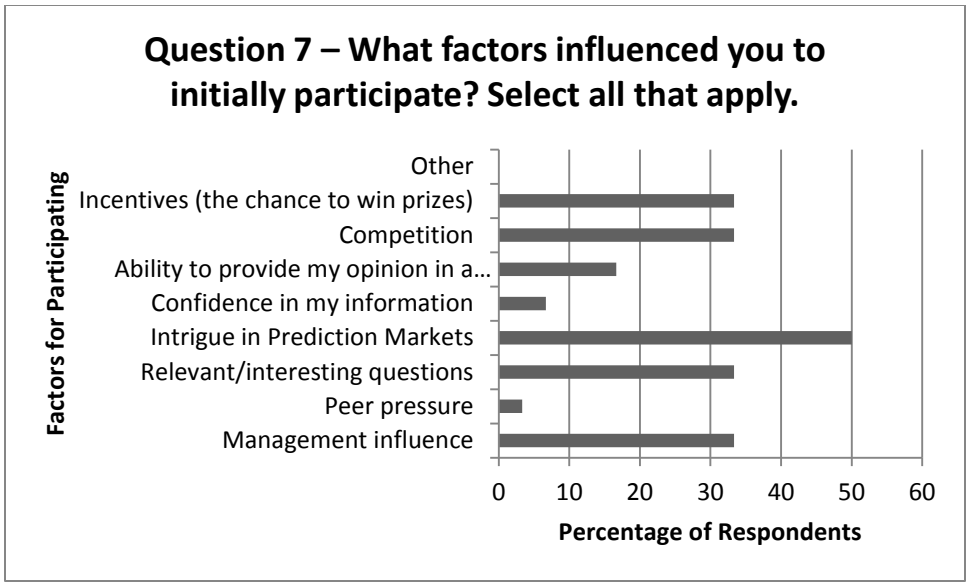

Figure 69. Factors that positively influenced participation (2d Intel market)

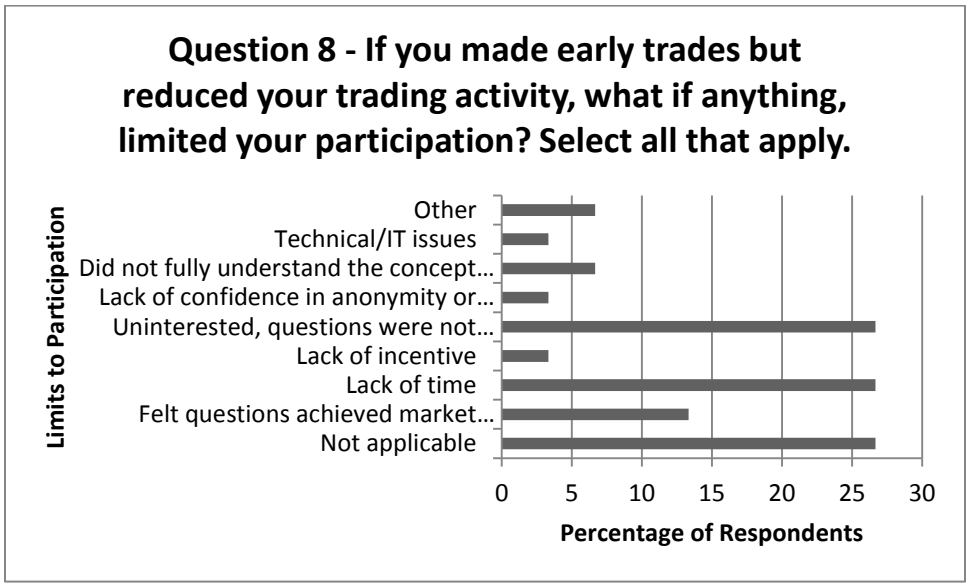

Figure 70. Factors that reduced participation after initial trades were conducted (2d Intel market)

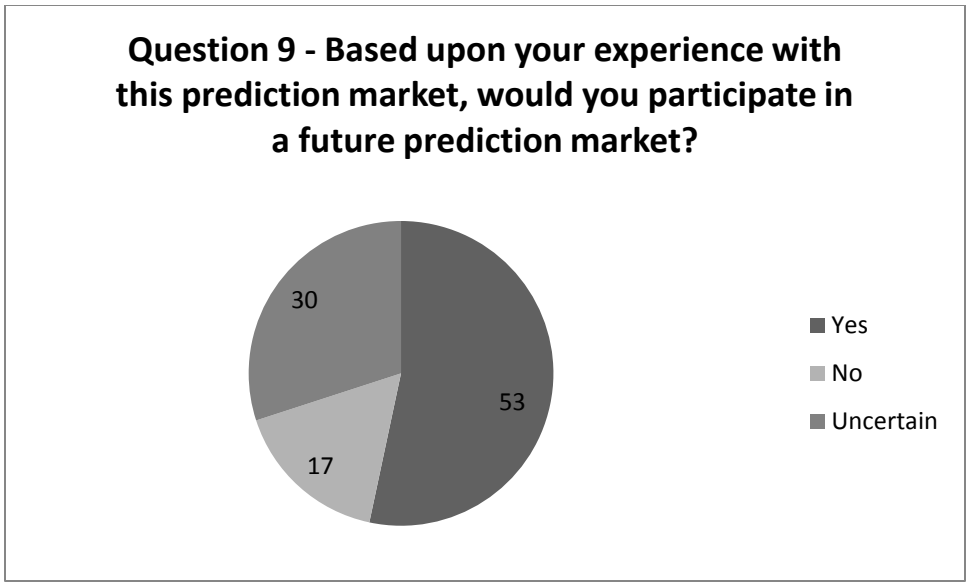

Figure 71. Likelihood of future participation in a prediction market (2d Intel market)

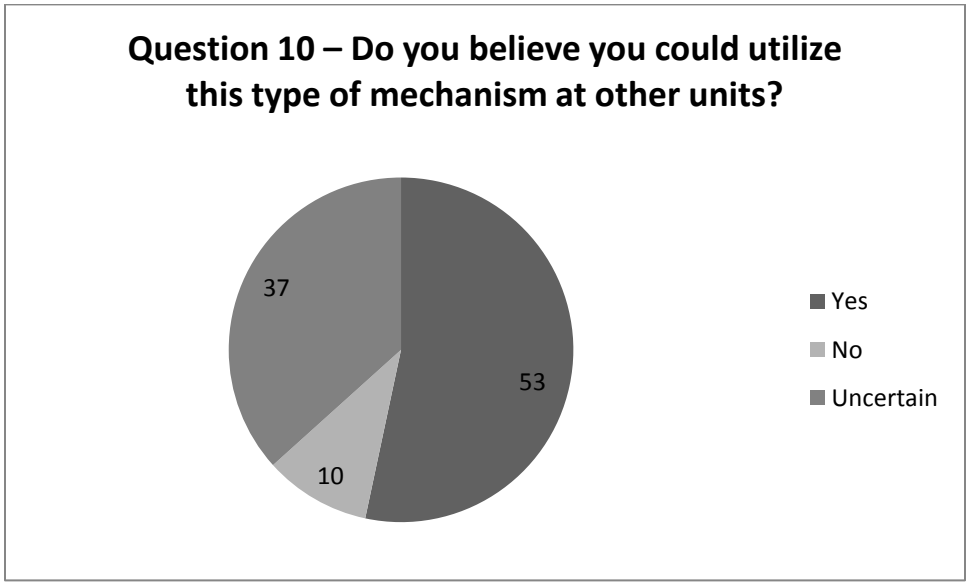

Figure 72. Likelihood of prediction market utility at other units (2d Intel market)

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