MSC in Finance and International Business

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Behavioural Finance

&

Sports Betting Markets

Aarhus School of Business

Handelshøjskolen i Århus

June – 2004

Introduction:

Betting, found in ancient times, has been a form of entertainment for many people in history. People like to challenge themselves on their knowledge – or luck – of predicting the winner in games, events or contests. Betting gives an opportunity to earn money with a proportion of the capital or lose it all; it is all or nothing. The outcomes are set prior to the event and they depend on the result. This clarity provides researchers a controlled laboratory test opportunity: The variables are few and the outcome is certain. In this sense, betting provides data to test some theories related to Mathematics, Statistics and Finance. One of the reasons that motivated me for such a research is that the controlled laboratory environment can help to test hypotheses that can not be tested in financial markets.

The complexity of human behavior exemplified by the gambling phenomenon has to be taken into account in understanding the etiology of bubbles in speculative markets. Gamblers may have very rational expectations, at some level, for the likely outcome of their gambling, and yet have other feelings that drive their actual behavior. On the other hand, the *bias* of seeing what others cannot see -and the excitement of it- may drive investor behaviors as well. If this occurs all at once for many, it might create bubbles in stock prices; like it did in the last decade. It is therefore important to research betting markets and bettor behavior from an investor view.

This research is planned as a literature survey and a market research on betting markets from a behavioral finance point of view. The paper is aimed to cover betting markets for financial researchers and to be a guide book on these markets for scientists. My expectation is that behavioral finance can be a tool to understand betting markets and these markets can provide some findings for behavioral finance. The first goal of this paper is to test the concerning expectation by analyzing the betting markets from a behavioral finance point of view and search if finance can benefit from these markets.

A major motive to study betting is to observe the gambler behavior and learn from a different decision making process. The similarities and differences of investor and gambler decisions can help scientists to find clues about rational and irrational behavior.

Furthermore, it is aimed to make a literature survey of finance on betting markets. By this study, I want to make a compilation of the present findings in betting markets and an extended guide for future financial researches that have interest in this field. There is no such study that covers all the researches in betting markets from a financial view. This project is aimed to be the first study that gathers all financial interest in this field and a guideline for further researches.

It is a major aim of this research to analyze betting market structure and betting industry. By covering this alternative market, this paper is aimed to be a guide for understanding the betting markets in detail.

Moreover, analyzing the traits and biases that motivate bettors is another major goal. The findings may help understanding decision making under uncertainty.

Moreover, betting provides an opportunity to observe risk management. The use of historical data, information, expert views are all in action trying to find mispriced odds. The hedging skills must be perfect for odd makers to exist.

Furthermore, a replication of Sauer and Brown (1993) with a different data is another goal for this paper. This replication is an important example of how tests that cannot be done in financial markets can take place in the betting markets.

The research is mainly focused on interaction of two main components, behavioral finance and betting markets. Besides all the goals above, this interaction will be the main theme of the paper. The interaction is both ways: The application of behavioral finance to betting markets and the findings in betting markets as evidence to behavioral finance terms.

Methodology

The research is divided into 2 main parts. The first part aims to create a base on how traditional and behavioral finance developed and a summary of key terms and findings in this field. In the second part betting markets are researched on the basis that is built on first part.

The paper starts with a brief summary in history of finance. The main theories and developments are briefly explained. Finance history part is compiled in a way that underlines the developments that brought behavioral finance. This paper is mainly concerned on behavioral finance's point of view on betting markets and therefore a base on behavioral finance is aimed in the first part. After the Efficient Markets Hypothesis is introduced, the birth of Behavioral Finance is explained. Behavioral Finance terms, discussions and its alternative approach to basic finance terms are introduced. Since Psychology is a big part of this discipline, its terms are used when in need. This base is built in order to form a stand point for the rest of the research. This stand point underlines that it is a financial research and it aims to have some answers, suggestions or alternative ideas from betting markets for financial markets.

Traditional finance and behavioral finance have some areas where each side has different opinions on. There are some topics where big discussions take place between followers of traditional and behavioral finance (efficient markets theory, investor rationality, biases etc.). Sports betting is researched in this paper in order to benefit from a different market place where testing some of these topics is easier and results can be a comparison tool.

Following the first base, betting is introduced. History of betting, specific terms, market structure and different sides of betting markets are researched. Bettor behaviors are analyzed and the reasons to gamble are researched.

Betting firms make profits as the bettors wager for each side of the result of a game.[1] With the commissions that odd makers charge the bettors, there is a secure profit in the long run for betting companies. The question of "Given these facts why do people bet?" is explored through this part.

After the reader gets familiar with betting and its components, a literature review in betting markets from a financial perspective is done. There are several famous topics for Finance researchers to conduct a study in these markets. The researches in each of them are explained. This part gives the reader a view of what opportunities the betting markets can bring the scientists to explore their theories in an alternative market. Following the financial literature review, an example of an interesting empirical study, Sauer and

[1] This situation is the aim of the odd maker in order to have a risk free income. It will be discussed further in the betting part.

Brown (1993) is explained in detail and their study is replicated with a different set of data.

At the end of the betting part, a new market structure, betting indexes, are introduced. This structure is inspired by stock market structure and is a perfect example of how betting benefits from findings of finance. Bettors become investors and free market rules start working with this new system. The research ends with a review of what can be the next for betting markets.

1. Development of Behavioral Finance

1.1. A Brief History of Finance:

Finance theory has a surprisingly short history in economics. Economists have long been aware of the basic economic function of credit markets but they were not keen on analyzing it much further than that.

Irving Fisher (1906, 1907, 1930) had outlined the basic functions of credit markets for economic activity, specifically as a way of allocating resources over time. Moreover, he had recognized the importance of risk in the process. In developing their theories of money, John Maynard Keynes (1930, 1936), John Hicks (1934), Nicholas Kaldor (1939) and Jacob Marschak (1938) conceived of portfolio selection theory in which uncertainty played an important role.

Many economists in this period didn't have substantial researches on price determinations. Financial markets were still regarded as mere "casinos" rather than "markets". In their view, asset prices were determined largely by expectations and counter-expectations of capital gains.

Big effort was spent on the topic of speculative activity (i.e. the purchase/temporary sale of goods or assets for later resale). For instance, in their pioneering work on futures markets, John Maynard Keynes (1923, 1930) and John Hicks (1939) argued that the price of a futures contract for delivery of a commodity will generally be below the

expected spot price of that commodity (what Keynes called "normal backwardation"). This, Keynes and Hicks argued, was largely because hedgers shifted their price risk onto speculators in return for a risk premium. Nicholas Kaldor (1939) went on to analyze the question of whether speculation was successful in stabilizing prices and, in so doing, expanded Keynes's theory of liquidity preference considerably. In later years, Holbrook Working (1953, 1962) would dispute this, arguing that there was, in fact, no difference between the motivations of hedgers and speculators. This led to an early empirical race. Hendrik Houthakker (1957, 1961, 1968, 1969) finding evidence in favor of normal backwardation and Lester Telser (1958, 1981) finding evidence against it.

John Burr Williams (1938) was among the first to challenge the "casino" view economists held of financial markets and questions of asset pricing. John Burr introduced the term intrinsic value to asset pricing. Intrinsic value, defined as the present worth of future dividends, or of future coupons and principal, is of practical importance to every investor because it is the critical value above which he cannot go in buying or holding, without added risk. If a man buys a security below its investment value he need never lose, even if its price should fall at once, because he can still hold for income and get a return above normal on his cost price; but if he buys it above its investment value his only hope of avoiding a loss is to sell to someone else who must in turn take the loss in the form of insufficient income.

Harry Markowitz (1952) realized that as the "fundamentalist" notion relied on expectations of the future, then the element of risk must come into play and thus profitable use could be made of the newly developed expected utility theory of John von Neumann and Oskar Morgenstern (1944). Markowitz formulated the theory of optimal portfolio selection in the context of trade-offs between risk and return, focusing on the idea of portfolio diversification as a method of reducing risk - and thus began what has become known as "Modern Portfolio Theory" or simply MPT.

The idea of an optimal portfolio allocation had already been considered by Keynes, Hicks and Kaldor in their theories of money, and thus it was a logical step for James Tobin (1958) to add money to Markowitz's story and thus obtain the famous "two-fund

separation theorem". Effectively, Tobin argued that agents would diversify their savings between a risk-free asset (money) and a *single* portfolio of risky assets (which would be the same for everyone). Different attitudes towards risk, Tobin contended, would merely result in different combinations of money and that unique portfolio of risky assets.

The Markowitz-Tobin theory was not practical. Specifically, to estimate the benefits of diversification would require that practitioners calculate the covariance of returns between every pair of assets. In their Capital Asset Pricing Model (CAPM), William Sharpe (1964) and John Lintner (1965) solved this practical difficulty by demonstrating that one could achieve the same result merely by calculating the covariance of every asset with respect to a general market index. With the necessary calculating power reduced to computing these less number of terms ("betas"), optimal portfolio selection became computationally feasible.

The CAPM would however be eventually challenged empirically in a series of papers by Richard Roll (1977, 1978). One of the alternatives offered up was the "intertemporal CAPM" (ICAPM) of Robert Merton (1973). Merton's approach and the assumption of rational expectations led the way to the Cox, Ingersoll and Ross (1985) partial differential equation for asset prices and, perhaps only a step away, Robert E. Lucas's (1978) theory of asset pricing.

A more interesting alternative was the "Arbitrage Pricing Theory" (APT) of Stephen A. Ross (1976). Stephen Ross's APT approach moved away from the risk vs. return logic of the CAPM, and exploited the notion of "pricing by arbitrage" to its fullest possible extent. As Ross himself has noted, arbitrage-theoretic reasoning is not unique to his particular theory but is in fact the underlying logic and methodology of virtually all of finance theory. The following famous financial theorems illustrate Ross's point.

The famous theory of option pricing by Fisher Black and Myron Scholes (1973) and Robert Merton (1973) relies heavily on the use of arbitrage reasoning. Intuitively, if the returns from an option can be replicated by a portfolio of other assets, then the value of the option must be equal to the value of that portfolio, or else there will be arbitrage

opportunities. Arbitrage logic was also used by M. Harrison and David M. Kreps (1979) and Darrell J. Duffie and Chi-Fu Huang (1985) to value multi-period securities.

The famous Modigliani-Miller theorem (or "MM") on the irrelevance of corporate financial structure for the value of the firm also employs arbitrage logic. This theorem Franco Modigliani and Merton H. Miller (1958, 1963) can actually be thought as an extension of the Separation Theorem" originally developed by Irving Fisher (1930). Effectively, Fisher had argued that with full and efficient capital markets, the production decision of an entrepreneur-owned firm ought to be independent of the intertemporal consumption decision of the entrepreneur himself. In other words, the profit-maximizing production plan of the firm will *not* be affected by the borrowing/lending decisions of its owners; i.e. the production plan is independent of the financing decision.

Modigliani-Miller extended this proposition via arbitrage logic. Viewing firms as assets, if the underlying production plans of differently-financed firms are the same, then the market value of the firms will be the same, since there would be an arbitrage opportunity otherwise. Consequently, arbitrage enforces that the value of the firms to be identical, *whatever* the composition of the firm's financial structure is.

The second important strand of work on finance was the empirical analysis of asset prices. A particularly interesting finding was that it seemed that prices tended to follow a *random walk*. More specifically, as documented by Louis Bachelier (1900) (for commodity prices) and later confirmed in further studies by Holbrook Working (1934) (for a variety of price series), Alfred Cowles (1933, 1937) (for American stock prices) and Maurice G. Kendall (1953) (for British stock and commodity prices), it seemed as there was no correlation between successive price changes on asset markets.

The Working-Cowles-Kendall empirical findings were greeted with horror and disbelief by economists. If prices are determined by the "forces of supply and demand", then price changes should move in particular direction towards market clearing and not randomly. Not everyone was displeased with these results. Many viewed them as proof that the "fundamentalist" theory was incorrect, i.e. that financial markets *really* were wild casinos and that finance was thus not a legitimate object of economic concern. Yet others

crowed that it proved the failure of traditional "statistical" methods to illuminate much of anything. High-powered time series methods were used by Clive Granger and Oskar Morgenstern (1963) and Eugene F. Fama (1965, 1970), but they came up with the same randomness result.

The birth of Efficient Markets Hypothesis

The great breakthrough was due to Paul A. Samuelson (1965) and Benoit Mandelbrot (1971). Far from proving that financial markets did not work according to the laws of economics, Samuelson interpreted the Working-Cowles-Kendall findings as saying that they worked all too well. The basic notion was simple: if price changes were not random (and thus predictable), then any profit-hungry arbitrageur can easily make appropriate purchases and sales of assets to exploit this. Samuelson and Mandelbrot thus posited the celebrated "Efficient Market Hypothesis" (EMH): namely, if markets are working properly, then all public (and, in some versions, private) information regarding an asset will be channelled immediately into its price. If price changes seem random and not predictable, that is since the investors are doing their jobs: all arbitrage opportunities have *already* been exploited to the extent to which they can be.

The "Efficient Markets Hypothesis" was made famous by Eugene Fama (1970). It did not please many practioners. "Technical" traders or "chartists" who believed they could forecast asset prices by examining the patterns of price movements were confounded: the EMH told them that they could not "beat the market" because any available information would already be incorporated in the price.

EMH is probably one of the most resilient empirical propositions. It is unable to explain on particular objections: for example, if all information is *already* contained in prices and investors are fully rational, then not only can one not profit from using information, indeed, there might not be any trade at all. These peculiar, contradictory implications of rational expectations were demonstrated by Sanford J. Grossman and Joseph E. Stiglitz (1980) and Paul Milgrom and Nancy Stokey (1982). Intuitively, the objection can be put this way (with some oversimplifying): The efficient markets hypothesis effectively implies that there is "no free lunch", i.e. there are no $100 bills lying on the pavement

because, if there were, someone would have picked them up already. Consequently, there is no point in looking down at the pavement (especially if there is a cost to looking down). But if everyone reasons this way, no one looks down at the pavement, and then any $100 bills that might be lying there will *not* be picked up by anyone. But then there *are* $100 bills lying on the pavement and one *should* look down. But then if everyone realizes *that*, they *will* look down and pick up the $100 bills, and thus we return to the first stage and argue that there are not any $100 bills (and therefore no point in looking down, etc.) This circularity of reasoning is what makes the theoretical foundations of the efficient markets hypothesis somewhat shaky.

Fundamental and Noise Risks:

On another main strand, researchers were arguing that some features of asset prices are most plausibly interpreted as deviations from fundamental value, and that these deviations are brought about by the presence of traders who are not fully rational. This was against Friedman (1953) argument. He stated in his work that rational traders would quickly undo any dislocations caused by irrational traders. He introduced an example with shares of car companies as follows:

"Suppose fundamental value of a share of Ford is $20. Imagine that a group of irrational traders become excessively pessimistic about Ford's future prospects and through its selling, pushes the price to $15. Defenders of the EMH argue that rational traders, sensing an attractive opportunity, will buy the security at its bargain price and at the same time, hedge their bet by shorting a "substitute" security, such as General Motors, that has similar cash flows to Ford in future states of world. The buying pressure on Ford shares will then bring their price back to fundamental value" (Friedman, 1953)

The argument against Friedman (1953) about asset prices was mainly on the ideality of substitute securities. Barberis and Thaler (2002) summarized argument from a behavioral finance point of view: "Even when asset is wildly mispriced, strategies designed to correct the mispricing can be both risky and costly, rendering them unattractive. As a result mispricing can persist unchallenged." This case is against market efficiency and it happens often in the financial markets. There are 2 different risks on the factors in the determination of prices; fundamental risk and noise trader risk. Barberis and Thaler (2002) work on the same example, Ford and GM in the car industry in order to explain

these risks. The most obvious risk an arbitrageur faces if he buys Ford's stock at $15 is that a piece of bad news about Ford's fundamental value causes the stock to fall further, leading to losses. This is the fundamental risk. They argue that arbitrageurs buying Ford at $15 and shorting GM, they hedge the industry risk; however they cannot hedge the risk of news specific to Ford Company, i.e. defective tires. They criticize that this kind of news is also a part of the fundamental risk and this risk cannot be justified by only hedging with a substitute stock.

"The noise trader risk is the risk that mispricing being exploited by the arbitrageur worsens in the short run" (De Long et al, 1990a). Arbitrageurs still face the risk that the pessimistic investors can cause Ford to be undervalued in the first place become even more pessimistic, lowering the price even further. *Noise trader risk matters* because it can force arbitrageurs to liquidate their positions early, bringing them potentially steep losses. A clear evidence for this kind of behavior is the index inclusions. Harris and Gurel (1986) found out when a stock is added to the index, it jumps in price by an average of 3.5%, and much of this jump is permanent, which supports the evidence that irrationality can persist.

Asset price volatility was researched by many scientists and tests were run in many researches. Shiller (1979) stated that both bond and stock prices are far more volatile than can be justified on the basis of real economic events. Arrow (1982) suggests that psychological models of irrational decision making of the type suggested by Tversky and Kahneman (1981) can help to explain behavior in speculative markets. There are many behavioral finance followers defending that existing evidence does not establish that financial markets are efficient in the sense of rationality reflecting fundamentals. On the other hand some researchers still point to the inability of professional money managers to beat the market as strong evidence of market efficiency.[2]

With these critics of efficient markets hypothesis, behavioral finance was born. It basically defends that investors can be irrational; prices might not reflect all information and markets can be wrong.

[2] Rubinstein, 2000, Ross, 2001

At this point, it should be stated that it is really hard to distinguish the noise and fundamental components in price volatility on assets in financial markets. In many cases, it is too complicated to determine which risk causes the price changes and it is hard to interpret them for taking positions. My paper is going to continue analyzing components of asset prices in section 2.6 in a different environment, where fundamental and noise components of asset prices will be discussed in betting markets. A replication study of Sauer and Brown (1993), analyzing fundamental and noise component in betting markets can be seen in the concerning section.

By the efficient markets hypothesis was being discussed in financial era, an alternative approach evolved. This alternative way is one of the main topics of this paper, namely, Behavioral Finance.

1.2. Behavioral Finance Literature:

"Behavioral finance is the application of psychology to financial behavior"(Shefrin, 2002).

Behavioral Finance has been a popular term in the finance literature since the 80's. Especially by bringing its own explanations on "anomalies" like the eastern markets crush and bubbles of technology stocks, behavioral finance gained more attention.

The main starting point for Behavioral finance was from psychologists. They pointed out imperfections of the investor decisions, inefficiency in markets and *heuristics and biases*[3] of human nature.

"In the 80s, scholars began to discover a host of empirical results that were not consistent with the CAPM and efficient markets theory. Proponents of traditional finance regarded these findings as anomalous, and thus called them anomalies. The anomalies started with size –e.g. the small-firm effect- and kept on coming. Soon there was January effect, the weekend effect, and the holiday effect. As they discovered new anomalies, scholars began to wonder whether traditional finance was incapable of explaining what determines security prices" (Shefrin, 2002).

[3] See Behavioral Finance terms, page 15

Starting as a critic of EMH, behavioral finance developed an alternative way of explaining financial markets. There were new terms and alternative approaches to the traditional finance and especially to the efficient markets model.

Robert Weintraub (1963) collected the skepticism and concerns about random walk hypothesis. He showed evidence that speculative prices do follow a trend. He also stated an interesting argument; the "seats" of floor traders on the NYSE, licenses to speculate where trades are executed, can often be sold for thousands of dollars (presently millions of dollars). Why would it be this expensive to have a seat in there if there were no price patterns? He states that these men earn their incomes by betting against the applicability of the random walk hypothesis to price moves.

Paul Samuelson (1963) covered risk and uncertainty from an alternative view. He applied the law of large numbers of James Bernoulli to insurance companies. He researched if insurance companies can reduce their risk by increasing the number of ships it insures. He found out that the correct relation is hedging by subdividing the ownership on the ships. He also concluded that a person whose utility schedule prevents him from ever taking a specific favorable bet when offered only once can never rationally take a large sequence of such fair bets, even if expected utility is maximized.

Niederhoffer (1966) pointed out the importance of psychology of investors and its effect on market. He underlined what previously Osborne found. Investors prefer trading on even eights rather than prices ending in odd eights. Having a psychological reason, he concluded that this is against random walk hypothesis.

Moreover, Stevenson and Bear (1970) found evidence on speculative price movements on commodity future prices do move in a systematic, as opposed to a random, manner.

Miller (1977) found contradictions in investor behaviors against EMH. He stated that it is implausible to assume that although future is very uncertain, and forecasts are very difficult to make, somehow everyone makes identical estimates of the return and risk from every security. In practice, the very concept of uncertainty implies that reasonable men may differ in their forecasts.

It wouldn't be exaggerating to say that Amos Tversky and Daniel Kahneman have made the pioneer researches in the area and they could be named as the inventors of Behavioral Finance. They introduced the heuristic-driven errors to finance in their first article,

Judgement under uncertainty: Heuristics and biases (1974). Moreover they explained a new term to financial markets, frame dependence (1979). They formed up an alternative theory to expected utility theory and called it as prospect theory. They concluded that people behave in many ways that systematically violate the axioms of rational behavior under uncertainty. These findings along with some others were turned into a guide book for behavioral finance followers (Judgment under uncertainty: Heuristics and biases, 1982). On a book review, another famous scientist, Richard Thaler, stated the following words for this work: "The papers chosen for this book are an excellent collection, generally well-written and fascinating."[4]This book is still one of the most referred sources in the field.Furthermore, many studies were inspired by prospect theory. Loomes and Sugden (1982) made a simpler alternative to this theory and named it as regret theory.[5]

In July 1985, The Journal of Finance gathered attention to behavioral finance by publishing two papers from this field. First paper, by Werner De Bondt and Richard Thaler, applied Tversky and Kahneman's notion of *representativeness*[6] to market pricing. De Bondt and Thaler (1985) argued that investors overreact to both bad news and good news. Therefore, overreaction leads past losers to become underpriced and past winners to become overpriced. The second paper, by Meir Statman and Shefrin, applied Kahneman and Tversky's notion of framing to the realization of losses. They called this phenomenon as the disposition effect, arguing that investors are predisposed to holding losers too long and selling winners too early. These two papers were among the first ones to point out that the irrationality can be general in the markets. They were referred by many further researches.

Keim (1983) found empirical evidence that for the period 1963 to 1969 positive returns to small firms during the first week of Janunary was unexpectedly large. This was called the turn of the year effect - or January effect. Roll (1983) worked on the same topic with a different time period and found consistent results on the turn of the year effect.[7] De Bondt and Thaler (1985) shed new light on the January returns by researching the returns earned

[4] Thaler, R. , book review, Journal of Economic Literature, Vol. xxi, sept. 1983, pp: 1048

[5] LOOMES, Graham and Robert SUGDEN, "Regret Theory: An Alternative Theory of Rational Choice Under Uncertainty", *The Economic Journal*, Volume 92, Issue 368 (Dec., 1982), 805-824.

[6] See Behavioral Finance terms, page 15

[7] Roll, R. , Journal of Portfolio Management, "The turn of the year effect and the return of the premia of small firms", 1983, 18-28

by prior "winners" and "losers." They found empirical evidence that portfolios of losers experienced exceptionally large January returns as late as five years after portfolio formation. They stated that their data is consistent with the researches in experimental psychology: Most people tend to overreact to unexpected dramatic news events.

Fischer Black (1986) introduced the term noise trading in the markets. He stated that trading on noise as if it was information, must be a significant factor in the securities markets. "Noise, in the sense of a large number of small events, is often a casual factor much more powerful than a small number of large events can be. Noise causes markets to be somewhat inefficient, but often prevents us from taking advantage of inefficiencies". (Black, 1986)

Trueman (1988) provided evidence that the incentive for a manager to engage in noise trading arises because of the positive signal that the level of manager's trading provides about his or her ability to collect private information concerning current and potential investments. Thereby another irrational behavior was found.

The efforts to adjust behavioral finance terms to decision making process have produced many interesting researches.

Heath and Tversky (1991) modified ambiguity aversion[8], a term introduced by Savage (1964). They argued that in the real world, ambiguity aversion has much to do with how competent an individual feels he is at assessing the relevant distribution.

Andrew Lo (1999) tried implementing Behavioral Finance in Financial Risk Management.[9] Beginning with behavioral issues in risk management, Lo introduced his three P's.: Prices (meaning the cost of reducing risk, by hedging for example), Probability (the chance of loss) and Preferences (how much risk to hedge). The analytic models in finance focus on the first two, and say little or nothing about the level of risk that is appropriate. The challenge for risk management is to integrate the three P's into a single and complete risk management protocol. Lo concludes that in order to find this protocol, one has to combine different sciences: "Economics and Finance, Statistics, Biology and the brain and cognitive sciences, may be a manifestation of the notion of consilience." Consilience was described by Wilson (1998) as "jumping together of knowledge by the

[8] See Behavioral Finance terns, page 15

[9] Lo, A., "The Three P's of Total Risk Management", *Financial Analysts Journal* 55(1999), 13-26.

linking of facts and fact based theory across disciplines to create a common groundwork of explanation."

It is aimed that Behavioral Finance would be adjusted to betting markets in the same way in order to understand these markets fully. "Consilience" is a need in this field, as it will be discussed further in this paper.

1.3. The Causes of Anomalies: Behavioral Finance Terms

Many of the anomalies in the markets were explained with irrationality of investors. The patterns that brought the anomalies were related to psychology. Therefore, the terms in the Behavioral Finance are mostly from Psychology rather than Economy. These terms can be hard to understand by just theoretical explanation; therefore an example for each term is given in the following.

Heuristic-driven bias is one of the main reasons for irrationality. It was introduced to Finance by Tversky and Kahnemann. *Heuristic* is defined as the process by which people find things out for themselves, usually by trial and error. These trials and errors lead people to develop some rules of thumb. Heuristics are said to be these rules of thumb. Heuristics are quite useful, but sometimes can lead the person to errors (*biases*) since it depends on the experiences.

"For example, the apparent distance of an object is determined in part by its clarity. The more sharply the object is seen, the closer it appears to be. This rule has some validity, because in any given scene the more distant objects are seen less sharply than nearer objects. However the reliance on this rule leads to systematic errors in the estimation of distance. Specifically, distances are often overestimated when visibility is poor because the contours of objects are blurred. On the other hand, distances are often underestimated when visibility is good because the objects are seen more sharply. Thus, *heuristic* of reliance on clarity as an indication of distance leads to common *bias*es"(Tversky-Kahneman, 1974). Such biases are also found in the intuitive judgment of probability which will be used in the following parts of this paper in understanding the gambler's behavior.

Another important term used in behavioral finance is known as *representativeness*. Representativeness refers to judgments based on stereotypes. People make assessments of the things they see and try to put them into groups. This grouping relies on stereotypes. These assessments depend on the representativeness of each thing to the observer.

One of the most famous representativeness examples is *the law of small numbers* or *gamblers fallacy*. People expect that a sequence of events generated by a random process will represent the essential characteristics of that process, even when the sequence is short. After observing a long run of red on the roulette wheel, for example, most people erroneously believe that black is now due, presumably because the occurrence of black will result in a more representative sequence than the occurrence of an additional red. The same sequence is observed on tossing coin, i.e. expectation of head after 5 straight tails. Even after 5 straight tails, probability is still 50-50 for heads and tails in a new toss. Chance is commonly viewed as a self corrective process in which a deviation in one direction induces a deviation in the opposite direction to restore the equilibrium. In fact, deviations are not "corrected" as a chance process unfolds, they are merely diluted.[10]

There are situations in which people assess the frequency of a class or the probability of an event by ease with which instances or occurrences can be brought to mind. This judgmental heuristic is called *availability*. It is a useful clue for assessing frequency or probability, since instances of large classes are usually reached better and faster than instances of less frequent classes. However, the reliance on availability leads to predictable biases. People can have a narrow availability, thus have wrong reasoning and wrong results based on this availability.

To help adjusting the terms, an example from betting markets can help us to understand availability. Biases based on availability are common in sports betting. The odds change with new information like doubtful injuries, player transactions and news about the teams. The gamblers that don't have the access to this information can miscalculate the probabilities. This bias is caused by the availability of the information to the gambler. It is more valid in financial markets; i.e. inside traders have a better view of the company

[10] Tversky A., Kahneman D., Judgment under uncertainty, Science, 1974, 185, p:1124-1131

than many other investors if the markets are not strongly efficient. Asymmetric information in betting markets will further be discussed in betting markets.

Anchoring is another term used commonly in behavioral finance. In many situations people make estimates by starting from an initial value that is adjusted to yield the final answer. The initial value, or starting point, may be suggested by the formulation of the problem or it may be the result of a partial computation. In either case, adjustments are typically insufficient.[11] Different starting points yield different estimates, which are biased toward the initial values. This process is called *anchoring.*

There is an interesting example of this process as follows. "Two groups of high school students estimated within 5 seconds, a numerical expression that was written on the blackboard. One group estimated the product

8 x 7 x 6 x 5 x 4 x 3 x 2 x 1

while the other group estimated the product

1 x 2 x 3 x 4 x 5 x 6 x 7 x 8

To rapidly answer such questions, people may perform a few steps of computation and estimate the product by extrapolation or adjustment. Because adjustments are typically insufficient this procedure should lead to underestimation. Furthermore, because the result of the first few steps of multiplication is higher in the descending sequence than in the ascending sequence, the former sequence should be judged larger than the latter. Both predictions were confirmed. The median estimate for the ascending sequence was 512, while the median estimate for the descending sequence was 2250. The correct answer is 40320." (Tversky-Kahneman, 1974)

Loss aversion is also one of the key terms in behavioral finance. Kahneman and Tversky find that sunk costs have about 2½ times the impact of a gain of the same magnitude. Many investors don't want to give up the hope of making money on a particular investment, or perhaps they want to get even before they get out.[12] People basically don't like loosing and hate to accept it. This phenomenon is called *loss aversion*.

[11] Slovic, P. & Lichtenstein S., 1971, Comparison of Bayesian and regression approaches to the study of information processing in judgment, Organizational Behavior and Human Resources, 6, 649-744

[12] Gross, L., 1985, The art of selling intangibles: How to make your million by investing other people's money, Prentice Hall

Kahneman-Tversky (1974) had a survey example to explain this concept. Subjects were asked:

In addition to whatever you own, you have been given 1000. Now choose between

A= (1000, 0.5)

B= (500, 1)

B was the more popular choice. The same subjects were then asked:

In addition to whatever you own, you have been given 2000. Now choose between

C= (-1000, 0.5)

D= (-500, 1)

This time, C was the popular choice.

Two problems are identical in terms of their final wealth positions and yet people choose differently. Subjects focus only on gains and losses. People are risk averse over gains and risk taking over losses (loss averse).

Conservatism is another bias practiced by investors. There are situations where base rates are over-emphasized relative to the sample evidence. Edwards (1986) run an experiment where there are two urns, one containing 3 blue balls and 7 red ones, and the other containing 7 blue balls and 3 red ones. A random draw of 12 balls, with replacement, from one of the urns yields 8 reds and 4 blues. What is the probability the draw was made from the first urn? While the correct answer is 0.97, most people estimate a number around 0.7, apparently overweighting the base rate of 0.5.

"At first sight, the evidence of conservatism appears at odds with representativeness. However, there may be a natural way in which they fit together. It appears that if a data sample is representative of an underlying model, then people overweigh the data. However, if the data is not representative of any salient model, people react too little to the data and rely too much on their priors" (Barberis-Thaler, 2002). In Edwards' experiment, the draw of 8 red and 4 blue balls is not particularly representative of either urn, possibly leading to an over reliance on prior information.

Traditional finance is aware of irrational human behaviors. However traditional finance followers defend that people, through repetition will learn their way out of biases; Experts in a field, such as dealers in an investment consultancy firm, will make fewer errors and with more powerful incentives, the effects will disappear.

While these factors can attenuate biases to some extent, there is little evidence that they will wipe them out altogether. The effect of learning is often muted by errors of application: when the bias is explained, people often understand it, but then immediately proceed to violate it again in specific applications. Expertise, on the other hand, is often a hindrance rather than a help: experts, armed with their sophisticated models, have been found to exhibit more overconfidence than laymen, particularly when they receive only limited feedback about their predictions. Finally, Camerer and Hogarth (1999) find out that while incentives can sometimes reduce the biases people display, no replicated study has made rationality violations disappear purely by raising incentives.

The biases above are a part of almost every decision making procedure. It is the task of every investor to adjust ways to prevent biases. Arnold S. Wood, President and CEO of Martingale Asset Management, gives a generic prescription for bias prevention as follows:

- Always ask what you don't know that you need to know when making a decision
- Give your full attention to contrary opinion, i.e. encourage it
- Document decisions so hindsight bias doesn't distort original intentions.
- Don't confuse competence with chance over short period

This set of principals is basically a result of experience and is an example of how investors use reminders to prevent biases.

As stated in the introduction, one of the main purposes of this study is to understand the findings of behavioral finance within betting markets. The terms used in behavioral finance literature is so valuable to explaining gambler behaviors that it is almost impossible to understand these behaviors without them. The terms explained above prepares a basis for understanding the bettor behavior in betting markets. While exploring the gamblers world, one would often face with many of the irrational anomalies explained. Some of them (overconfidence, wishful thinking), as we will see, can even be seen as the reason why these markets exist.

2. Betting

2.1. Gambling and Introduction to betting

There are different definitions in the literature for gambling. Some of them are as follows.

- Risking money in order to win money on an outcome that is wholly or partly determined by chance (Walker, 1992)
- Wagering of valuables on events of uncertain outcome (Devereux, 1968)
- Staking money on events driven by chance (New Zealand Productivity Commission, 1998).

Gambling is a term that covers betting while betting is used for gambling activities which does not contain only pure luck. For example staking money on sports games is a form of betting, while staking money on a roulette machine is not (Both of these activities are a type of gambling but sports betting is justified by sports knowledge of bettor).

While there appears to be general agreement about what constitutes gambling, all of the above definitions are unsatisfactory in that they also include other moderate to high-risk activities. Starting a new business or investing on the stock market, for example, could be included. However, most people do not regard these activities as gambling because while the outcome of these activities may involve chance, they are not specifically designed to part investors and their money. Gambling, as it is typically considered in science, industry and public discourse, is presented as a form of entertainment or recreation. In addition, consideration is usually confined to those activities that are widely perceived as gambling and/or are defined as such by statute or for taxation and regulatory purposes.

Gambling covers all the games that people pay to participate and have a chance to get more money in return. Lotteries, bets on sports results, bingo etc. is all under the term gambling. In this sense, gambling also covers betting. However this study is only specializes on sports betting. To make the distinction clear, when the term betting is used, the sports betting is meant.

Gambling comes in many forms and takes place in a variety of social settings such as retail outlets, hotels, clubs, casinos, race-tracks and, increasingly at home via the

telephone, television and Internet. It involves real money and real risks of winning and losing. It is undertaken by a wide diversity of people with varying attitudes and experience related to betting. Walker (1992) cautions researchers on the field: "…there is a great danger that studies conducted with students in simulated gambling environments for bogus money, small prizes, or course credit, will yield nothing of relevance to the real gambling of genuine gamblers in their natural environments". However, my paper aims to see the market as a whole and observe all kinds of bettor behavior in order to track clues for behavioral finance. To understand their rationale could lead us to the rationale of investors.

2.1.1 History of Betting

Before going further with the tracking the clues of behavioral finance in betting, one should get familiar with this market. There is a time that built up the professional sports betting that goes back to very early times in forms of basic gambling. Gambling is an ancient form of recreation. There is archaeological and historical evidence of gambling in many ancient civilizations including those of the Egyptians, Chinese, Japanese, Hindus, Persians, Hebrews and Huns[13]. "Gambling has been widely documented in prehistoric cultures as well as among indigenous tribal peoples" (Gabriel, 1996). From these accounts it is likely that Gambling emerged independently in a number of different societies. In addition, gambling innovations and practices have been widely transported across geographical and cultural boundaries.

Gambling appears to have been widespread throughout Europe and Asia in the Middle Ages. "In England, by the Sixteenth Century, gambling was common place through all social strata. Both men and women participated. Although tolerated amongst the aristocracy and upper classes, legal measures were introduced during the early part of the Seventeenth Century to curb gambling excesses in the lower classes. Legislation was passed making gambling illegal for commoners except at Christmas time. Betting clubs and houses proliferated. George II established the first national lottery. Betting on horse races and most other sporting events became popular." (Volberg, 1999)

[13] Volberg, R., Gambling and Problem gambling in Louisiana, Gemini Research Ltd., 1999

The rise of the Protestant work ethic during the early part of the Nineteenth Century was associated with a further period of betting restriction throughout much of Europe. In England, casinos were closed; gambling laws introduced and the state lottery was abolished in 1826. Bear-baiting and rat, dog and cock-fighting were prohibited. However, the new laws were enforced in a discriminatory manner. Upper class gambling continued to be condoned and flourished. Working class gambling went underground (Grant, 1994).

The first lotteries for prizes probably took place in Italy in the Middle Ages and were brought to France and England in the mid-1500s (Clotfelter & Cook, 1989). In revolutionary France, the glittering Palais Royal served as a tourist centre with shops and cafes as well as over 100 illicit gambling operations featuring dice and card games. Although the five main clubs were legalized by Napoleon in 1806, anti gambling forces were able to compel the clubs to close in 1837. The Napoleonic laws legalizing casino gambling formed the basis for legal gambling casinos today in France (Barnhart, 1992). France was the first European country to reintroduce casinos at spas and resorts at the beginning of the Twentieth Century.

It is impossible to tell just when the first sports gambling started. It seems from the records that horse racing is one of the oldest forms of sports betting. It has started in England in 17th century and spread to other countries. However, the professional sports betting is valid since the sports became professional in the beginning of 20th century.

The main continents for Sports betting have been US and Europe for a long time. In the first years the casinos were the only places where people could bet on sports events. Television broadcasting helped the sports betting to spread faster. The rise of professional sports, especially televised professional sports, has brought significant increases in the volume of sports betting in the United States. Moreover, legalized sports wagering in Nevada flourished considerably when the federal gambling tax was gradually reduced from 10 percent to 2 percent from 1975 to 1979. The sports handle[14] in Nevada increased dramatically from less than $41 million in 1973 to almost $258.7 million by 1979. [15] This

[14] see glossary for “handle”

[15] The numbers are available from the website, www.delugeonline.com

figure is around $2 billion dollars per year now and gives an idea of how sports betting grew in years[16].

The Internet has been another milestone for sports betting firms. Now most of the companies have an online department and almost everyone over 18 years old can have an account from all over the world. This brought a big impact on state taxes on betting. Some countries announced that they would not get any taxes on betting, and therefore many companies located their base to these countries (offshore). In other words, the Internet provided gambling a tax free location.

2.1.2. Betting Terms

There are many specific terms that are used in betting markets. A brief introduction of the terms related with this research is summarized below. For further explanations, a betting glossary can be found at the Appendix A of this research. The following part explains the terms in order to understand the concept of betting.

Odds: American or European?

An *odd* means the betting fraction, the return of money offered for each unit bet. *Odd maker* (bookmaker, bookie, or wager) is the person who offers the odds. There are two different ways of stating an odd; American or European. There is another type of betting called Pari-mutuel betting, where the odd is hidden (-not shown to the bettors) until the game starts. This type of betting will be introduced at the end of this part.

American odds are shown fractionally and do not include the capital involved. An American odd of 10/11 means that the odd maker gives $10 for every $11 if the bet is won. European odd on the other hand is shown on decimals and includes the capital. The same odd would be 1.91 (1 + 10/11) in terms of European odds. While the American odds state the profit, European odds state the total income. A European odd always seem higher to bettor since it includes capital. This can create a psychological effect on bettors: Since the capital is included in the odd, all numbers are bigger than 1, and misleads the bettor causing the income to seem bigger. Assume that an American odd for a team to win is 1/1. European version of this odd is 2. It is like stating the same truth with different

[16] Congressional Report, (2002)

sentences: in terms of American odds one would say “you invest $1 and make $1 profit if you win” while it would be stated as “you double your money if you win” in terms of European odds. The odds used in this research are European. American odds will not be used hereafter.

The odds set on the different odd makers generally hold single-price principle, meaning that all the odd makers offer usually the same odds for same games. Especially after usage of internet became common, people can have different betting accounts on hundreds of different companies. If there was a difference between the odds, then bettors could take advantage of arbitrage opportunities of different prices. Therefore many book makers do not set odds for some games before seeing market price. In fact, there seems to be an information network between odd makers around the world.

There are several types of odds set by the odd makers; the main types are point spreads, single odds, over-under. Moreover, some odd makers find some special bets and offer their clients but these are not in interests of this paper.

Point spread market is one of the most common research fields in betting. Point spread is valid mostly in American centered sports leagues like NBA, NCAA, NFL and NHL. Point spreads, like prices in financial markets, can be viewed both as market clearing prices and predictions of outcomes. The outcome of interest here is the score of the game, more precisely, the difference in points by two teams. Suppose that L.A. Lakers are hosting Chicago Bulls and that the wagering market clears with a point spread which favors the Lakers by 11 points. This means that bets on Lakers are winners only if the Lakers win by more than 11 points. Similarly, bets on the Lakers lose if Bulls either wins, or lose by less than 11 points. If Lakers win by 11 points all bettors get their money back and this is called a void bet.

The traditional sports betting companies serve odds to bettors in a way that they represent the risk and in the long run leave a commission to the company. Most of the odd makers in sports betting aim a commission over all bets. One can see this best on point spread betting since they are claimed to have equal probabilities on both sides. We can work on the same example of Los Angeles Lakers-Chicago Bulls game. The point spread (two teams’ score margin) was announced as 11 points by the odd makers, making the two sides equally probable. This means that odd makers think that this game will finish by 11

points in favor of Lakers and given the abilities of the two teams, there is no profit opportunity by betting on whether they will score more or less than 11 points margin. The odd makers offer odds of 1.91 for both sides of the spread, meaning that they pay 91% profit and the capital back for the winner party. This 91% is called pay out share. The loser party loses the capital invested. There can be more bettors positioned in one side of the point spread causing the company loss in some single events, but in the long run the odd makers secure their 9.89% (=(1/.91) -1) profit by offering odds at 1.91. In case of unbalanced positions on a side, some odd makers attract the weak part by offering higher odd or decreasing the heavy part's odd. Some take positions by announcing different spreads like making the spread bigger for the favorite team in order to attract bettors to the long-shot (short side). The knowledge of the odd maker on the game to set the odd for point spread is crucial. In order to make the betting markets an efficient one; this spread should give the bettors the most probable result, making the bet a 50-50 choice to take positions on one side.

The *single odds* on the other hand are set by the odd makers according to the probabilities of the teams to win the game. The odds are set by dedicated probability. If we use the same example, the return offered for Lakers to win would be less than for Chicago to win. Assume that the odd makers profit margin is set on 9.89 percent, thus pay out share is 91%. In order to find the odds, the odd maker appoints probabilities first. Assume that odd maker thinks there is a probability of 75% for Lakers to win while 25% for Bulls. The odds are set as follows:

Odd for Lakers = Pay out share / Probability of Lakers to win

Odd for Bulls = Pay out share / Probability of Bulls to win

Odd for Lakers[17] = 91% / 75% = 1.21

Odd for Bulls[17] = 91% / 25% = 3.64

Thus, Lakers odd offers 21% profit to bettors in case of victory while Bulls odd offers 264% profit. By offering the odds this way, the betting companies balances the money

[17] Note that the odds are *European*.

invested on each side maximizing their profit. In the long run, they secure their commission.

Under/Over bets are set for the total score of the game and usually consist of 2 same odd on each side. Likewise in point-spread odds, in an efficient market, an under-over total score would be the predictor of the real result.

A major and one of the oldest types of betting is pari-mutuel betting. According to the system, the holders of winning tickets divide the total amount of money bet on a race (the pool), after deductions for tax and racetrack expenses. The uniqueness of pari-mutuel betting lies in the fact that the gambling public itself determines the payoff odds (e.g., if many people have bet on the actual winner of a contest then the payoff will be low, simply because many winners will divide the pool). In pari-mutuel betting, a predetermined percentage is taken out of the betting pool to cover the cost of market-maker and the remainder is returned to winning bettors in proportion to their winning stake.

The origin of the pari-mutuel system lies in horse-race betting. “In 1865, a Frenchman named Pierre Oller, in reaction to losing too much of his own money to the odd makers, developed a wagering system which dispenses with odds makers who use their judgment to decide how much a given wager should pay” (Koessler, F. , Broihanne, M. H. & Ziegelmeyer, A., 2003). He called his system “parier mutuel", meaning mutuel stake or "betting among ourselves." When the system was adopted in England, it became known as “Paris mutuals" and then “pari-mutuels." Nowadays pari-mutuel wagering is the accepted betting procedure at major horse-racing tracks throughout the world; it is exclusively used by racetracks in North America, France, Hong Kong, and Japan and it coexists with a bookmaking market in Australia and Great Britain. In these pari-mutuel gambling systems, if the horse chosen by an individual wins, then his investment yields returns (calculated through final betting odds) that are decreasing with the proportion of bettors who have bet on the same horse. Besides, the proportion of the money in the win pool that is bet on any given horse is interpreted as the subjective probability that this horse will win the race and it corresponds to the implicit price of one unit of money bet.

2.1.3. Betting Market Structure:

Gambling is a large-scale business in 21st century. Data sourced from National Gambling Impact Study report (1999) estimate that people spend around $380 billion annually in one form of gambling in USA.[18] Gambling on sporting events involves large amount of money, but just how large may be impossible to determine, because a large part of sports betting is still done illegally.

Sports betting is legal in many countries and only in Nevada in USA. Gambling was banned by US Congress in 2002, and the reason was announced as "to protect American youth from addiction and bad habits". Since then, it is forbidden to use credit cards on the internet for gambling purposes in US. Many people think that there were Las Vegas odd makers behind the ban, who were losing their share to companies overseas. However, people find ways to get around this law by transferring money in offshore countries.

Online sports betting is developing as the users get familiar with the internet and overcome the security issues online. It grew further despite the bans in 2002 as worldwide revenues topped $4 billion for that year.[19] Of that amount, over $2 billion was wagered by US residents. Bear Stearns, investment bank, backed up these findings by estimating that the worldwide market would have been in excess of $5 billion had many American credit card providers not discontinued offering transfers to offshore sports books. Meanwhile, the total money wagered in Nevada on sports books (handle) was less than $2 billion in 2002; this was the first time in a decade that the Nevada handle dropped below $2 billion.

The Congressional Report (2002) states that the tremendous growth of both legal and illegal betting is expected to continue into upcoming years both in US and other countries. It is predicted by this report that the future growth of the online gaming industry will come more rapidly on a worldwide basis than in the United States. Americans, which now represent half of the online gaming revenues, are projected to be only 24% of the $14.5 billion worldwide market anticipated in 2006. Japan is of extreme

[18] It is very hard to find the exact figures for these markets since most of the companies keep this kind of information confidential. The most dependable research is National Gambling Impact Study which was published in 1999 by University of Chicago.

[19] US Congressional Report, US General Accounting Office, December 2002

interest to the industry because its household internet penetration of greater than 80% is the largest in the world and it is a country nearly as obsessed with sports as America is. Countries with even more long-term promise for the industry are China and Malaysia where already two times more people have gambled on the internet than have purchased a product online.[20]

While international markets clearly offer an opportunity for expansion, the offshore industry can continue to attract more new players to the industry in all countries if it satisfies new player concerns. According to the River City Group, the primary concerns of potential new players include: a hassle free experience; quick payments; easy instructions; attractive web sites; easy registration; secure credit card transactions; certificates from consumer protection agencies; better odds; ability to play for free; 24/7 customer service.[21]

Since the first internet gaming sites began appearing in 1995, 73 governments have approved some form of internet gambling. The industry has grown to 1400 gambling sites (Balestra, 2004). However, most of these sites are fairly small and cannot live for long because of intense rivalry. There are many sites closing their operations recently because of this rivalry.

Odds making is a money intense business. Firms must have enough liquid to balance the bets and afford losses in single events. Betting firms can be seen as risk management firms, hedging their risk of loss to each side. The odd maker is simply a middleman who operates on a small - middle profit margin and, ideally, likes to see half the money wagered on one team, and half on the other, assuring him of a profit. If too much money is wagered on one team, the odd maker will move the line, or point spread, to encourage bets on the other team thus enabling him to balance his book. A fair odd would create equal amount of money on each side, but firms have to track the bets and change the odds in case of imbalance, new information or speculations. Some firms even serve different odds to different customers because of hedging purposes. The reasons vary for this kind of price discrimination. For example, national games usually create overconfidence on national team and odd makers discriminate their prices in different parts of the world.

[20] US Congressional Report, US General Accounting Office, December 2002
[21] Balestra, M., "Internet Gambling Report", River City Group, 2004

Moreover, some skilled bettors are forbidden to wager more than some limit in order to prevent large losses. A further discussion of how odds are set is discussed on section 2.3.

The profit that odd makers earn from the commissions is fairly small. It is between 3 to 5 percent of all the money wagered. It is said to be the only profit source of oddmakers, however Strumpf (2003) finds that odd makers gamble and take positions on games, and raise their profit by their knowledge. The most possible reason is the rivalry in the market. The commissions got lower in order to attract customer making the war on market share very intense for companies. Odd makers try decreasing the costs and internet has helped a lot on it. Now that almost everything is online, the wagers have lower cost. Many of them try building brand by heavy advertising and giving special offers. However, in many countries people still prefer betting by cash in small shops. Therefore, there is still a substantial amount of cost related with rent, employment and paper for the companies who targets this group. Big companies who have this kind of organization reasonably charge with higher commission rates. The following statement is taken from an advertisement of William Hill, one of the biggest odd makers in England:

*Founded in 1934, we have over **65 years' experience** of offering betting services. Currently we operate over 1,500 licensed betting offices in the UK. We have over 300,000 telephone clients worldwide, making us the **world's largest telephone betting organisation**.*

*We **employ over 9,000 people** to ensure that we offer a customer experience that is second to none. With a yearly turnover in excess of US $2.5 billion, you can rest assured that in placing a bet with us you are wagering in a totally safe, legal and confidential environment.*

Reasonably, William Hill charges higher commission because of this type of big organization. They offer 1.83 for point-spreads where others offer usually around 1.91 (10 for 11). This means that William Hill charges a commission of almost 2 times the others'. The same type of organization can be seen in Dansk Tipstjeneste, where company has licensed offices in Denmark and serve lower odds for local games compared to the international internet sites. The customers accept lower odds because of trademark: They know the brand and trust the odd maker. They assure that their credit card information is not stolen. People are reluctant to spend money on the internet

because of their security concerns. The rumor about credit cards to be stolen over the internet is basically the biggest reason why people do not prefer internet betting. Using trust as a strategy is typical by the old firms that were in the business before Internet. However, this trust problem against internet seems to dissolve and people shop more and more on the internet. Therefore the big companies lose their customer on the internet to the small companies. In the long run, people will probably choose to bet with the odd maker who offers the highest odds and lowest commissions.

There are more issues other than trust and high odds when people choose their odd makers. One big issue is friction. Some companies charge customers with high transaction costs: they charge wire cost to transfer the winnings of the client. Some even refuse to pay if the client does not have an overall profit in his or her entire account history. Many big companies have reduced these frictions in order to satisfy customer needs. Another issue that attracts bettors is the bonus offered by odd makers. Many companies offer money when a new client signs up. Typical bonus is 20%, up to a limit; meaning that the company adds 20% of money on a new account. This bonus is "spend-only", meaning customer has to gamble it on an event within the company. This kind of offers and heavy advertising over the internet brings the conclusion for this sector: there are big rivalry and tough market share wars going in this market. The number of wagers is high and it is a dynamic market they are sharing. They have to fight to gain and hold their market share. Betting firms usually make more money as the trade increases, so they offer odds on many games, from horse races to curling, football to chess. Of course, this needs more attention on each game, a perfect information network. An odd maker has to know more than the bettors in order to make a fair analysis. The information is so valuable and can cause steep changes on the company's profit for related event. Therefore the information web is highly developed and very complex.

Moreover, this is a business where law of one price mainly holds; one can see more or less the same odds for the same games in every wager. This prevents the arbitrage opportunities for bettors who have accounts on different betting firms.

2.1.4. Taxation:

Taxing on betting has always been a hard issue in all countries. Before the development of the Internet, taxation of betting was various in different parts of the world. There were hard rules, bureaucracy frictions, high costs and therefore big commission rates in betting markets in many countries. The internet revolution pushed betting to a different level. Since the Internet allows transactions to take place between individuals located on opposite sides of the globe as easily as on opposite sides of the street, it is assumed that Internet gaming is controlled by international law (or by no law at all), and that it is a problem to be dealt with solely by national federal governments. After the Internet has become a part of daily life, some odd makers moved their services to online and they carried out their centers to the countries where there were no tax on betting. In this way they could still serve to clients all over the world but still pay less on costs and taxes. Many odd makers chose this way that some states lost their tax income on betting drastically.

Great Britain is one of the good examples to study how Internet betting has changed state view on betting. Great Britain used to have heavy tax on legal betting operations. Therefore some of the best known operators moved to other parts of the British Commonwealth. Ladbrokes, for example, calls itself “the world’s biggest odd maker.” Its website was licensed by the government of Gibraltar. Ladbrokes.com, launched in February 2000, highlighted repeatedly that bettors pay no tax. The loss of not just future tax revenue from online wagers but existing tax revenue from wagers placed by telephone and in person was forcing the British government to reexamine its position of simply ignoring Internet betting. The U.K. was charging a 6.75 percent tax on every bet placed with a British betting establishment. United Kingdom Chancellor, Mr. Gordon, proposed that this tax on betting be eliminated by January 2002. Yet, there was more than one catch: A new tax would be created, 15 percent of odd makers’ companies’ gross profits. The licensed odd makers would be required to return to the country. Operators who refused would not be allowed to advertise in the U.K. He stated that "A requirement for changing the betting duty is the repatriation of odd makers who fled to friendlier locales, like Gibraltar, Malta and others." After the new tax law at 2002 in Great Britain, the "Big

Four" operators, William Hill, Stanley Leisure, Coral and Ladbrokes, turned their bases to England. This fast reaction led Britain to be the market leader country in the world, the base of a developing market.

There are still negotiations in many countries about taxing bet incomes; it is expected that they will move in the same direction and states will choose to tax the odd maker over their profit. However Britain's rapid move gained the British firms a competitive advantage. They have the sufficient experience and customers; moreover, they already built trust on them. Today, the biggest odd makers are British oriented on the internet.[22]

As a conclusion, it seems that the taxing bettors have a tendency to disappear in the long run. Countries change their law and they tax the betting companies instead of bettors, and companies are still happy with that, since this move attracts bettors to gamble.

2.1.5 Customer Profile:

Betting is a common type of entertainment among adults all over the world. The Congressional Report (2002) states that one million Americans gamble online every day. According to David Lee, manager of Mandalay Bay casino, one of the reasons for the large amount of online sports bettors is the similarity between the typical sports gambler and the typical heavy internet user. Lee states that according to their database 77% of online sports gamblers are men. They tend to be single, 25-34 years old, college educated, and with incomes between $40,000 and $80,000 per year[23]. A survey of 2900 internet users by online gaming industry research company, The River City Group, backs up Lee's findings. The 2001 study indicated 74% of online gamblers are male and that they are among the youngest, highest income, highest education group on the internet. Another study, conducted by National Gambling Impact Study Commission in 1999, supports that, 48% of online gamblers are in the age of 25-44.[24] They are also technologically advanced, early adopters, and heavy wireless users.

[22] Ladbrokes is the world's biggest oddmaker, while William Hill is second.
[23] Jay, R., "A Profile of the online gambler", report for gambling firms, 2003
[24] National Gambling Impact Study Commission, "Report of Gambling Impact and Behavior Study", University of Chicago,1999

There are five different types of gamblers as Barrett (1996) defined from a psychological state of view. In the following, this classification of Barrett is adjusted to be assessed from a customer targeting point of view.

92 percent of the gambling population is called as socials, consisting of people who consider gambling as entertainment and set reasonable limits if they gamble. They see gambling as fun and they gamble i.e. in order to have extra excitement seeing a game, to have a chat with friends at work, etc. This type of bettor is the target profile of all odd makers. They have an average view on sports and they spend their money until their account is empty, meaning they do not win too much and even if they win, they gamble once more instead of cashing it, in order to have fun for another game.

4 percent of the bettors are defined as problem bettors who bet consistently, and they have a will to win, and an addiction to betting. Even though this type of bettors are very much into sports and follow information on sports, they usually are not the type of customer to hurt odd maker on the long run. That is because they do not know where to stop and keep on betting consistently.

Barrett defines another 1 percent type of bettors as professionals. They are the people who make their living out of betting. They are definitely the type of bettor that odd makers do not want to have as a customer. This type of customer is given limits and their bets are not accepted higher than these limits. They typically have different accounts from different odd makers. They pick their games and they bet just on them, they have a good information network and make great judgment on them.

The remaining 2-3 percent is defined as compulsive bettors as a further stage of problem gamblers and criminal bettors as the ones who try fixing games. This type of bettors is certainly not wanted as customers and does not represent any significance in terms of customer value to odd makers.

There are many surveys about the profile of bettors researched in many countries. Most of them research gambling from a social perspective. Many surveys track the problem gambling; intensive addiction to gambling. Since this paper focuses on betting from a scientific point of view, these surveys are not a topic of this paper.

While ending the first part in betting, it should be stated that this part was necessary as a base to understand the betting market structure and for further research opportunities on

betting markets. By the end of this part, the reader is ready to make a comparison and the analysis of interaction of behavioral finance with betting markets.

2.2. Why Do People Bet?

As mentioned earlier, the commission that odd makers charge the bettors makes sure that the odd makers make profit in the long run. This means that the bettors will always lose over the long time periods. As a conclusion, in traditional betting, there is no way that a bettor can win against the odd makers in the long run, unless he or she has the knowledge and luck better than the odd makers. Then the question comes to mind, *why do people bet, given the expected returns are negative?*

2.2.1 Psychological Reasons:

A tendency to gamble, to play games that bring on unnecessary risks, has been found to pervade various human cultures around the world and appears to be indicative of a basic human trait. Modern theories of gambling motivation are quite different from some earlier theories. Early social scientists theorized that gambling was a way to deal with the pressures of industrialization. Karl Marx grouped it with religion as an opiate for the masses. Psychoanalysts had a different view. Sigmund Freud analyzed Fyodor Dostoyevsky's heavy gambling and diagnosed him as punishing himself for his oedipal urges.

In the modern theory, the answer of the question why people bet is highly involved with findings of behavioral finance. The psychological traits explained by Tversky, Kahneman and Slovic are key issues to gambler behaviors.

The tendency for people to gamble has provided a puzzle for the theory of human behavior under uncertainty, since it means that one must accommodate both risk-avoiding behavior (as evidenced by people’s willingness to purchase insurance) and an apparent risk-loving behavior. People who gamble do not appear to be systematically risk seekers in any general sense; instead they are seeking specific forms of entertainment or

arousal.[25] Moreover, the gambling urge changes from person to person; it tends to take for each individual only certain forms: people specialize in certain games. The favored forms of gambling tend to be associated with a sort of ego involvement: people may feel that they are especially good at the games they favor or that they are especially lucky with these.

Oster (2001) researched the reasons why people participate in lotteries. The findings are mostly explained with sociological and psychological reasons. Oster believes that most bettors are addicted to the fun. She has discovered that a person's motivations for beginning to play are completely different from the reasons they continue to play. 72% of frequent betting shop gamblers had early luck in their gambling careers in comparison with 15% of the occasional betting shop gamblers who reported early luck when they started gambling. Moreover the main reason why gambling behavior persists after inevitable losses is mainly because the gambling behavior is maintained by one of the most powerful reinforcement schedule; random reinforcement.

In the light of these researches, the traits that affect gambler behaviors can be explained as follows.

Sensation Seeking is one of the main reasons to start betting. It is observed that gamblers are looking for varied, novel, and complex sensations and experiences. Several researchers have confirmed the hypothesis that gamblers score higher than non-gamblers on measures of sensation seeking[26].

Overconfidence, first introduced by Tversky and Kahneman for investor behaviors, is also one of the main gambler behaviors. Bettors overestimate their knowledge and luck to predict sports games and this is found to be one of the main reasons to start betting by surveys conducted in sociology.

Moreover, Fischoff, Slovic and Lichtenstein (1997) find that people are poorly calibrated when estimating probabilities: Events that they are certain to occur actually occur only around 80 percent of the time, and events they deem impossible occur approximately 20 percent of the time.

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[25] Shiller, R., "Human Behavior and The Efficiency of the Financial System", Handbook of Macroeconomics, Taylor & Woodward, 1997

[26] From the Casino Guide, "Why people Gamble",http://1stcasinoguide.itgo.com/whygamble.html

Risk-loving behavior is also one of the main elements that build characteristics of a gambler. It is a type of overconfidence. People love to challenge themselves in many fields for different reasons. The confidence intervals people assign to their estimates of quantities are very narrow. Shleifer made a survey and asked his students to estimate the max and min level of Dow Jones Index in a year, and found out that their interval is too narrow, meaning that maximum guess is too low when the minimum is too high.[27] Even the students were not given any limit, they drew a narrow spread in their estimates. Shleifer states that "this behavior is driven by overconfidence". Moreover, the researches on favorite- long shot bias show that people bet on horses that are not favorite for a race in order to get higher odds. This is a pure risk-loving behavior and it will further be discussed in the betting literature part.

Optimism and Wishful Thinking is another behavioral finance term that one can see as a gambler behavior. Most people display unrealistically rosy views of their abilities and prospects (Weinstein, 1980). Most people assign higher scores to their abilities than normal. "90 percent of people surveyed in a research think that they are above average in such domains as driving skill, ability to get along with people and sense of humor" (Barberis & Thaler, 2002). The feeling of being better than others pushes the bettor to gamble. Bettors are optimistic on their knowledge about sports events and want to "beat some others on knowledge of sports". Even though the long time period is surely against bettor, people continue to bet.

Another reason to bet on sports is the *feeling of reality* of the game. People choose to gamble on sports betting because they think their chance is better compared to other gambling offers like roulette or black jack. They think they can foresee the result by valuing two teams and guessing the winner better than they foresee if the next roll is black or red. Broadcasting of sports events on TVs, newspapers, to be a fan of sports, the feeling of involving the game motivates people to bet on sports.

These reasons are not unfamiliar to behavioral finance followers. The same reasons can drive investors, thus ruin investor rationality and decisions. These traits are almost the same traits that drive noise traders. Sensation seeking, optimism and wishful thinking,

[27] Shefrin, H., Beyond Greed and Fear, 2002, Oxford University Press,p.18

overconfidence etc. are effective on human nature and can affect serious financial decisions as well as sports betting coupons. Moreover both noise traders and bettors want to win money in a short term period. As one can see, there are similarities between noise traders in financial markets and bettors in terms of risk taking behavior. By researching bettor behaviors, one can have a broader view for behaviors of noise traders.

Other Bettor Traits

There are more bettor behaviors that can be explained by findings of behavioral finance. Some behavioral finance hypotheses are seeded from bettor behaviors. Gambler's fallacy is perhaps the most famous of them.

Representativeness is valid in sports betting as well. People can make predictions on a sports game by *representativeness*. An average bettor that gambles for the fun of the game can pick the winner by selecting the outcome that is the most representative of inputs (historical data). The confidence they have on their prediction depends primarily on the degree of representativeness with little or no regard for the factors that limit predictability. For example, people may express great confidence on teams which have won consecutive games (streaks). Consistency of a pattern of inputs is a major determinant of one's confidence in predictions based on these inputs.

Sample size neglect is a representativeness bias from behavioral finance. Gilovich, Valone and Tversky (1985) find that sports fans become convinced that a basketball player who has made three shots in a row is on a hot streak and will score again, even though there is no evidence of a hot hand in the data. [28] When judging the likelihood that a data set was generated by a particular model, people often fail to take the size of sample into account: after all, a small sample can be just as representative as a large one. This belief that even small samples will reflect the properties of the parent population is known as the law of small numbers. This, as explained earlier, generates gamblers' fallacy. In the same sense, bettors who have seen a number of games and believe that they have the necessary knowledge, think that they know what will happen in the next game.

[28] This discussion is called "hot hand fallacy" and will further be discussed in the betting literature review.

Availability biases is valid on gamblers information about the team conditions, injury situations, players' forms etc. When judging of an event, people often search for relevant information. However, some information is not available to all bettors and some are not even to some odd makers. On the other hand some bettors can have access to team information by their personal contacts to players, manager etc. These situations create asymmetric information, a term which is familiar to financial researchers. Inside information concerning a risky asset is presumed to be beneficial to its holder in financial markets. Measurement of the impacts and benefits of inside information are difficult because its use for financial gain is often illegal. Ideally one would like to investigate and compare two mutually isolated groups, one with and the other without access to information. The Australian horse betting market was researched in this sense by Schnytzer and Shilony (1995). It was found that even exposure to 'second hand' inside information effects a change in behavior, a rise in pay offs and adds power and significance to the prediction of race results.

Anchoring in sports betting is valid in interpretations of streaks. People tend to overestimate the probability of conjunctive events. They overestimate the probability of a team with winning streak to win their next game and likewise they underestimate the probability of a team with loosing streak to win their next one.[29]

Loss Aversion, as explained earlier, is one of the main bettor behaviors. People continue to bet even though they lose. The more people lose money the more they are willing to take more risk to at least get even. This behavior also exists in many investors.

2.2.2 Factors Behind Bettor Behavior:

There are a number of surveys by sociologists on the motives of betting behavior. They find out that different groups are more inclined to gamble than others. A review of several studies on demographic factors which relate to gambling behavior helps

[29] Camerer, C., *"Does the market believe in hot-hand?", The* American Economic Review, 79-5, (1989)

answering the question of who gambles the most. [30] Waiman and Hrbata (1997) find the following factors behind bettor behavior:

- ***Gender.*** Men and women tend to have different preferences in their gambling. Men are more likely to gamble in games such as blackjack and lotteries and women are more likely to engage in bingo and raffles.

- ***Age.*** There is a negative relationship between age and gambling behavior. That is, the older one becomes, the less likely she or he is to gamble.

- ***Marital Status.*** Single, divorced, and separated people were found to be more likely to gamble than married people.

- ***Community Size.*** Studies have found community size to be positively related to gambling propensity, meaning that residents of big cities gamble more.

- ***Religion.*** Catholics were found to be more likely to gamble than Protestants and other religious groups. Catholics were also found to be less likely to disapprove of gambling than other religious groups.

A national study of 1,771 undergraduate college students in United States showed that men gambled much more than women in all areas except bingo. The same study showed that among college students, more men (25 percent) than women (8 percent) experienced some gambling problem.[31] Competence is a masculine behavior and that explains why most of the gamblers are male. Researches suggest that in the southern region of the United States men widely subscribe to a traditional gender role that emphasizes masculinity in terms of aggressiveness, competitiveness and strength (Hurlbert & Bankston, 1998; O'Neil, 1982; Hantover, 1978). A study conducted by Evans, Gauthier and Forsyth (1998) argues that this masculinity is often associated with dogfighting, a highly competitive gambling sport illegal in all fifty states. There is arguably a culture of

[30] Waiman P. , Hraba, J. "Age and Gambling Behavior: A Declining and Shifting Pattern of Participation," Eadington and Cornelius, eds., pp. 56-59, (1997)
[31] Cincinati Enquierer, www.enquirer.com/editions/1996/12/19/tmpo_gamblingnumbers.html

masculinity that influences both the dog fighting and gambling that accompanies it. Theoretically, this culture of masculinity seeks to distribute masculine honor and status more than monetary gain. It creates an environment within which bettors consider winning money as important, but solidarity and respect from others is paramount.

Data collected by Chapple and Nofziger (2000) in bingo clubs, churches, and casino bingo parlors in the southwestern United States reveal a similar dual purpose principle, suggesting it might apply to gambling activities other than dogfighting. Bingo playing research respondents randomly selected and interviewed by Chapple and Nofziger (2000) readily admitted that they were drawn to bingo because of the potential money they might win. When asked what they considered "fun" about bingo, most research respondents referred to the amount of money that a particular game was worth (Chapple & Nofziger, 2000). Also, respondents considered other games that paid the most money to be the most fun to play. Furthermore, these respondents stated that both potential and realized winning streaks also inspired them to play bingo. The following words are taken from the notes of Chapple and Nofziger (2000) reflect these sentiments. “She was on a really good streak and told me that Thursday she went to the casino and that she didn’t have any money that night to spend but that she did have some of those coupon books (used for free bingo sheets)… and actually won $300. With some of that money she bought a game and won another $250. She then said that she played Friday night and won then, too. Saturday, she didn’t win, but she did win here today too.” (Sunday-almost four days straight of playing bingo) However, many of the same respondents claiming to be attracted to bingo due to its potential monetary rewards also cited the social benefits derived from gambling on bingo. Indeed, respondents of retirement age considered bingo as the means by which they remained socially occupied during their "senior years" (Chapple & Nofziger, 2000). According to Nofziger and Chapple (2000), these women considered bingo a tool to cure boredom, not simply a gambling activity by which they could win money. Other middle-aged women used bingo playing as an opportunity to gather socially with friends. This can be seen as the same type of behavior as in dog fighting, it is seen as a social value by the gambler to play bingo. In case of a win, they love to talk about.

All these reasons explain that there are different reasoning patterns to different groups but people find a justification for their behavior. These reasons gives us clues how people find excuses for their irrational behavior; knowing that they will lose on the long run, they continue to gamble.

2.3 How Odds Are Set

As mentioned above, bettors justify their behavior in various explanations. On the other hand, odd makers have different procedures, to make their business profitable. In order to understand the betting markets, one should know how the odds are set. As mentioned before, it is quiet different than financial markets. In the traditional betting markets, the odds are set by the odd maker while price is determined by supply and demand in financial markets.[32]

Although the mechanism used for price-setting in sports betting seems peculiar, there are at least three scenarios in which the odd maker can sustain profits by implementing it. In the first scenario, odd makers are extremely good at determining in advance the price which equalizes the quantity of money wagered on each side of the bet. If this occurs, the odd maker makes money regardless of who wins the game since the odd maker charges a commission (known as "vigorish" or the "vig") on bets. Following this strategy, odd makers do not have to have any particular skill in picking the actual outcome of sporting events, they simply need to be good at forecasting how bettors behave. Popular depictions of odd maker behavior have stressed this explanation.[33]

[32] Betting exchanges on the other hand , work like financial markets and will be explained in section 2.7

[33] For instance, a website devoted to educating novice gamblers (www.nfl-betting.org) writes, "A sports bettor needs to realize that the point spread on a game is NOT a prediction by an odds maker on the outcome of a game. Rather, the odds are designed so that equal money is bet on both sides of the game. If more money is bet on one of the teams, the sports book runs the risk of losing money if that team were to win. Odd makers are not gamblers--they want to make money on every bet regardless of the outcome of the game." Similarly, Lee and Smith write, "Bookies do not want their profits to depend on the outcome of the game. Their objective is to set the point spread to equalize the number of dollars wagered on each team and to set the total line to equalize the number of dollars wagered over and under. If they achieve this objective, then the losers pay the winners $10 and pay the odd maker $1, no matter how the game turns out. This $1 profit (the "vigorish") presumably compensates odd makers for making a market and for the risk they bear that the point spread or total line may be set incorrectly.

An alternative scenario under which this price-setting mechanism could persist is if odd makers are systematically better than gamblers in predicting the outcomes of games. If that were the case, the odd maker could set the "correct" price (i.e. the one which equalizes the probability that a bet placed on either side of a wager is a winner). Although the money bet on any individual game would not be equalized, on average the odd maker will earn the amount of the commission charged to the bettors. Unlike the first scenario above, however, if prices are set in this manner, the odd maker will lose if gamblers are actually more skilled in determining the outcome of games than is the odd maker.

The third possible scenario combines elements of the two situations described in the preceding paragraphs. If odd makers are not only better at predicting game outcomes, but also proficient at predicting bettors preferences, they can do even better in expectation than to simply collect the commission. By systematically setting the "wrong" prices in a manner that takes advantage of bettor preferences, odd makers can increase profits. For instance, if odd makers know that local bettors prefer local teams, they can skew the odds against the local team. There are constraints on the magnitude of this distortion, however, since bettors who know the "correct" price can generate positive returns if the posted price deviates too much from the true odds.[34]

These possible scenarios show us how different the betting markets are set. As seen, odd makers consider the psychology of bettors, as well as the sports knowledge. This explains how high the sentiments are involved in betting markets. The efficiency is up to odd makers in betting markets which doesn't sound very convincing since it is against free market mentality. However as it will be presented in section 2.6, there is high efficiency in odd making.

After stating the betting terms, bettor traits and how odds are set, the following part will state the differences and similarities of both markets.

34 This assumes that odd makers are unable to offer different prices to different bettors. Indeed, there is evidence that local odd makers who deal repeatedly with the same clients are able to exercise some degree of price discrimination. See Strumpf (2002) for empirical evidence that odd makers both shade the odds against the home team and offer different odds to bettors with different past betting histories.

2.4 Comparison between Financial Markets and Betting Markets

Financial markets and betting markets are different structures and this study aims to find the interactions between them. Theories and tests on each of them can give clues to the other.

There are many similarities between trading in financial markets and betting in sports wagering. First, in both settings, investors with heterogeneous beliefs and information seek to profit through trading as uncertainty is resolved over time. However, in case of betting this time period is relatively shorter, it is up to a sporting event, the investors (bettors) get their profit (or lose their capital) after the event.

Secondly, sports betting, like trading in financial derivatives, is a zero-sum game with one trader on each side of the transaction except for the commission differences. If the amount staked on each side of the game is the same, the odd maker have a risk free profit and bettors seem trading each other.

Another similarity is the large amounts of money are potentially at stake. The total amount of money wagered in the markets is called “handle” and it is hard to determine the turnover on betting markets precisely since there is a large amount of illegal betting.

Betting markets share many important features in common with stock markets. In particular, while betting market is dominated by individual traders, there are many professional bettors who devote themselves to attempting to exploit misprision. They call this style of betting as value betting, where they state that an odd that is higher than expected is a value bet. They state that only betting on these value picks, one can secure a profit in the long run. In a way, it is not different than the average investor looking for under priced securities.

As in the stock markets, information about prices is widely disseminated in betting markets; many newspapers have tips and predictions about upcoming sports events. Finally, the wisdom of “experts” is in demand; picks are available on online services, newsletters, sports shows, newspaper columns, books, pay-per-view services and 1-900 services.

In light of these similarities, it is surprising that these two types of markets are organized so differently. In most financial markets, prices change frequently. The prevailing price is

the one which equilibrates supply and demand. The primary role of market makers is to match buyers with sellers. With sports wagering, however, market makers (casinos and odd makers) simply announce a "price" (which takes the form of a point spread or a single odd), after which adjustments are typically small and infrequent. These prices almost never change except for the hedging purposes or news like injuries or team forms. If the first announced price is not the market clearing price, then the odd makers may be exposed to substantial risk. If bettors are able to recognize and exploit mispricing on the part of the odd maker, the odd maker can sustain large losses. The risk born by odd makers on sports betting is categorically different than the casino's risk on other games of chance such as roulette, keno, or slot machines. In those games of chance, the odds are stacked in favor of the casino and the law of large numbers dictates profits for the house. In contrast, however, if the odd maker sets the wrong line on sporting events consistently, it can lose money in the long run. The presence of even a small number of bettors whose skills allow them to achieve positive expected profits could cost financial disasters to the odd maker. Such bettors could either amass large bankrolls, or in the presence of credit constraints, sell their information to others.

On the other hand, another difference in two markets is there are no win-win situations. In the financial world, the stock holder and the company can gain value together by the increase in the price of the stock, while the odd maker and the bettor can never win at the same time: One gets the entire stake that other party put for the concerning bet.

In recent years, a new type of betting was found as betting exchanges. Betting exchanges provide bettors to make trades between each other just like trading in stock markets. This can actually be seen as the introduction of free market laws to betting markets and a turn of betting markets starting to work like stock markets. It is a great example of how two markets can affect and learn from each other. Further analysis on this type of betting will be discussed in section 2.7.

2.5. Financial Researches on Betting

Although professionals and other commentators often assert that relatively little has been written or is known about betting, there is, in fact, a substantial body of published

literature. Wildman (1997) has recently attempted to provide a comprehensive review of this literature. He lists over 3,500 books, articles and reports. Other writers have published integrative reviews from particular disciplinary perspectives, e.g. Walker (1992) from a psychological perspective.

There are many researches on betting from different perspectives, yet this paper is focused on the sports betting researches from a finance point of view. There are a few famous topics with this content in sports betting literature.

First argument is whether organized sports betting markets are efficient or not. The efficiency tests are usually done in point spread markets. These markets are said to be the optimal forecasts of the results of the games. The way that they are determined by odd makers usually depend on the comparisons of abilities of the two teams competing. Another famous topic is favorite/long shot bias. It contains researches about the bettor's bias on betting on high odds for long shot instead of low odds for favorites. The last 2 topics are hot-hand fallacy and asymmetric information. These topics are highly involved with Statistics, Mathematics and Finance. All topics have relations or clues to financial markets and investor behaviors. The researches summarized below have an aim of finding reasons and answers of financial markets in a different market structure. Odds and results provide a good database to test the efficiency, rationality of investors, effects of asymmetric information and since the outcome is fixed and related to a result of a sports event, the tests are easily interpreted.

2.5.1 Point Spreads and Efficiency in Betting Markets

Point spreads, as explained before in section 2.1.2, are the type of bets that bettors predict if the point difference between two teams will be under or over the spread that is stated. There are many researches in point spread markets in particular to test efficiency.

In an efficient market, the point spreads will be an optimal forecast of the difference in points scored by two teams. Clearly, if the optimal forecast deviates from the point spread, informed bettors can capitalize by betting on the appropriate team. Thus, "point spreads which depart from optimal forecasts are profit opportunities and would not be observed in an efficient equilibrium." (Sauer and Brown 1993)

The question of whether organized sports betting markets are efficient has received much attention in the literature of sports betting. Golec and Tamarkin (1991) document that point spreads set in the U.S. National Football League (NFL) betting market are systematically biased predictors of actual results. This finding is sometimes offered as evidence of inefficiency in the sports betting market, although it is not clear that this bias can be exploited via a profitable trading strategy. In particular, Golec and Tamarkin document that betting on home team underdogs[35] was consistently profitable over their sample period. Gray and Gray (1995) show that this bias is lost over time and no longer exists.

Gandar, Zuber, O'Brien, and Russo (1988) are unable to find any statistical evidence of inefficiency in the NFL betting market using a relatively simple econometric model. They establish evidence of *economic* inefficiency, however, by demonstrating the profitability of various betting strategies.

Brown and Sauer (1993) show that observable variables can be used to predict outcomes of professional basketball games, beyond the information contained in the spread. Brown and Sauer (1993) use the betting market for professional basketball games to address the issue of unexplained asset volatility. In this paper, researchers make a model to predict the winner and the point spread of the basketball games. The model maintains that the outcome of a game (the difference in score) is a function of luck, the home court advantage and the relative ability of the two teams. In addition both observable (e.g. injuries to key players) and unobservable (idiosyncratic) factors also affect scores. However, the model identifies a noise component in market point spreads. Although this component is small relative to its systematic counterpart, it is not irrelevant. They find that in its absence, point spread forecasts of game outcomes would be significantly biased. They conclude that the noise component is essential to predicting the outcome of the game itself. A brief discussion and a replication of this research with a different set of data will be presented in the section 2.6.

Gandar, Zuber, O'Brian and Russo (1988) finds that standard statistical tests on their data do not reject the hypothesis that the NFL point spread betting market is characterized by

[35] see betting glossary in appendix A for underdog

rational expectations. These scientists use several different tests on NFL data, and find very interesting results. They first define 4 rules to bet on and call them ad-hoc; mechanical rules, meaning they depend on rational expectations. Moreover they define 3 other rules based on some specific idea of irrational public betting behavior in this market. They find out that while the mechanical rules examined were not profitable during their sample period, the results of the behavioral technical rules strongly indicate that irrationality characterizes the NFL betting market.

Avery and Chevalier (1999) researched investor sentiments, which they define as any non-maximizing trading pattern among noise traders that can be attributed to a particular exogenous motivation. They tested the hypothesis that bettor sentiment can affect both average prices and path of prices in an empirical analysis of football point spread betting. They examined the hypothesis that bettors bet on past winners, follow the advice of experts, and bet on teams with name-recognition or prestige. They focused on these kinds of betting strategies since these have been alleged to be important sources of sentimental trading in the stock market. They show that bettors do, to some extent, have the hypothesized betting proclivities and these proclivities lead to predictable movements in the betting line. Moreover, they show that a betting strategy designed to exploit the sentiment-induced mispricing of the betting line is borderline profitable in their sample.

Gray and Gray (1997) tested the profitability of a number of betting strategies and came up with result that they generate statistically significant profits in the NFL point spread market. They do not use the ordinary least squares (OLS) regression methodology; instead they use what they call a probit model. This circumvents potential econometric problems and allows them to implement more sophisticated betting strategies where bets are placed only when there is a relatively high probability of success. In-sample tests they indicate that probit-based betting strategies generate statistically significant profits whereas the probability of a number of these betting strategies is confirmed by out-of-sample testing. They also confirm that widely documented inefficiencies in NFL betting market tend to dissipate over time.

Levitt (2003) attempted to understand the structure of the market for sports gambling by exploiting a data set of approximately 20,000 wagers on professional football placed by 285 bettors at an online sports book as part of a high-stakes point-spread contest. Two

aspects of his data set are unique. First, in contrast to the previous studies of betting that only had information available on prices; he observed both prices *and* quantities of bets placed. That information allowed him to determine whether the odd maker appears to be equalizing the amount of bets on each side of a wager. Second, he was able to track the behavior of individual bettors over time, which provides a means of determining whether some bettors are more skillful than others. A number of results emerge from the analysis. First, he demonstrated that the odd maker does not appear to be trying to set prices to equalize the amount of money bet on either side of a wager. In almost one-half of all games, at least two-thirds of the bets fell on one side of the gamble. Second, his findings prove that it is profit maximizing for the odd maker who sets the spread. Third, there is little evidence that there are individual bettors who are able to systematically beat the odd maker. The distribution of outcomes across bettors is consistent with data randomly generated from independent tosses of a 50-50 coin. Moreover, how well a bettor has done up to a certain point in time has no predictive value for future performance. These findings are very important and provide evidence that odd makers actually take positions in the games.

2.5.2 Favourite/Longshot Bias

Several studies explored the analogy between security markets and betting markets at the empirical level on favorite long-shot bias. In general they have sought to test whether the odds established in betting markets reflect the true probabilities of occurrence of the specific outcomes of sports events. The evidence suggests that there is a systematic tendency for the betting public to overbet on long-shots and to underbet on favorites in pari-mutuel betting markets (such as horse races). (Ali, 1977, Asch, Malkiel and Quandt, 1982, Asch and Malkiel, 1984) The implication is that a betting strategy that selects favorites can generate higher returns (or lower losses), on average, than strategies involving bets on longer priced horses. Taking into consideration the average track take of about 18 percent causes such a strategy to give rise to an average 9 percent net loss approximately. As win bets are placed on progressively longer-priced horses, however, the average losses increase, implying the existence of a negative risk premium in this

market (Hausch, 1981). This result may be explained either by the existence of inefficiency in the market, i.e. biased expectations, or by heterogeneous risk attitudes among bettors, some of whom act as risk-lovers. This is at least an evidence of irrationality can drive a large amount of bettors and given the size of the test data, this situation can not be explained as an anomaly. This finding is an important one for behavioral finance.

Australia is one of the countries where betting is very common. Bird and McCrae (1987) examine the efficiency of odd makers' markets at Melbourne horse racetracks. Consistent with overseas evidence, they find that average returns from betting on favorites are significantly greater than average returns from betting on long shots, but that no strategy yields a positive return. Bird and McCrae note that prior knowledge of movements in odds during the course of betting could lead to significant returns. Such knowledge, however, is privileged information and in the football markets studied in their paper, is impossible to obtain. In contrast, Tuckwell (1983) finds that changes in horse racing odds do not move in a random fashion and concludes that racetrack betting in Australia is inefficient. He states that while this result is prima facie evidence of statistical inefficiency, there is no direct link to economic inefficiency.

Thaler and Ziemba (1988) review the literature on racetrack betting markets, noting the consistent favorite/long shot bias. The expected return from betting on favorites is significantly greater than the expected return from betting on long shots. Swidler and Shaw (1995) fail to find evidence of this bias in a small racetrack betting market. Woodland and Woodland (1994) document that the favorite/long shot bias in racetrack betting exists in reverse for baseball bettors, but again that no betting strategy earns profits in excess of commissions. This situation shows that odd makers earn money no matter what the result is.

2.5.3. Asymmetric Information

Asymmetric information has always been one of the key issues in betting markets. One can always hear from a bettor that "I have heard this from a very confidential source", or witness an overconfidence of knowing what others don't. Inside trading, although illegal,

attracts many bettors. It is almost a part of the horse races to have an “inside information conversation”.

Favorite-long shot bias has shown that people go for long shots in pari-mutuel betting. Ottawani and Sørensen (2003) propose an explanation of this bias on late betting by small privately informed bettors. These bettors have an incentive to protect their private information and bet at the last minute, without knowing the bets simultaneously placed by the others. Once the distribution of bets is revealed, if bets are more informative than noisy, all bettors can recognize that the longshot is less likely to win than indicated by the distribution of bets.

Their analysis shows that the market odds are typically different from the empirical odds if bettors place bets without knowing the final distribution of market bets. The sign and extent of the favorite longshot bias depends on the interaction of noise and information.

Feeney and King (2000) find that there is an advantage of being an early mover in the pari-mutuel betting markets , that early players might choose actions with an *ex ante* low probability of success, and that layer action choices can ‘flip’ with small changes in the parameters of the game.

Moreover, Feeney and King adjust their results to other economic fields. They state that their result can help explaining why an early retailer of a new product might prefer to locate in a relatively small town rather than close to a larger market, or why sequential investment decisions might appear to be characterized by clustering subject to sudden switches in choice.

2.5.4. Hot Hand Fallacy

This topic is a good example of how sporting events can provide evidence to behavioral finance. It provides an evidence of people’s biases affect their decisions.

In basketball, players believe that they should "feed the hot hand," by giving the ball to a player more often if that player has hit a number of shots in a row. However, Gilovich, Vallone & Tversky (1985) analyzed basketball players’ successive shots and showed that they are independent events. Thus the hot hand seems to be a fallacy.

Gilovich, Vallone and Tversky (1985) defined the “hot hand” in basketball as the belief that during a particular period a player's performance is significantly better than expected on the basis of a player’s overall record. Gilovich et al. found that 91% of fans agreed that a player has “a better chance of making a shot after having just made his last two or three shots” and 68% said the same for free throws; 84% of fans believed that “it was important to pass the ball to someone who has just made several (two, three, or four) shots in a row.” Numerical estimates reflected the same belief in streak shooting, and most players on a professional team endorsed the same beliefs. Thus belief in the hot hand appears to be widespread, and Gilovich et al. suggest that it may affect the selection of which player is given the chance to take the next shot in a game. This implication is captured by a phrase heard in basketball commentary: "feed the hot hand." To test if the phenomena described by the hot hand actually exist, Gilovich et al. (1985) analyzed a professional basketball team’s shooting over a season in order to see if streaks occur more often than expected by chance. They found that for each individual player, the proportion of shots hit was unrelated to how many previous shots in a row he had either hit or missed. Analysis also showed that the number of runs of hits or misses for each player was not significantly different from the expected number of runs calculated from a player’s overall shooting percentage and assuming that all shots were independent of each other. The same independence was found for free-throws, as the probability of hitting a free-throw was the same after a hit as after a miss for a group of professional players. A controlled study of college players provided the same independence between shots and found that observers could not predict which shots would be hit or missed. Thus the hot hand phenomenon appears to be a fallacy. Why do fans and players believe in the hot hand if the empirical evidence shows that successive shots are independent? Gilovich et al. (1985) suggest that the persistence may be due to memory biases (streaks are more memorable) and misperception of chance, such as belief that small as well as large sequences are representative of their generating process (Tversky & Kahneman, 1974).

Falk and Konold (1997) see the hot hand as a cognitive illusion that is another example of people's inability to perceive randomness. Again we see people inventing superfluous explanations because they perceive patterns in random phenomena. Gilovich et al.'s

(1985) result has been cited over 100 times in journals. Many of these citations are in the decision making literature, but it is also widely cited across a variety of fields. There are many citations in sports science (Vergin, 2000) and economics (Pressman, 1998), but it has also been cited in literature on law (Hanson & Kysar, 1999) and religion (Chaves & Montgomery, 1997). There have been some challenges to Gilovich et al.'s (1985) conclusion that there are no more streaks than expected by chance in basketball, or at least to the finding's generalisability. Gilden and Wilson (1995) found some evidence of more streaks than expected in golf putting and darts, although they explain this as due to fluctuations in performance producing more streaks than expected rather than a real dependence between events. Miyoshi (2000) used simulations to suggest that Gilovich et al.'s analysis may not have been sensitive enough to detect the hot hand if hot-hand periods are relatively infrequent. One reason for the wide interest in Gilovich et al.'s result may be the implications it appears to have for behavior. As Gilovich et al. state "...the belief in the 'hot hand' is not just erroneous, it could also be costly." This is not only because it may affect the way shots are allocated between members of a team but also as an evidence of irrational expectation of a majority of people.

Taking the correctness of their result as a starting point, Burns (2004) suggests that if one looks at the hot hand phenomena from Gigerenzer & Todd's (1999) adaptive thinking point of view, then the relevant question to ask is if the belief in the hot hand lead to more scoring by a basketball team. Burns (2004) show that the answer to this question is yes; essentially since the streaks are predictors of a player's shooting percentage. Thus belief in the hot hand may be an effective, fast and frugal heuristic for deciding how to allocate shots between members of a team. In this sense, Burns (2004) defend that Hot-hand effect is a fallacy but an adaptive thinking could be considered to understand and get a use of it.

By the hot hand fallacy, one can see that people can have irrational expectations and these may lead a majority of them to biases. This is an evidence of Tversky and Kahnemann's heuristics and biases affecting the decisions of mankind.

By the end of the literature part on Sports betting, it should be stated that the researches covered provide quite important results in these markets. However, the disappointment for the researchers is that applicability of these findings to financial markets is a very

hard task. To adjust the findings to a much bigger market (i.e. stock market) with more variables is very hard as it is stated in many of the conclusions of these researches. In this sense, the literature survey showed that much more effort has to be done in adjustment task for upcoming researches.

2.6. Fundamentals or Noise?

During the preparation of Literature survey in betting markets, an interesting research on point spread markets that took my attention was Brown and Sauer (1993). They tested the efficiency on these markets and tried to find the fundamental value and noise component on point spread determination. In this way, a very basic discussion of financial markets was being tested in betting markets.

My paper aims to cover a replication study of Brown and Sauer, 1993 with a different set of data in the following.

Fundamentals based model is often used in financial markets in order to have a guide to predict the price changes and understand the effects on various developments on prices. It basically depends on regression models and the ability of the model to explain the changes. However, the significance of the model to explain price variations is usually found low in researches done in the financial markets. Fundamentals based model is usually criticized to have a too simplistic approach. The inability to explain the ex post explanations for price changes has been viewed by many as a failure of the fundamentals-based model. "The difficulty that the economists have had in explaining any significant amount of variation in speculative prices suggests that valuation errors are being made continuously" (Summers, 1986). On the fundamentals based theory, the error term is seen as the noise that is unrelated to fundamental valuation. There is no information in the error term and this term can not be foreseen.

There is another approach to noise term that goes back to 40's[36]. This approach defends that the error term represents fundamentals which are known to some traders but are unobserved by the econometrician. In that sense; prices summarize complex signals, capturing "the particular circumstances of time and place" (Hayek, 1945). Therefore, the

[36] Hayek, Fredrich A. (1945) "The Use of Knowledge in Society," *American Economic Review*, Vol. 35, No. 4: 519-30

idea that the determinants of prices could be fully identified in a simple model is a vain hope. A pricing model's error term is packed with fundamental information in this view, although the fundamentals themselves are difficult to identify. This hypothesis is called unobserved fundamentals hypothesis.

Why is it important to use sports betting for testing noise component?

The point spread market provides conditions which enable tests of the unobserved fundamentals hypothesis. Brown and Sauer (1993) researched market efficiency in NBA point spread betting markets. "In the point spread market, the actual event being forecasted is singular and readily observed. Hence, the relation between the idiosyncratic factor (abnormal return) and actual outcomes can be examined in this market. Under the fundamentals based theory, the presence of an idiosyncratic component in the point spread entails an equivalent adjustment in the expected score difference of the basketball game. In the stock market, the lack of simple outcomes makes it difficult to determine if unexplained price variation is irrelevant noise, or rather an amalgam of factors based on complex fundamentals. In the point spread market these characterizations are testable hypotheses" (Brown & Sauer, 1993). They find that the fundamental component in point spread betting explains 89% of the prediction. They set a model where they compare the team abilities in home court and out court with point spread lines to determine how efficient the point spreads are set. They run regression on opposing team abilities being independent variables and the point spreads on dependent. They find 88.9% R square with a standard error of 2.06 points. They interpret this 88.9 percent as fundamental risk and the rest as noise component. It is reasonable to state that the noise component is fairly small.

The point spread pricing model, developed in their research, depends on 2 components.

$PS_t = \delta_t + \varepsilon_t$

Point spread of a game (PS) is determined by fundamental and noise components. The fundamental component, δ_t, is based on the relative abilities of the opposing teams. The residual component, ε_t, comes from a noise source that is unobserved by econometrician. Brown and Sauer (1993) show that variation in δ_t accounts for the vast majority (89%) of variation in point spreads between basketball games. However, they also focus on the

residual component. They think that they can make a test to find if the noise is relevant to the game score. Suppose that they find that ε_t is unrelated to the game score: This is the situation in which an "error term is irrelevant noise" hypothesis would be supported. On the other hand, the hypothesis that the error term represents unobserved fundamentals would be supported only if the residual is related to the game scores in a precisely defined way. Brown and Sauer concluded that the noise term found representing its unobserved fundamentals in their setting.

In this part of my study, a replication of this research in another time period is done and searched if the results are consistent for other years or if it was only identical to the period Brown and Sauer estimated. They used a data of 6 seasons from 1982 to 1988 in National Basketball Association (NBA). The data sample in my research is more recent, it is the last four seasons (1999 to 2003) of the same league, NBA.

There have been several changes in the league. First of all, the number of teams, hence the number of independent variables increased from 24 to 29. There have been rule changes in the game itself, the players, teams have also changed. The betting markets started using internet and this change brought an even more sophisticated information channels for bettors and odd makers. By conducting the same test, my hope was to see if the fundamental value could still be as high and how all these changes affected the efficiency in point spread betting market.

The table below presents some descriptive statistics on the data analyzed in this paper with my data. The data is a sample of 4715 games played over 4 consecutive seasons from 1999 to 2003. The point spreads (PS) are observations from the betting analysis website, covers.com. Four seasons of NBA game point spreads data can be viewed on this website as well as some other historical data sources. Each season is studied individually, meaning the regressions were run separately. This is necessary since the team abilities change every season. The actual difference in the score of a game is denoted by DP. Both DP and PS are ordered on a home team less visiting team basis. Therefore, the average of DP (i.e. 3.427 points in 99-00) is the average number of points by which the home team outscored visiting team. The average value of PS (3.236 points in 99-00) can be interpreted as the betting market's estimate of the home court advantage.

Table 1: Means and Standard Deviations of Home Team – Visitor Point Differences

Data are from covers.com. N denotes the number of observations for each year. The NBA regular season consists of 1189 games; games for which point spreads were not valid are excluded. mDP and s(DP) are the sample mean and standard deviaton of the difference in points scored between the home and visitor team. mPS and s(PS) are the sample mean and standard deviation of the point spreads offered by odd makers. The mean forecast error of the point spreads is mFE; s(FE) is the standard deviation of mFE. P(h0) is the p-value from testing the hypothesis that E(FE) = 0.

Season	N	mDP	S(DP)	mPS	s(PS)	mFE	s(FE)	p(h0)
99-00	1147	3.427201	13.00365	3.236269	6.138062	0.190933	11.52078	0.287303
00-01	1187	2.919124	12.64285	3.187869	5.939663	-0.26874	11.32882	0.793121
01-02	1189	3.396131	13.05184	3.349453	5.935083	0.046678	11.86499	0.446047
02-03	1192	3.866611	12.69714	3.424916	5.926469	0.441695	11.51483	0.092693

Table 1 summarizes the data statistics. The Forecasted error is denoted by FE = DP – PS. The mean forecasted error is positive in 3 of 4 years, indicating that home teams did slightly better than predicted on average. This also coincides with Brown and Sauer's findings, where they found 5 out of 6 years of positive mFE. Nevertheless, the hypothesis that the market correctly measured the home court advantage (that the mean value of FE is zero) is not rejected for any of the 4 seasons. Although the measures of central tendency seem clear, there is a big unpredictability in the score differences (DP) as one can see from the high standard deviation of point differences relative to point spreads.

The estimates of point spread changes can be constructed with a simple point spread pricing model. The model is based on producing a point spread line that would be observed in the absence of adjustments due to abnormal factors. It maintains that the outcome of a game is a function of luck, the home-court advantage, and the relative ability of the two teams. In addition, both observable (like injuries to key players) and unobservable (idiosyncratic) factors also affect scores. My aim is to obtain parameter estimates of these factors.

Score differences are generated by the following:

$DP = g(S_i^H, S_j^V, v, w)$

DP is the points scored by the home team (i) less the points scored by the visitor (j), S_i^H and S_j^V represent the ability of team i when it plays at home, and team j when it plays on the road. v and w are random components, where w represents "luck" that cannot be anticipated, and v represents factors that may be known to the market (like injured players, fatique, match up problems, etc)

The assumption is that $g(S_i^H, S_j^V, v, w)$ has a linear form given by

$DP = S_i^H - S_j^V + v + w$ (1)

Since luck cannot be foreseen, the following condition implies the absence of profit oppurtunities:

$PS = E(DP) = S_i^H - S_j^V + v$ (2)

This condition, if satisfied, assures that the sign of DP – PS cannot be predicted.

Another version of this model is obtained if we assume that each team ability is increased by a common increment (h) over its base line ability (S_i) when playing at home. Thus,

$S_i^H = S_i + h = S_i^V + h$ (3)

The estimation is based on the fact that each game includes a single home team and a single visitor team. Let D_{it}^H = (1 if team i is the home team for game t, 0 otherwise) and D_{it}^V = (1 if team I is the visiting team for game t, 0 otherwise). Let $D_{it} = D_{it}^H - D_{it}^V$. This D_{it} is a dummy variable with the value of 1 if team i is the home team and -1 if team is visitor, and 0 if team i is not participant in the game t. Using (3), the definition of D_{it}, and relaxing the coefficient restrictions between (3) and (4), the model becomes:

$DP_t = h_1 + \sum_i S_{1i}. D_{it} + v_{1t} + w_t$ (4)

$PS_t = h_2 + \sum_i S_{2i}. D_{it} + v_{2t}.$ (5)

Equations (4) and (5) define a fixed regression model which yields coefficient estimates for the home court advantage (h_1, h_2) and abilities ($S_{1i,}$ S_{2i} , i = 1,…29) of the 29 teams. The model is run for each season since there are differences between team abilities and home court advantages between seasons.

Table 2 presents coefficient estimates and summary statistics obtained by estimation of (5) for the 2002-2003 NBA season. As one can see from the table, point spread equation explains a great proportion of its variance (R^2 = 0.80). This is a fairly high result, and indicates that the model finds a fundamental value which highly explains the data. However, this is not unexpected. Brown and Sauer (1993) also found R^2 as high as 0.889 for 1982-1983. The estimations for the other years in my study provide approximately same results, around 80% for fundamental value.[37]

[37] See Appendix B for details

On the other hand the standard error of the point spread for 2002-2003 season is 2.72 points. This is fairly small and also consistent with Sauers findings where they found a standard error of 2.06 for 82-83 season. It is clear that my data confirms the findings that Sauer and Brown found in 1993.

Table 2 Estimates of the fixed effects point spread pricing model, 2002-2003 NBA season.

The coefficients are estimates obtained from independent estimation of

$PS_t = h_2 + \sum_i S_{2i}. D_{it} + v_{2t}$

The equation regresses the point spread PS_t on a constant and a set of 0-1 dummy variables D_{it} indicating which team is the home team is the home team and which team is the visitor. The coefficient on the constant in regression is the home court advantage (h), and is listed below as Home Court. The coefficients on the dummy variables are estimates of team abilities. These coefficients are labeled as the team's home town name except for Lakers and Clippers where they both come from Los Angeles. The fixed effects model identifies only relative team abilities. The coefficients reported below are the ability estimates relative to the average team.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,898(a)	,806	,801	2,72359

Coefficients(a)

Model		Unstandardized Coefficients	
		B	Std. Error
1	Home Court	3,573	,085
	ATLANTA	-3,517	,430
	BOSTON	,137	,430
	CHICAGO	-5,941	,430
	CLEVELAN	-8,000	,430
	DALLAS	6,551	,422
	DENVER	-8,616	,423
	DETROIT	1,141	,430
	GOLDENST	-2,744	,423
	HOUSTON	,500	,423
	INDIANA	1,292	,430
	CLIPPERS	-3,727	,538
	LAKERS	4,565	,538
	MEMPHIS	-4,849	,423
	MIAMI	-6,093	,430
	MILWAUKE	-,716	,430
	MINNESOT	,849	,423
	NEWJERSE	3,588	,430
	NEWORLEA	-,064	,430

NEWYORK	-3,919	,430
ORLANDO	-,695	,430
PHILADEL	1,027	,430
PHOENIX	-1,217	,419
PORTLAND	2,326	,423
SACRAMEN	5,470	,424
SANANTON	4,473	,420
SEATTLE	-,477	,423
TORONTO	-6,234	,430
UTAH	1,317	,424
WASHINGT	-1,502	,430

a Dependent Variable: Point spread lines

Since the regression uses only 0/1 indicator variables, these estimates are measures of points as well. In Table 2, the relative ability estimates have been calibrated such that the average team receives an estimate of 0. The estimated homecourt advantage is 3.573 points. Thus contest between two teams with equal ability in both equations for 2002 would see the home team favored by 3.573 points (1.31 times the standard error of the regression). The team with the highest ability is Dallas Mavericks. The team with worst ability is Denver Nuggets. Given the home court advantage of 3.573 points, the model implies that Dallas Mavericks would be favored to beat Denver Nuggets by 18.7 (= 3.573 + 6.551-(-8.616)) points at home. Clearly, the model implies substantial differences between the best and the worst teams in the league. More important, the model's standard error is a small fraction of range of predicted point spreads.

As a conclusion, my data confirms that fundamental value explains a great proportion of it. The results are consistent with Brown and Sauer (1993) which means that the findings were accurate, and not identical to the period they researched. With more recent data, this research has found a high R square, thus high fundamental value. Moreover, the standard error is found fairly small, again consistent with prior study.

Brown and Sauer continue their research by testing if there is any information left in the noise component. They test if the injuries of the key players were effective on the placing of point spreads. By this way, they tested if these injuries made any difference on point spreads.

After conducting some tests, Brown and Sauer conclude that their model identified a noise component in the market. They state "Although this component is fairly small

relative to its systematic counterpart, it is not irrelevant. In its absence, point spread forecasts of the game outcomes would be significantly biased. This implies that the noise component is essential to predicting the outcome of the game itself" (Brown and Sauer,1993). This is an important result for finance to look for answers from other markets. They find that the noise term represents unobserved fundamentals in their setting. They demonstrated that information known to a market but not the econometrician can be mislabeled as irrelevant noise. Noise is news in the point spread market.

However, they state that their findings can not be transferred directly to other markets since there are many variables in these markets but at the very least this is a guide for them. It does not decrease the importance of their findings. This research is still a good example of how financial theories can find an environment to be tested in betting markets.

2.7. Stock Market Developments on Betting Markets: Betting Exchanges

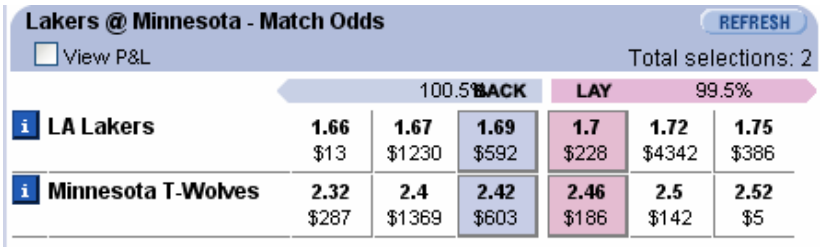
An interesting development for financial researches in the betting markets is the betting exchanges. This new system brings the mentality of the stock exchange into betting markets by taking the odd maker out for just executing trades on prices where two bettors who has different opinions.

Betting exchange is a new system that simply changed the betting markets. It is a system where people can bet with more fair odds. It basically puts the odd maker in a position where it is only responsible to meet the supply and demand between bettors. Bets are matched between people with opposing views. In the betting exchanges, people can either bet for a winner or offer odds (lay) to others to bet. To lay a selection is to bet that concerning team will not win. Bettor puts an offer either to back or lay on an odd he himself decides. If any other bettor has an opposing view and wants to trade for that odd, the trade occurs and according to the result, the market maker charges the winning party's profit by 5%. This is much lower than the traditional odd makers' vig which can be as high as 10% of the capital. The odds are slightly higher and every party is happy: the

bettors find better odds than odd makers. The market maker (not odd maker anymore) makes profit regardless of the result of games.

An example of how a game offer on a betting exchange system is displayed below.

Table 3: An example of a game offer in betting exchanges (from Betfair.com)



The blue boxes are the highest odds that are laid for each team and the red ones are the lowest odds the bettors would like to pay for. The bold numbers on top represents the odds while the $ figures show the amount that is available on the concerning odd. When two numbers meet, the trade occurs. The odd maker gets the commission of 5% of the profit from the winning party.

This system is quiet new and it was found by an Irish company called Betfair. Betfair was given the Queens award for being the best enterprise in the innovation category in 2003.[38] It created great attention since its service is extraordinary and the system is revolutionary. Betfair is one of the largest, if not the largest, online betting exchange. It is the trading name of The Sporting Exchange Ltd, a registered limited liability company in England and Wales. It was founded in 1999 and holds an odd maker permit in England and Wales. They continue to offer the best odds which are usually 15 - 20% better than at a traditional odd maker. Their turnover exceeds $150 million per week.[39] The differences that betting exchanges bring to traditional betting firms are summarized as follows.

- Bettors can back or lay a bet in better odds.
- Bettors can choose the odds they want to bet at.
- Bettors can bet whilst the game is in play.

These differences attract the bettors to betting exchanges. The future of betting seems to be in person to person betting exchanges; however there are also disadvantages as well as the advantages of this system.

The biggest problem for this system to work is the volume. In case there is not enough volume, trade gets harder, the prices vary and it gets harder to find attractive odds. To gather everyone in a system is a hard issue, it is harder than setting up the system. The

[38] A Queen's Award is given (as its name suggests) by the Queen, on the recommendation of the Prime Minister, and following a full assessment by the Department of Trade and Industry.

[39] From a website that writes comments on different betting sites, http://www.setyourodds.com/

start of a company using this system is almost the hardest part of the job. Heavy advertising, special offers, introducing a new system to people and the threat from the major companies in the business are very tough obstacles to overcome. But once it is settled, it is a profitable business; without any hedging skills, the odd maker makes money whoever wins the game. All odd maker has to do is to offer the games and gather the volume for it.

Another problem with low volume is that it can create speculative movements in the market. A large volume customer can simply speculate the prices and make profits: buy all high odds, lay on lower odds and this way an arbitrage opportunity occurs regardless of the game result. Low volume is always dangerous as it is also the case in stock markets.

After witnessing the development of betting exchanges, it is hard to predict where betting markets are leading to. This research ends with an idea for the future of the betting in the following.

A think tank: What is next for betting?

The Internet is very important for betting exchanges. All trades occur online. The firms earn on the bets with a commission. What comes to mind is, can the bettors get rid of this commission? Just like in the illegal music sharing over the internet, could the bettors exchange odds between each other without a commission or just paying the wire cost? A software program, just like the file sharing programs over the internet could do this easily. A firm with such a product can actually have a great income by just putting advertisement to the program. Instead of commission, advertisements could secure the firm a good income and the users would enjoy a fair competition. Kazaa, the file sharing program, serves customers the opportunity to share music for free and is making money only from advertisements. A sharing software program could work the same way for betting. This is actually possible on theory but there is no such development yet. In my opinion big credit card firms, such as VISA or Mastercard might like to get involved to a development which they already have familiar system and would increase the use of their cards. Moreover they would enjoy a big income once they overcome the volume and the security problem. Yet this kind of development would be very dangerous for the traditional gambling firms and drop their income just like the music companies' profit

decreased after Kazaa's software. It would at least be as risky as Kazaa's development, lawsuits and licenses would all be the problem. Yet since it would use internet, the international law would rule and the company would probably be found as innocent as Kazaa, which has won the lawsuits from the music producers and continue to provide sharing between internet users.[40] Such a development would create almost a frictionless market and be one step closer to being an efficient market.

Even this idea could be another topic for a research that aims to find an ideal market. Betting markets offer ideas like this to scientists. It is researcher's work to get inspired and implement it to other markets.

By this part it was aimed to make a brainstorming of what could be the next thing for betting markets. It might sound unrealistic, yet if achieved; it would be one of the closest markets to being frictionless.

Conclusion

This study aimed to research betting markets from a behavioral finance point of view. The effort is spent to learn from an alternative market that promises data and research opportunities. It has been a long literature survey starting with traditional finance, went on with efficient markets hypothesis, behavioral finance, psychology and finally betting. Furthermore betting markets are analyzed from a behavioral finance point of view.

This study provides a detailed guide for new researches in the field. In this way, the aim of researching betting markets is fulfilled. The industry figures, market structure, key issues are studied. Thus, there are several results of this study to underline at the end.

A major finding that should be underlined is the similarity of the investor and bettor traits. This research showed that the findings in behavioral finance about investor behaviors are consistent with bettor behaviors. As a conclusion, investors can observe biases and traits that drive bettors and learn from an alternative type of decision making. These observations can help investors to make risk involved decisions more rationally. It provides a broader view for investors and hints about their biases.

[40] This is personal view of the researcher and should not be considered for any reliance on any future development

An important result is that the first expectation of this study is confirmed: behavioral finance helps explaining the betting markets. Behavioral Finance especially helps analyzing bettor behaviors. Moreover, as explained in detail above, findings in this different structure have interesting clues for the behavioral finance. Scientists have important results in data from these markets.

The empirical work on the replication of Brown and Sauer (1993) showed consistent result with more recent data. The results provided a fundamental value of approximately 80% which is a high level for a market. It states that the comparison of the abilities of each team highly explains the point spreads.

A major problem that was observed during the research is the applicability to financial markets. Betting markets serve a good data base for the financial researches, and there are some serious theories tested on these markets. Many of these researches are published in famous journals. Some of them included significant results that were never achieved in financial markets. However, this is only one side of the story: The importance of these researches seems like it does not satisfy the scientists. There are very few researches which quote these test results in betting markets. It seems that these researches performed successful tests and achieved some results, yet their impact is not very impressive. The first reason that comes to mind is that it is hard to convince people that findings in betting markets could reflect a significant result for a much more complicated market like the stock exchange. The controlled laboratory environment is accused to be too simplistic and the controlled issues are actual variables in financial markets. My view on this issue is that people do not see the betting markets as an alternative market. They do not believe that the results of these researches can be adjusted to financial researches. Even the researches that found significant results in this field end their papers with a conclusion that states their findings can not be easily transferred to other markets. What found is accused to be characteristic to betting markets. Moreover, there is a high conservatism on testing financial theories in markets like sports betting which is seen as a symbol of a market that is set to take the money and the bettor apart.

In my opinion, the problem is that the researches are too focused on testing the hypotheses and running the empirical effort in betting markets while the applicability to finance was left out. My suggestion for further researches would be to overcome this

adjustability problem. The findings, no matter how important they are, have to be adjusted to the financial markets. Therefore, in this sense, the researches in betting markets have been disappointing.

Moreover, risk management skills of odd makers were seen in search of the market structure. The theories on the how the odds are set provided interesting hedging skills to analyze these markets. These theories can give hints for risk managers in their field.

Betting markets have a complex structure. By this study, this structure and how things work in this market were explained in detail. The findings provide guidance to further betting researches. It was an interesting and exciting field to track the footprints of rationality and finance rules. It has been a great journey on an alternative market to search clues of more complicated ones; financial markets. In this sense, this paper achieved to conduct a “consilience” on an alternative field, sports betting markets.

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Appendix

Appendix A: Betting Glossary

Action: A live bet or bets.

Arbitrage: Betting the same event at separate sports books in order to lock in a profit by taking advantage of different betting lines.

Bankroll: Total capital available for betting sports.

Board: A presentation of all the games and events available for betting in a sports book. (If wagers are being taken on a game, the game is "on the board," otherwise it is "off the board.")

Bookmaker (or bookie): A person who accepts bets.

Buyback: The money that comes in on the underdog after a favorite is bet heavily enough to move the line.

Chalk: A favorite, usually a heavy favorite.

Chalk eaters: Bettors who like to bet big favorites (often a derogatory term).

Circled game: A game in which the sports book has reduced its betting limits, usually due to weather or the uncertain status of injured players.

Cover: Winning against the point spread. (A 10-point underdog that loses 20-14 has covered, or "covered the spread.")

Exposure: The degree of risk that a sports book will lose money on a given game, result, or proposition. (If a book is "highly exposed" on the Cubs in World Series futures betting, it will lose a lot of money to bettors if the Cubs win the World Series.)

Fade (Lay): To take the opposite side of another bettor's wager, or to accept that bet yourself.

Favorite: A team (or player) that, according to the odds, is the stronger or strongest in a given matchup, or is regarded as such by the betting public, or is expected to win.

First-half betting: Wagers that involve the outcome of the first half of a game only.

Freeroll: A bet one can win or "push", but not lose.

Futures: A type of wager involving the outcome of a season or how a particular team or player will perform over the course of a season.

Halftime betting: Wagers, based on betting lines posted at halftime, which involve the outcome of the second half of a game only.

Handicap: Point spread for soccer games.

Handle: The amount of money in wagers accepted. ("The handle was down this year on the Super Bowl.")

Hedge: To make a bet that takes the opposite side of your original position, usually to reduce risk or lock in some profit.

House: The casino, sports book, or bookmaker.

Lay: See fade.

Layoff: A type of wager made by one bookmaker with another, often larger bookmaker in order to balance action or reduce risk.

Limit: The maximum wager accepted by a sports book.

Line: The point spread or odds on a game or event.

Lock: A bet that cannot lose

Long shot: The team that has a low chance of winning on a game.

Matchup proposition: A betting option that pits two players against one another in a contest or event, often used in golf and auto racing wagering.

Middle: A situation in which one bets both sides in a game and wins both bets, due to favorable line moves. (Example: Bet a football favorite at minus 2 ½, then bet the underdog at plus 3 ½ at another book or later in the week. If the favorite wins by exactly 3 points, both bets win.)

Money line: The odds on a team winning a game outright, regardless of the point spread.

Offshore: Designation for the organized sports betting industry outside of the United States.

Out: A place to get bets down, whether it's a Nevada sports book, offshore book or illegal bookmaker. ("It's good to have a lot of outs.")

Over/under: See "totals."

Overlay: A situation in which the odds are favorable to the sharp bettor.

Parlay: A bet in which two or more events must happen in order to win; if any one of them does not happen, the wager loses.

Player: A sports bettor.

Pleaser: A specialized form of a parlay that improves the point spread (for the book) but pays off at improved odds.

Point spread: The number of points added to or subtracted from a team's actual score for betting purposes.

Price: See "line."

Proposition (or prop): An unusual or offbeat betting opportunity.

Public: Average, unsophisticated or casual bettors as a whole; or, used to describe money bet by the public ("a lot of public money came in on the Cowboys"); see "square."

Puck line: In hockey, a betting structure that dictates the favorite must win by a set number of goals, and/or adds a set number of goals to the underdog's actual score.

Push: A bet in which the money wagered is refunded; a tie.

Rotation: The official list of all the games on the betting board, presented in a specific order.

Round robin: A specialized form of a parlay that uses every combination of a set of teams in a wager. For example, there would be six two-team parlays within a four-team round robin.

Rundown: A reading of all the games and betting lines on a particular day.

Runner: See "beard."

Scalp: A form of a middle in which one bets both sides in a game, taking advantage of line movements to secure a profit.

Sharp: Savvy, highly informed; or, used to describe the money bet by sharp players ("a lot of sharp money came in on the Eagles").

Side: A variation of a middle in which you win one bet and push the other; also, a particular team in a matchup. ("Which side do you like?")

Sports book: The part of the casino that accepts bets on athletic contests or a sports betting firm.

Square: An unsophisticated or casual bettor, the opposite of a wise guy; see "public."

Steam: One-sided action.

Straight: A single bet, usually laying 11 to win 10.

Teaser: A specialized form of a parlay that improves the point spread (for the bettor) but pays off at reduced odds.

Totals: A type of wager that involves whether a score or result will go over or under a posted number.

Tout: A person who sells his predictions to bettors (often derogatory).

Underdog: A team (or player) that, according to the odds, is the weaker or among the weakest in a given matchup, or is regarded as such by the betting public, or is expected to lose.

Vigorish (or vig): The commission charged by the bookmaker.

Wise guy: A sharp, successful, established professional sports bettor.

Wood: The price of a heavy favorite.

Appendix B

Model Summary for 1999-2000

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,874(a)	,763	,757	3,02490

Model Summary for 2000-2001

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,887(a)	,787	,781	2,77669

Model Summary for 2001-2002

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,872(a)	,760	,754	2,94093

Model Summary for 2002-2003

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,898(a)	,806	,801	2,72359

a Predictors: (Constant), WASHINGT, LAKERS, CLIPPERS, NEWORLEA, PHOENIX, PHILADEL, DALLAS, MILWAUKE, MINNESOT, TORONTO, BOSTON, SEATTLE, PORTLAND, ATLANTA, GOLDENST, INDIANA, MEMPHIS, NEWJERSE, HOUSTON, DETROIT, ORLANDO, DENVER, UTAH, CHICAGO, SACRAMEN, NEWYORK, CLEVELAN, SANANTON, MIAM