

Posted-Offer vs. Double Auctions Revisited: An Investigation into Online Sports Betting

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May 20, 2005

Abstract

The experimental literature on the comparison between posted-offer markets and double auction (DA) institutions is well-established and came to the agreement that DA is superior to posted-offer design, because the convergence to the competitive price is rapid and resulting allocations are highly efficient. The field study counterpart, however, is nonexistent. The organization of online sports betting markets allows us to conduct a field study that fills this gap. In these markets, betting exchanges (DA) compete with traditional bookmakers (posted-offer) to attract bettors. We compile and analyze a dataset of National Basketball Association (NBA) games and find that the odds on the leading betting exchange (Betfair) are consistently higher than that of the two leading bookmakers (William Hill and Ladbrokes), a confirmation of the experimental results in the field. Moreover, the net returns are also higher on the exchange suggesting that the online sports betting markets are not efficient. Late betting does not correct these inefficiencies. These results are puzzling, since the bookmakers continue to be profitable. We discuss possible explanations for “the bookie puzzle”, the observation that bookies attract a lot of betting although better returns are available elsewhere, and dismiss them.

Keywords: Double Auctions, Posted-offer, Efficiency, Market microstructure.

JEL Classification: D44 (Auctions), G14 (Information and Market Efficiency; Event Studies)

1 Introduction

Markets have different structures. Most markets still follow the posted-offer rule, the sellers post prices and the buyers make a decision upon observing the price. This institution dominates the retail industry. Double auction markets (DA), also known as open outcry markets, on the other hand, are organized as follows: Buyers and sellers post prices simultaneously, bids and asks, respectively, and whenever there is a match, trade occurs. Most securities markets operate under this rule. At any point in the trading period, buyers and sellers can observe the highest bid and lowest ask (or all bids and asks), accept an outstanding bid/ask or post new offers, which are queued and could be accepted in the future.

There is a huge experimental literature on the comparison of these two fundamental institutions.¹ That literature agreed on the following: Double auction markets are more efficient than posted-offer institutions. Since it is the experimenter who designs demand and supply schedules, the theoretical competitive equilibrium price, and hence the total possible surplus is known to him. One can then run experiments under different institutional assumptions and measure (ex-post) efficiency as the ratio of realized surplus over total surplus.² These studies have found out that the convergence to the competitive price is quite rapid under DA, whereas in posted-offer markets the price either converges more slowly or does not converge at all. The superiority of DA over posted-offer market is fairly robust to the number of agents, design parameters and changes in rules. For example, efficiency has been obtained even in monopoly settings and with as few as four buyers and four sellers.³

Experiments are very useful in order to understand human behavior as well as to test theories. But they clearly have their limitations. The biggest concern is that subjects would not behave the same way as they would in real world, partly because the monetary incentives are small. However in practice much more is at stake, and the participants are more experienced. Lab experiments are very useful complements to, but clearly not substitutes for, real settings. Therefore field studies should be used whenever possible. Only a combination of theory, experiments and field studies will help us to understand how the markets truly work.

The comparison between different market institutions has been a very

¹See, for example, Ketcham *et al.* (1984) and Hong and Plott (1982).

²For a discussion of this measure and other alternatives see Plott (1989) and Davis and Holt (1993).

³For a survey of this literature, see Davis and Holt (1993), Chapter 3.

active area in the laboratory, but is virtually nonexistent in the field literature. The reason for this is clear. A comparison of this sort requires a market where identical products are traded through different market mechanisms. Whatever market is picked, the market institution is usually fixed and rarely changes over time. Even it does, it would be hard to control for other changes that have occurred in that time frame. A natural starting point is the cross-sectional comparison of markets that operate under different rules. This is the path that Cohen *et al.* (1986) have taken. They compared two specialist DA markets (NYSE and AMEX) to two non-specialist DA markets in Tokyo and Rio de Janeiro and found price volatility is reduced in specialist markets. Clearly other factors might affect the outcome hence it is very hard to distill the effects of the institutions on the outcomes. Amihud and Mendelson (1987) put it succinctly: "...it would be hard to discern differences resulting from the trading mechanism itself from differences due to dissimilarities of securities and environment". These authors attacked the problem by comparing NYSE open-to-open price changes with close-to-close price changes. NYSE is a hybrid institution, the open prices are determined using a clearinghouse and trade follows a DA process until the close.⁴ Since both constructions cover exactly one day, the differences in returns are attributable to differences in institutions. Along with the subsequent paper of Stoll and Whaley (1990), who use a bigger dataset and reach similar conclusions, these are the only papers of which we are aware that compare different market structures using field data. Moreover, the clearinghouse and DA institutions are close variants and they yielded almost identical results in lab settings.⁵ To our best knowledge no attempt has been made to compare posted-offer markets to DA markets in a natural setting. As Friedman (1993) put it, "Field data unfortunately rarely permit such clean [institutional] comparisons."

This paper builds on one of these rare incidences. The organization of online sports betting markets provides us with the opportunity to undertake an institutional comparison. The traditional betting method is placing wagers with a bookmaker. The odds are provided by the bookie, and the

⁴The clearinghouse mechanism is a discrete-time two-sided auction, where all bids and asks are collected, and then cleared at the end of the trading period. The continuous time version is sometimes called continuous DA, a term which we simply refer to as a double auction.

⁵Friedman and Ostroy (1995) have documented this perfectly. One can think of DA being more efficient than the clearinghouse mechanism because of the continuity it possesses, in fact, it was exactly the position taken by one of the authors before they carried out the project. Although they ran experiments which are explicitly designed to produce different outcomes under different institutions, the two institutions fared equally well.

bettors, upon observing these odds, decide to wager or not. This is still the most common betting method. But currently punters have the option of betting on a betting exchange. Betting exchanges differ from conventional bookmakers in two important ways. First, bettors can bet on the outcome that a team will lose, in betting jargon, they can “lay” a team. By doing so they can essentially act as a bookmaker. Second, the bettors do not have to accept the outstanding back or lay odds, they can post their own. A betting exchange, therefore, works just like a financial exchange. The introduction of betting exchanges into online sports betting has changed the structure of the market substantially.

Economically speaking, the traditional system is a posted-offer mechanism, and betting exchanges are double auctions. Therefore the online sports betting market is a unique testing ground in which the performance of two fundamental institutions can be compared. The main contribution of our paper is complementing the experimental literature by comparing the DA and posted-offer institutions using field data.

Our dataset consists of National Basketball Association (NBA) games played between December 2004 and February 2005.⁶ The compiled dataset includes odds at one leading betting exchange and two leading bookmakers, all based in UK.⁷ The analysis shows that odds on the exchange are consistently higher, a result that was expected *ex ante*. The field data therefore replicate the empirical findings.

Wagering markets have established their own literature since they give us valuable insights about the functioning of the markets. They are deemed as close replicas of financial markets along with the additional advantage of price revelation. The price of a security is never known, but the price of a gamble is revealed in the long run as many similar events unfold. One can then test the market efficiency using a series of events. These studies presented several anomalies and questioned arbitrage opportunities (Ali, 1977; Snyder, 1978; Thaler and Ziemba, 1988; Woodland and Woodland, 1994).⁸

Better odds on the exchange were expected *ex ante*, but whether the returns on the exchange would also be consistently higher or not was far from obvious. The two are not the same, the betting exchange charges a

⁶In fact, our dataset will eventually cover the entire season. At the time of this writing, the analysis is carried out for three months and the paper reports these preliminary results.

⁷The details of the dataset will be summarized in section 3.

⁸Explicit or not, these studies are partly motivated by the assumption that the results will generalize to financial markets. Tetlock (2004) challenges this assumption and concludes that it might not be appropriate.

commission on net winnings, putting a wedge between the odds and the returns. Since the contracts traded on both venues are identical, net returns should converge, otherwise all bettors would migrate to the more profitable alternative driving the other out of business. We show that the net returns are consistently higher on the exchange. At the same time the bookmakers' profits grow, let alone stabilize or decrease. In tandem, these results imply that we might be dealing with inefficient markets.

When it comes to efficiency, hasty conclusions should be avoided. One possible scenario is that markets are not really inefficient, rather the differences are worked out over time. Several papers have established that late betting is common, the main reason for that is the willingness to wait because of potentially valuable information arrival. Our results reveal that although the differences in returns tend to diminish a little bit, there is no sign of price convergence.

In the light of the empirical findings it is not surprising that prices are more competitive on the exchange, but the fact that bookmakers attract a lot of bettors even in the presence of better returns elsewhere seems puzzling. In section 4, we will discuss possible reasons that might have contributed to these results. Some possibilities are: legal differences, unawareness, first mover advantage, switching costs and brand loyalty, other differences between the exchange and bookmaker, and sampling issues. Overall, we believe that none of them is a convincing explanation and further work is needed to resolve this puzzle. Another very important factor which is not yet fully explored in this paper is liquidity. A betting exchange, by design, relies heavily on the number of players on the exchange and the size of their bets. The term order flow externalities refers to the fact that an increasing number of buy and sell orders will generate further orders and since orders are beneficial for traders, the trade will pick up. This has been the main reason behind the market dominance of Betfair. Presumably, then, the order flow externalities can also lead to some games drawing more attention. Bettors might be willing to place a bet with the bookmaker instead of the exchange if the market (for one event) is not liquid enough. Unfortunately, we do not have access to the volume data at the bookmaker. We use the odds revision as a proxy for the volume, if volume is zero, the odds will never be revised. If volume is high, however, depending on the heterogeneity of beliefs there might be revisions. If there is sufficient dispersion among the beliefs of the bettors, revisions might not be needed, but if there is heavy betting on one side, modifications are necessary. We apply a goodness-of-fit test, and find no evidence between liquidity and odds revisions. At this point this analysis is silent about the alternative hypothesis that low liquidity does translate

to increased action at the bookmaker, but because of the heterogeneity that doesn't lead to revisions and therefore not observable in the data.⁹

Our paper essentially intersects two literatures. By comparing the odds from wagering institutions that operate under different rules, it improves our understanding of the effect of the market institution on prices. Our paper is the first attempt to compare the two most fundamental market designs, posted-offer and DA, using field data and it nicely extends the experimental results to the field. By comparing returns from different investing opportunities, it also contributes to the literature on market efficiency. Ours is certainly not the first paper that presents inefficiencies in betting markets, but in our case the observed anomaly uniquely follows from the differences in market microstructure.

The rest of the paper is organized as follows. The next section briefly summarizes the online sports betting market. Section 3 explains the data used in this study and contains the main results. Section 4 outlines some possible explanations to the puzzle. Section 5 concludes.

2 The Online Betting Market

US and UK are worlds apart when it comes to gambling. In US, gambling is limited to certain states, Indian reservation areas and on-boat gambling. Online gambling is illegal. In a sharp contrast to this, there are no legal restrictions in UK, which is considered as the betting center of the world. Sports betting is a very important part of online gambling, about 42% according to ESPN magazine.

The most comprehensive listing we could find online lists 2228 gaming sites of which 608 are online sportsbooks, although the number is believed to be approaching a thousand.¹⁰ There are about 35 betting exchanges worldwide. In UK, William Hill, Ladbroke and Coral, "The Big Three", dominate the bookmaker market with around 60% market share in total. Betting with bookmakers takes three forms. You can bet at betting offices, via telephone, or online. Although betting offices are the main source of revenue for bookmakers, internet betting is growing fast.

The introduction of betting exchanges is considered as a radical change in the gambling industry. According to BBC, "The betting exchanges, Betfair,

⁹A natural next step is to come up with a theoretical framework that might explain this puzzle. This would be a interesting companion paper and is in our research agenda.

¹⁰Source: <http://www.casinocity.com/>

Betdaq and co. represent the greatest revolution in gambling in generations.” (BBC, 17 August 2003).

How do betting exchanges work? This is best understood with an example. Let’s say Mr. D thinks the Democrats will win the presidential election with a probability slightly more than 50 percent. Therefore Mr. D, assuming risk-neutrality, will accept a bet that pays even money. If these odds are available, in other words if the outstanding bid is either that, or higher, he can back the democrats by accepting it. In order this to happen someone else must lay the Democrats, that is someone else should be willing to accept the obligation of paying even money if the Democrats win.¹¹ In that case we have a match and trade occurs subject to both bettors’ liquidity constraints. If the outstanding back odds are not as high as desired, Mr. D can post these odds, which are then queued, hoping they will be matched later.

At any point, bettors on the exchange have access to the last contract price, the quantities of bids and asks at all prices, and the quantities traded at all prices. Furthermore, they can see a graph of the price trajectory. The Appendix contains a snapshot of the market information page.

Betting exchanges therefore differ from bookmakers in two important ways. These differences occur simply because of the fundamental differences in the market institutions. First, the odds are not a take-it-or-leave-it offer as is the case with bookies. If punters are not happy with existing odds, they are free to offer new ones. Second, you can back a team (or player) as you would do with a bookmaker but you can also lay it and essentially act as a bookmaker. On the other hand, there is another dimension that matters. On an exchange you have to pay a certain commission on net winnings, which we will talk about in detail below. The bookmakers do not charge any explicit commission, their profit margin is built into the odds.

There are other differences, somewhat less important, but presumably they still contribute to the consumption value. We defer the discussion of further differences to Section 4.

We collected data from William Hill, Ladbrokes and Betfair. In a world with numerous online sportsbooks and a growing number of exchanges, our main selection criterion was the the market share. Ladbrokes and William Hill are the two largest bookmakers in UK, and Betfair is the clear market leader on the exchange market. Now we will briefly discuss these companies

¹¹This is a typical contract and was offered on most sports betting sites prior to the elections. However, our data will consist of sports contracts because of the high frequency of sports events. For an excellent survey of what type of contracts are traded at online exchanges, see Wolfers and Zitzewitz (2004).

in turn.

William Hill. William Hill is established in 1934. Its shares have been publicly traded on London Stock Exchange since June 2002. It is the second largest operator in UK and has about 1500 betting shops. These shops are still the biggest source of revenue but as a result of an increase in the use of the internet, the contribution of online gambling started to follow an upward trend. In 2003, internet betting surpassed telephone betting for the first time, but the penetration rates were still low, about 10%. In the first six months of 2004, however, William Hill revealed a pre-tax profit of 118 million pounds, of which 24 million came from online units. Thus, the contribution of online gambling, of which sports betting is a significant part, has more than doubled in 2004.

The minimum bet that the bettors can wager with William Hill is one cent. William Hill does not accept wagers from US.

Ladbrokes. Ladbrokes Limited is the betting and gaming division of the Hilton group. It has around 2000 betting shops in UK and is the biggest operator in UK. Ladbrokes continues to be a very profitable company. In 2004 Hilton reported pre-tax profits of 156.7 million pounds for the six months to 30 June, up from 74.5 million pounds a year ago. Most of this profit was due to Ladbrokes, and the share of online division was on the rise.

Like William Hill, Ladbrokes does not accept wagers from US.

Betfair. Betfair is the leading betting exchange. It is established in 1999 and became operational in 2000. Soon after that, it merged with Flutter.com, the then-leading betting exchange. Betfair operates mostly on an online basis but it also provides its customers with the option of phone betting, however the minimum bet with phone betting is 100 dollars. The minimum online bet is 4 dollars.¹²

Betfair is estimated to have 90 percent of the exchange market is obviously the leading exchange site. Betfair has published its first financial statement recently and in the financial year to April 30, their revenues were up 106% to 66.7 million pounds with their pre-tax profits rising to 11.9 million pounds with a 52% increase.

Betfair is estimated to have 325,000 registered users of which about 75,000 are active.¹³ Betfair's business model is now widely recognized and respected, the company landed the Ernst and Young Emerging Entrepreneur of the Year Award in 2002 and the Queen's Award for Enterprise in 2003.

¹²The issue of betting in smaller units has been raised in forums and it is claimed that bots, automated programs that can bet according to prespecified strategies, are allowed to place smaller bets. We could neither confirm nor refute this claim.

¹³An active user is someone who placed at least one bet in the last thirty days.

Betfair, like its main competitors, does not accept bets from within the US.¹⁴

As mentioned before one significant difference between the bookmakers and exchanges is the commission structure. Betfair charges 5 percent commission on *net* winnings.¹⁵ If a winning bet of 100 dollars pays even money, the exchange pays out 195 dollars. Losing bets are not charged any commission. There is also an incentive scheme reminiscent of airlines' frequent flyer programs. As you bet more on the exchange, your commission goes down and can be as low as 2 percent. But there is also a 15 percent weekly decay that is applied to bettors' accumulated Betfair points, thus consistent betting is encouraged.

The Online Betting Industry. What is the industry's stance about the alleged odds differences? Betfair claims that odds are 15-20 percent better than a traditional bookmaker. The betting industry seemed to accept this. For example, in an official statement Australian Tab Limited predicted "Betting exchanges will mean the end for bookmakers." (5 September 2003)

The empirical literature tells us that double auction mechanism is superior to posted-offer markets. The industry seems to agree. But if the difference between odds are sufficiently large, the differences between returns will be large, and there will be two different prices for identical contracts. That would not qualify as an anomaly if we didn't observe much action with the bookmakers. Interestingly enough, internet gambling at bookmakers doesn't seem to have been affected by the rapid growth of exchanges. Not only did William Hill's profits increase, the revenues for the online unit has grown even more. In the next section we will compare both the odds and returns to shed light on these issues.

3 Empirical Analysis

We will first explain how the data were collected. The remainder of the section tests the claim whether the odds and returns are different across the

¹⁴They claim that they have access to a technology that is capable of locating the customers. Although these geolocation technologies might not be perfectly accurate, the author of this paper was not allowed to activate his account when located in US, although he supplied a non-US address as well as a non-US credit card.

¹⁵5 percent commission is more or less the industry standard, although smaller players in the exchange market charge lower commissions, or no commissions, with the hope of attracting bettors.

selected bookmakers, William Hill and Ladbrokes, and the leading exchange, Betfair.

The Data. The dataset consists of 623 National Basketball Association (NBA) games played between December 2004 and February 2005. For each game we manually collected odds from two bookmakers, William Hill and Ladbrokes and one betting exchange, Betfair twice a day. The first snapshot is taken randomly before the game, provided that there is at least 45 minutes and not more than five hours between the snapshot and the start of the game. With this procedure there is usually enough trade going on to make a meaningful analysis, but there is also sufficient time to see the adjustment of the markets, late-betting, odds revisions by bookmakers and alike. The second snapshot is taken right before the start of the game. Betfair announces that the market gets suspended, after which no bets are allowed. A snapshot of this very moment is included in the appendix. This is exactly the point at which the second snapshot is taken.¹⁶ At William Hill and Ladbrokes we noted the odds at each snapshot, which are potentially different, because the bookies might want to balance their books if there is heavy betting on one team. At Betfair we know all back and lay odds and the corresponding quantities (in dollars), in other words we have access to the entire electronic order book. We also know the total quantity traded up to that point. Unfortunately, when a certain trade has been made, say of 100 dollars, it is impossible to tell whether this is one big trade, or a few smaller trades. However we recently realized that Betfair Developers Program, part of Betfair, decided to make some data available for its registered users on a monthly basis. This dataset includes the number of trades at each price. We will combine this new set of information with the data we collected. This information will be useful, because it will tell us the average bet for each event, which in turn, might explain how much liquidity matters.

The second snapshot then tells us an almost complete history of the market.¹⁷ We also noted the final contract price for each team, the price at which the last trade has been made.

The number of observations unfortunately falls short of all the games played. Depending on the comparison this might be just a few games or more. There are several reasons to this. Sometimes, bookmakers do not provide odds for all games played. On several occasions, the market was

¹⁶Odds are removed from William Hill at about the same time. Ladbrokes removes the odds five minutes before their competitors.

¹⁷The history is not fully complete, because some information is impossible to get. If 100 dollars changed hands at certain odds, we don't know whether these are back or lay orders.

suspended well before the tip-off. At Betfair, some games turn in-play and therefore the market does not get suspended.¹⁸ On some other occasions data at the time of the suspension were not available. Technical problems at the websites or maintenance issues have prevented some data collection. Since almost all these factors are random, the exclusion of certain games should not affect the results substantially.¹⁹ Moreover, on almost all occasions the problem is with only one website, thus does not affect the analysis when we compare the other two.

Analysis of The Data. Using this dataset, we are now able to make some head-to-head comparisons. Ex ante, we expect the odds at Betfair to converge to 2, at William Hill to 1.9, and at Ladbrokes to 1.83. Where do these numbers come from? In the long-run favorite wins and underdog wins will balance out and winning bets should pay even money, in other words the competitive price (in odds formulation) is 2. Since Betfair is a DA mechanism, the price can be expected to converge to 2. The numbers for the bookmakers are evident from looking at any of the two: i) The case of equally strong teams. Whenever a bookmaker thinks that both teams have equal chances of winning, the odds are the same. Clearly, the odds are adjusted accordingly when the teams are not equally matched, but the odds will still revolve around that particular number and in the long-run the average winning odds will converge to that number. ii) Spread-betting. Although our focus is not on spread betting, bookmakers' behavior in this game tells us what percentage is kept by the bookmaker as the profit margin. In spread betting, bookmakers usually fix the odds at a particular number (which usually coincides with the number in scenario i) above) and adjust the spread should unbalanced betting occur.

Our first goal is to compare both the odds and the returns across different alternatives on the basis of the first snapshot. Table 1 depicts the average (back) odds on winning bets at Betfair, William Hill and Ladbrokes and also how many times the highest odds are offered by that sportsbook or exchange. The total number exceeds the number of observations because of the ties.²⁰

Table 1 explicitly reveals how DA aggregates information perfectly. In

¹⁸In-play betting is also called betting-in-the-run. If that option is available punters can place bets until the game ends.

¹⁹We are not aware of any rules as to which games will turn in-play, but there is a high correlation between games that attracted a lot of betting and games for which in-play betting was made available.

²⁰On a few occasions, odds were not reported by one of the three. These observations are still included in the sample.

Table 1: Average Odds and The Frequency of Best Odds

Website	Observations	Average Odds	The Frequency
Betfair (B)	623	2.000	547 times (88%)
William Hill (WH)	623	1.916	89 times (14%)
Ladbrokes (L)	623	1.851	49 times (8%)

Table 2: Average Odds on Winning Bets

	Observations	mean I	mean II	Difference	t-Value
B vs. WH	607	2.003 (1.254)	1.916 (1.090)	0.086 (0.214)	9.971*
B vs L	607	2.004 (1.256)	1.853 (0.986)	0.150 (0.337)	11.020*

Note: Standard deviations are in parentheses.

* significant at the 1 percent level

this paper, we do not intend to provide an explanation for the price dynamics, but rather we want to compare prices that result from differences in market institutions.²¹ The natural next step is to test whether these differences are statistically significant. Table 2 summarizes the statistical results of the odds comparison analysis.

As Table 2 reveals, the differences in odds are statistically significant at the 1 percent level. Therefore the results are in agreement with the empirical findings. Just as the lab experiments have predicted, DA institution, in our case, Betfair, gives us competitive prices and with posted-offers, the sellers have the leverage of setting high profit margins.

The significant differences in odds clearly do not tell the whole story. Since Betfair charges a commission on net winnings, the return differences between the exchange and bookmakers will be lower. Although the commission might be lower for heavy punters, we will look at the limiting case of 5 percent commission.²² Table 3 depicts the returns on a \$1 bet for Betfair, William Hill and Ladbrokes in a head-to-head fashion.

As Table 3 shows, the return differences are also significant at the 1 percent level. These results are puzzling because the bookies still attract

²¹How and why DA aggregates this information so perfectly, however, is an extremely important topic and can be thought as one of the main questions in economics that is still not fully understood.

²²It is believed that most bettors on Betfair are heavy punters and the estimated average commission is 3 percent.

Table 3: Average Winning Payouts per \$1 Bet

	Observations	mean I	mean II	Difference	t-Value
B vs. WH	607	1.953 (1.192)	1.916 (1.090)	0.036 (0.168)	5.360*
B vs L	607	1.954 (1.194)	1.853 (0.986)	0.100 (0.285)	8.674*

Note: Standard deviations are in parentheses.

* significant at the 1 percent level

a lot of bettors as demonstrated in section 2. However, before claiming that we have an example of inefficient markets, we need to make further elaborations.

It might be the case that some bettors hold off on their bets until the last minute because either they want to withhold some information, or they are waiting for possibly useful information to arrive, such as game-time decisions of injured players. The situation of late-betting is pretty common in parimutuel wagering.²³ With fixed-odds betting the incentives to wait until the last minute are diminished, since the returns are known at any time. On the other hand, if bettors believe that betting will pick up as the start of the game approaches, to the extent that the competitiveness of prices increases with volume, the bid-ask spread might tighten, and late betting can be a rational strategy. If the differences in returns at the tip-off are comparable, it can be claimed that the markets are not really inefficient, rather they are adjusting over time. For this reason we also compared the returns across the alternatives using the second snapshot. Since DA markets and posted-offer markets do not necessarily absorb the information the same way, this comparison might not perfectly reflect the changes in bettors behavior. In particular, the adjustment by bookmakers might be slower, or less accurate because of the lack of continuity in the adjustments that the bookmaker makes.²⁴ However, we believe it is a good first approximation.

²³Parimutuel betting is a system in which the total amount wagered is distributed to all the winning tickets. The main difference between parimutuel betting and fixed-odds wagering is the uncertainty of returns when placing a bet. See Camerer (1998) for a demonstration of late-betting in parimutuel systems. See Ottaviani and Sørensen (2004) for an informational explanation.

²⁴The bookmakers have prespecified odd pairs and the adjustments are rather discrete. As an example if the odds are 1.52 vs 2.65 and the odds for the favorite are lengthening, they become 1.55 vs. 2.60. The odds on the exchange do not possess full continuity either, but relatively speaking the adjustments are more flexible.

Table 4: Average Odds and The Frequency of Best Odds at The Tip-off

Website	Observations	Average Odds	The Frequency
B	532	1.998	421 times (79%)
WH	532	1.925	114 times (21%)
L	532	1.854	75 times (14%)

Table 5: Average Odds on Winning Bets at The Tip-off

	Observations	mean I	mean II	Difference	t-Value
B vs. WH	538	1.993 (1.294)	1.921 (1.145)	0.072 (0.211)	7.957*
B vs L	540	1.992 (1.292)	1.849 (1.012)	0.143 (0.375)	8.862*

Note: Standard deviations are in parentheses.

* significant at the 1 percent level

Table 4 replicates the results of Table 1 at the tip-off. It can be seen from the table that Betfair is still dominant, but bookmakers slightly caught up, the frequency of best odds at Betfair is lower, as well as the differences in average odds. Clearly, Table 4 just gives a few summary statistics and we need to carry out a statistical analysis to see whether the differences in odds and returns are significant.

Table 5 and Table 6 summarize the differences in odds and returns, respectively. As far as the comparison between Betfair and William Hill is concerned, the return differences at the suspension time are lower, but still significant at the 5 percent level. The return differences between Betfair and Ladbrokes continue to be significant at the 1 percent level. The same holds for the comparison between two bookmakers. Therefore, we conclude that late-betting might diminish the differences in return, but there is no evidence of price convergence.

Our analysis shows that, just as the experimental literature has suggested, DA institutions result in competitive prices compared to posted-offer settings. Moreover, the return differences across two institutions are not at all trivial, and they do not disappear through intraday trading and late-betting. Notice that this result occurs despite the fact that the markets coexist. This is in contrast to the lab experiments where only one market is active at any time. Provided that the two market institutions compete, sellers that post offers have further incentives to undercut, but that is not

Table 6: Average Winning Payouts per \$1 Bet at The Tip-off

	Observations	mean I	mean II	Difference	t-Value
B vs. WH	538	1.944 (1.232)	1.921 (1.145)	0.022 (0.168)	3.132*
B vs L	540	1.943 (1.228)	1.849 (1.012)	0.093 (0.324)	6.690*

Note: Standard deviations are in parentheses.

* significant at the 1 percent level

observed in the data.

It's then puzzling that the bookmakers continue to post big profits, they somehow manage to sell the same product at higher prices. In the absence of price convergence the natural thing to expect is that the sellers with higher prices be driven out of the market, as Australian Tab Limited predicted. However, there is no sign of a slowdown in online betting business, hinting to a possibly inefficient market. Potentially there might be other factors that may rationalize our results. The next section outlines these possibilities.

4 The Bookie Puzzle

In the previous section we demonstrated that the returns from alternative investments are not equal. Coupled with the fact that bookmakers continue to be profitable, the obvious question is the following: Why do we still see a lot of betting with bookies, although better returns are available elsewhere? This section discusses some possible explanations.

Liquidity. It should be noted that our analysis in section 3 does not take the quantities into account. Therefore a game in which the outstanding back price is 1.60 with 10 dollars available is equivalent to a game with the same back price with 1000 dollars available. Moreover, the quantities at lower odds are also important. Betting exchanges, by design, require liquidity to survive. If a bettor wants to bet 1000 dollars on a Lakers win, he can do so with a bookmaker, but a 1000 dollar bet might not be available on the exchange. One can then either wager whatever amount is available on the exchange and place the rest of the bet with a bookmaker, or one can simply skip the exchange completely, which will lower the returns but also lower the transaction costs. The question we want to analyze is the following. Does the size of the bets on offer matter? In other words, is it possible that some bettors substitute away from the exchange because the exchange market is

thin?

Liquidity can be analyzed in three dimensions: immediacy, width and depth. Immediacy represents the transaction costs that result from a desire of immediate execution. Such market orders are costly because of the bid-ask spread. Width refers to the cost of doing a trade at a given size. Depth reflect the size of a trade at a given cost. Naturally, different traders value different measures of liquidity. Impatient traders are concerned with immediacy, small traders closely follow the width and large traders analyze depth. If bettors are impatient, and want to place a bet as quickly as possible then then a wider bid-ask spread might result in switching. If there are bettors with large bankrolls who want to place big bets, the lack of depth might result in substitution. We proceed as follows. First, using the first snapshot we pick games such that the *net returns* on the exchange are higher than the bookie's (William Hill). Then we multiply all the odds that are higher than the bookmaker's with corresponding quantities on the exchange and find the sum. From this total we subtract the money that one would have made had he placed a same size bet with the bookmaker.²⁵ This yields the excess gross returns, the money that can be won in excess of the bookmaker returns by betting on the exchange.

Unfortunately we do not have access to the data at the bookmaker level so it is not obvious that the activity at the bookmaker is increased by people who substitute away from the exchange. One thing we can look at is the revision of odds at the bookmaker. If more bettors place their bets with the bookmaker than there is a greater chance that odds will be revised. Therefore it is conceivable that games with lower liquidity translate to a greater number of revisions. Using December data (216 games), we rank the excess gross returns from highest to lowest and break the sample into eight equally-sized subsamples (27 games in each group). In 48 games, the odds were revised by the bookmaker and the final odds were different.²⁶ If the above claim is true, more revisions should fall into the bottom groups. Table 7 reveals the results.

We used a goodness-of-fit test to see whether the observed differences are

²⁵As an example, suppose that the odds for the winning team are 1.45 at the bookmaker. On the exchange 100 dollars are available at 1.51 and 200 dollars are available at 1.52. Since anything above 1.4736 on the exchange will generate higher net returns, an individual can then earn $1.51 \cdot 100 + 1.52 \cdot 200 = 455$ on the exchange. Had he invested the same amount at the bookmaker, he would have made 435 dollars. The difference, 20 dollars, can be seen as a liquidity measure.

²⁶Sometimes, the odds may be revised more than once with the final odds unchanged. Our data unfortunately do not capture this possibility, and if the number of those incidences is large, our results may be erroneous.

Table 7: Excess Gross Returns and The Number of Revisions

	Observations	Expected Revisions	Observed Revisions
Group 1	27	6	10
Group 2	27	6	5
Group 3	27	6	4
Group 4	27	6	6
Group 5	27	6	7
Group 6	27	6	8
Group 7	27	6	5
Group 8	27	6	3

significantly different than the expected ones. The results show that they are not (The test statistic is well below the 5 percent level). Therefore there is no obvious pattern between gross returns in excess of the bookmaker and the revisions made. To the extent that the number of odds modifications is a proxy for bets placed with the bookmaker, the liquidity seems irrelevant. As we mentioned before, that does not necessarily imply liquidity does not matter, it is just not captured by this analysis.

The analysis in this section will be definitely developed further. We believe that understanding this relationship would be central to this line of research. We hope to give more concrete results as our dataset spans the whole season. There are other liquidity measures, including a few ones that are used on order books, that we can borrow from the financial literature. Future researchers can also utilize high-frequency data should they become available.

Legal issues. Do the sportsbooks and exchanges have important differences in terms of legality? None of them accepts bets from US, a claim verified by us. On the other hand, we managed to open an account with William Hill and wagering some bets by supplying a non-US credit card and address. As we mentioned in footnote 14, the same procedure failed with Betfair. Potentially, if there are a lot of gambling addicts in US who have access to foreign credit cards, this might account for some of the betting activity with the bookmaker. This, however, does not seem very likely, not only because of the enormous profits made by the online sportsbook, but also there is no reason to believe that all these people choose William Hill, given that there are hundreds of online sportbooks. Moreover, most of these online venues are rather small and hoping to increase their market shares, they cannot afford rejecting bets from US, further diminishing the possibility to bet with William Hill in the absence of the option of betting with

Betfair.

Unawareness. Could it be the case that some bettors are simply not aware of the existence of Betfair? William Hill, for example, has been around since 1934 and when they started their online operation they were already very well known. Betfair started as an internet startup. Although it is possible, it is hard to imagine, that bettors have never heard of betting exchanges, especially Betfair. In our opinion, there are several reasons. We can safely assume that online bettors are sufficiently comfortable with the internet, and it is hard not to come across betting exchanges, especially with the rise of another group of websites, that provide a comparison of odds from many bookmakers and exchanges. Moreover, the youth is an important part of the betting crowd implying that not many bettors who wager online are switchers, who replaced betting offices with online units within the same bookie. On top of that, the turnover in Betfair is already higher than any of the other three bookmakers and with its revolutionary business model Betfair has been highly publicized earning them several prestigious awards as mentioned before. All in all, we do not believe that unawareness is a satisfactory explanation.

First Mover's Advantage/Switching Costs/Brand Loyalty. The traditional bookmakers clearly entered the market before betting exchanges and accumulated a large customer base. If the switching costs are high for the bettors and/or if there is some sort of brand loyalty, it might justify the observed results.

In our opinion, the switching costs can not be high. Both exchanges and bookmakers have similar designs and learning should be negligible. It might be the case that posting odds and laying teams require a considerable amount of learning but for our purposes this is irrelevant.

As for the brand loyalty, some observations from other industries could be useful. For example, in the pharmaceutical industry, it has been observed that brand-name products do not sell at lower prices after the patent is over, sometimes they even became more expensive. This might be a sustainable signalling equilibrium, the brand wants to signal that it is superior to generic products and consumers are convinced that this is indeed the case. However, we believe that this signalling is less likely to work in the betting industry. The sports events are always the same, so the only relevant quality dimension is the possibility of financial trouble. It is still possible that consumers do not trust the exchange in financial terms yet with all the publicity and reputation Betfair has, such beliefs on the consumer side are hardly justifiable.

Differences between the exchange and bookmaker. No two markets are exactly the same. Our case is no exception. There are some differ-

ences across the selected sportsbooks and the exchange, which might potentially contribute to the consumption value. On the exchange punters have the freedom of posting their own odds and laying a team. In-play betting is also available.²⁷ On the negative side, the minimum bet is \$4 compared to a cent at William Hill and multiple bets are not allowed on the exchange.²⁸ For example, if most of the betting at William Hill is in the form of multiple bets, the observed results could be justified. However, this does not only require extreme risk-loving attitude on the part of the bettors, it also requires the somewhat strong assumption that the options at William Hill are more valuable to the punters than those offered by the exchange. Our opinion is that the betting crowd is heterogeneous enough and such differences are likely to balance out.

Sampling issues. The lack of data on basketball market at the bookmaker level can be considered as a weakness of our project. Indeed, one assumption implicit in the paper is that all markets in the online unit attract a lot of betting. It could be argued that the market we have chosen, the basketball market, does not have a high turnover and the profitability of online unit relies on other markets. We tend to dismiss this explanation for two reasons. As far as William Hill is concerned, in almost 30 percent of the games the final odds were different than the first round of odds. On some occasions the odds have changed more than once. Some games have seen large odd revisions. We believe that rather frequent modification of the odds reflects that the basketball market has been active. Second, a quick look at the other markets, including soccer, golf and horse racing, reveals that both odds and returns differences have been large. However our sample in these other markets is rather small and the events are less frequent. Although the preliminary analysis suggests that the results from American basketball market will carry over, future work should definitely focus on other markets which might establish robustness and strengthen our results.

²⁷It is worth to mention that in-play betting was only available on the exchange in the beginning, but William Hill started to offer this option to its bettors in January 2005. Two interesting observations: First, the in-play games at Betfair and William Hill mostly coincide. Second: Whenever William Hill posts odds during the game, they are always inferior to pre-game odds. Presumably higher prices (lower odds) are required to compensate the additional risk. Interestingly, these inferior odds coincide with Ladbrokes's pattern, i.e. the live odds at William Hill would converge to 1.83. There may be some communication, if not collusion, between online venues as far as these games are concerned.

²⁸A multiple bet, or parlay, is placing a wager on any number of events simultaneously. Should all events have the desired outcome, the return is equal to the product of all odds, hence the returns can be enormous. If one event is not correctly guessed the returns are zero.

Discussion. In a recent paper Levitt (2004) asked the question why the gambling markets and financial markets are organized so differently, in particular he wondered why the bookmaking markets follow the posted-offer rule rather than DA. He demonstrated that the bookmakers are more skilled at predicting the outcomes than the bettors, which allows them to post non-market clearing prices and earn supranormal profits. He also mentions that in financial markets individuals who possess similar skills and can beat the market regularly don't exist. His paper offers an explanation why bookmakers have adapted this rule initially, but it doesn't explain why the turnout rate with traditional bookmakers is still very high. In fact, he doesn't consider betting exchanges at all, most probably because they were not highly recognized even two years ago. But unawareness became much less of a factor and the puzzling results definitely need some justification.

As we mentioned above, we will refer to the bookie puzzle as the fact that traditional bookmakers still attract a lot of bettors, even in the presence of better returns elsewhere. In this section we discussed several alternatives that might help explaining our results. We believe that all explanations are probably at work to some degree. However, in the light of the evidence we showed, we do not think that any of these explanations is satisfactory. The reader might object and claim that one explanation or the other is more important than we believe and the markets are not really inefficient. This issue is also raised in Gabriel and Marsden (1990), which is the first paper that exhibits inefficiencies between two similar betting opportunities. They finish their paper by saying "Are we observing an inefficient market or simply one in which the tastes and preferences of the market participants lead to the observed results? ... [Is it ever possible to] separate an inefficient market from one in which the participants are pursuing the satisfaction of nonmonetary preferences?" That remark is an excellent reflection of our position. Unless satisfactory explanations are offered, we think our conclusions on the basis of the evidence shown will remain firm and we argue that the online betting markets are very puzzling, if not inefficient. We also believe that coming up with theoretical models that improve our understanding of betting markets and/or utilizing other data might turn out to be fruitful for future research.

5 Summary

Price formation under different institutional assumptions has always been a hot topic. The experimental literature has firmly established that the

double auction markets (DA) are superior to posted-offer design and it yields competitive prices and almost full efficiency. It has been almost impossible to replicate these findings in real settings due to apparent difficulties. Our study uses the online sports betting markets to conduct a field study that fills this gap. In these markets DA and posted-offer institutions coexist, betting exchanges (DA) compete with traditional bookmakers (posted-offer) to attract bettors.

Using data from National Basketball Association (NBA), the leading exchange (Betfair) and the online units of the biggest two bookmakers in UK (William Hill and Ladbrokes), we confirm the experimental findings, and the beliefs of the betting industry: The odds (prices) on the exchange are competitive and the we have almost full efficiency. There is an efficiency loss of 10-15% with the bookmakers, which is essentially their profit margin.

Betfair charges a 5% commission on net winnings for brokerage services, lowering the returns for its customers. However, the return differences are not trivial and our analysis shows that there is an obvious advantage to using the betting exchange. Intraday trading and late-betting squeezes the differences in returns a little bit, but convergence in returns does not occur.

Our results suggest that we might be dealing with inefficient markets. Bookies still see a lot of betting action although better returns are available elsewhere. We discuss several factors that could have contributed to the puzzling results. In our opinion, none of them offers a convincing explanation.

A lot of work remains to be done. Trying to understand why these results are observed should be a priority for future research. To this end, high-frequency data from the exchange might turn out to be very fruitful. Until today, wagering markets and the finance literature are also successfully combined, a convention that will continue to pay off. Overall, we are facing a unique market design in which two different institutions compete, and understanding the price formation in these markets will definitely improve our understanding of the markets in general.

References

- [1] Ali, Mukhtar M. (1977): Probability and Utility Estimates for Race-track Bettors, *Journal of Political Economy* 85, 803-16.
- [2] Amihud, Yakov and Haim Mendelson (1987): Trading Mechanisms and Stock Returns: An Empirical Investigation, *Journal of Finance* 42, 533-53.

- [3] Camerer, Colin (1998): Can Asset Markets Be Manipulated? A Field Experiment with Racetrack Betting, *Journal of Political Economy* 106, 457-82.
- [4] Cohen K.J., S.F. Maier, R.A. Schwartz and D.K. Whitcomb (1986): *The Microstructure of Securities Markets*, New Jersey: Prentice-Hall.
- [5] Davis, Douglas D. and Charles A. Holt (1993): *Experimental Economics*, Princeton: Princeton University Press.
- [6] Friedman, Daniel and Joseph Ostroy (1995): Competitiveness in Auction Markets: An Experimental and Theoretical Investigation, *The Economic Journal* 105, 22-53.
- [7] Friedman, Daniel (1993): The Double Auction Market Institution: A Survey in Daniel Friedman and John Rust, eds., *The Double Auction Market: Institutions, Theories, and Evidence*. Proceedings Volume XIV in the Santa Fe Institute Studies in the Sciences of Complexity.
- [8] Gabriel Paul E. and Jamer R. Marsden (1990): An Examination of Market Efficiency in British Racetrack Betting, *Journal of Political Economy* 98, 874-885.
- [9] Hong, James T. and Charles R. Plott (1982): Rate Filing Policies for Inland Water Transportation: An Experimental Approach, *The Bell Journal of Economics* 13, 1-19.
- [10] Ketcham, Jon, Vernon L. Smith and Arlington W. Williams (1984): A Comparison of Posted-Offer and Double-Auction Pricing Institutions, *The Review of Economic Studies* 51, 595-614.
- [11] Levitt, Steven D. (2004): Why Are Gambling Markets Organized So Differently From Financial Markets?, *The Economic Journal* 114, 223-246.
- [12] Ottaviani, Marco and Peter N. Sørensen (2004): The Timing of Bets and the Favorite-Longshot Bias, *mimeo*.
- [13] Plott, Charles R. (1989): An Updated Review of industrial Organization: Applications of Experimental Methods, in R. Schmalensee and R. Willig, eds., *Handbook of Industrial Organization, Volume II*, New York: North-Holland.

- [14] Snyder, Wayne W. (1978): Horse Racing: Testing the Efficient Markets Model, *Journal of Finance* 33, 1109-18.
- [15] Stoll, Hans R. and Robert E. Whaley (1990): Stock Market Structure and Volatility, *Review of Financial Studies* 3, 37-71.
- [16] Thaler, Richard H. and William T. Ziemba (1988): Anomalies: Parimutuel Betting Markets: Racetracks and Lotteries, *Journal of Economic Perspectives* 2, 161-74.
- [17] Tetlock, Paul C. (2004): How Efficient Are Information Markets? Evidence from an Online Exchange, *mimeo*.
- [18] Wolfers, Justin and Eric Zitzewitz (2004): Prediction Markets, *Journal of Economic Perspectives*, forthcoming.
- [19] Woodland, Bill M. and Woodland, Linda M. (1994): Market Efficiency and Favorite-Longshot Bias, *Journal of Finance* 49, 269-79.

APPENDIX

The first graph is a snapshot of the the main screen for a game that is just suspended. The second graph depicts the market information page (the electronic order book). Customers can reach this page at any time by clicking on a team on the main screen.



English - AUS & NZ

Home | Join Now | About Us | Help | Forum | Poker

username

[Forgotten your password?](#)

Login

- All Markets
- Basketball
- NBA 2004/05
- Fixtures 30 November
- Detroit @ Houston**
- Match Odds
- Handicap Match Odds
- Total Match Points

Detroit @ Houston - Match Odds

Refresh

☒ View P&L [\[Settings\]](#) [?](#)

100.9% 99%

Total selections: (2)

USD

Back

Lay

Detroit Pistons	2.84 \$415	2.88 \$415	3 \$305	3.05 \$418	3.15 \$426	3.2 \$39
Houston Rockets	1.44 \$581	1.46 \$104	1.48 \$88	1.51 \$55	1.52 \$10	1.79 \$15

[NBA Match Odds](#)

Place Bets [My Bets](#) [Rules](#)

New to Betfair? [Register](#) to bet now.

What are decimal odds?

Decimal odds express your total return for the stake you place. Therefore even money is expressed as 2.0 - you get back your stake plus the same again as winnings - twice your initial stake. T other odds use the [odds converter](#).

	Fractional	Decimal	American
2.10 \$17000	11/10	2.10	110
	1/1	2.00	-100

What is the Amount Available?

2.10
\$17000 This is the amount of money available for you to bet these odds. You can bet all or part of this amount. If want more than the amount shown, the system will p the remaining stake as an unmatched bet available for others to take. [more info](#)

What is Backing?

2.10
\$17000 Back bets are those placed in the normal way. You c also ask for better odds, or more money than current available. In either case your bet will appear on the side of the market.

Suspended

Seattle @ Portland - Match Odds

Betting on: Seattle Supersonics

Total matched on this event: **\$14,153**

Betting summary - Volume: **\$8,409**

Last price matched: **2.16**

Price/Volume over time



☐ Inverse Axis

The information on this page may be slightly delayed.

Traded and Available			
Odds	To back	To lay	Traded
1.61	\$11		
1.91	\$22		
1.94	\$16		
1.95	\$67		
1.98			\$16
2.02			\$445
2.04	\$1,328		\$314
2.06			\$266
2.08	\$7		\$555
2.10			\$2,449
2.12	\$2,188		\$1,443
2.14			\$1,776
2.16	\$109		\$811
2.18			\$106
2.20		\$79	\$228
2.36		\$8	
2.38		\$16	