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Abstract

This paper investigates the puzzling coexistence of the quote-driven market structure characterized by traditional bookmakers and the order-driven market structure characterized by betting exchanges in the betting industry. Even though betting exchanges are considered as the superior business model due to less operational risk and lower information costs, bookmakers continue to be successful. We show that liquidity, which is only guaranteed at the bookmaker market, significantly improves the bookmakers' price competitiveness. Using matched panel data of both bookmaker and betting exchange odds for 17,682 soccer matches played worldwide, we find that a major bookmaker offers more favorable odds than a major betting exchange in the early pre-play betting period and less favorable odds shortly before match start.

JEL Classification: D40, L10, L83
Keywords: Market Structure, Market Performance, Liquidity, Betting Market

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1 Introduction

Since the beginning of the 2000s, the betting industry has been characterized by the coexistence of quote-driven and order-driven markets. Similar to intermediary market makers in quote-driven financial markets, bookmakers operate on their own account and quote betting odds at which bettors can place their bets (Croxson & Reade, 2011). In the order-driven market, betting exchanges serve as a market place where buy and sell orders are directly matched between bettors in a continuous double auction, without intermediaries (De Jong & Rindi, 2009).

This coexistence of market structures is puzzling. Even though betting exchanges offer superior odds and returns to bettors (Ozgit, 2005; Croxson & Reade, 2011), face less operational risk (Koning & van Velzen, 2009), have lower information costs (Davies, Pitt, Shapiro, & Watson, 2005) and exhibit higher prediction accuracy in their odds (Smith, Paton, & Vaughan Williams, 2006, 2009; Franck, Verbeek, & Nüesch, 2010), bookmakers continue to be successful. Namely, bookmakers have not only managed to survive but have also generated considerable growth in net revenues. For example *William Hill* and *Ladbrokes*, two major bookmakers in the United Kingdom, increased their net sportsbook revenues from £42m to £166.7m (+297%) and from £61.7m to £77.8m (+26%) respectively, between 2008 and 2012.

Previous studies have, either explicitly or implicitly, suggested several explanations of why bookmakers remain competitive. One explanation is that by actively managing quotes, bookmakers exploit bettor sentiment (e.g., Levitt, 2004; Forrest & Simmons, 2008; Franck, Verbeek, & Nüesch, 2011). The presence of sentimental bettors with preferences for bets with particular characteristics, e.g., betting on popular teams, results in an asymmetric volume demand. A bookmaker can exploit this sentiment by intentionally shading the odds for highly demanded bets and thereby increasing his profit. Furthermore, Franck, Verbeek, and Nüesch (2013) argue that because the identity of the bettors is known to the bookmakers, they are able to anticipate the future trading behavior of their customers.

Therefore, bookmakers sometimes offer better odds than betting exchanges to acquire new customers. Once an account is opened with a bookmaker, bettors face switching costs to transfer their custom to a betting exchange and continue to place their bets at the bookmaker even under unfavorable conditions, which overcompensates the initial discount offered by the bookmaker. Croxson and Reade (2011) argue that learning costs from the new interface of betting exchanges and efforts undertaken by bookmakers to retain their customers provide a plausible explanation for the continuing survival of bookmakers. Finally, Ozgit (2005) provides an order-size explanation. By analyzing the limit order book of a betting exchange, he observes that execution costs rise sharply and that the higher returns vanish as the order size gets larger. Thus, bettors with high bankrolls will prefer to place their bets with bookmakers.

In this paper we suggest the liquidity advantage of the quote-driven bookmaker market as an alternative explanation for the coexistence of both market structures. In particular we test how liquidity affects the relative competitiveness of the bookmaker market and the betting exchange market.

From a theoretical perspective, Demsetz (1968) argues that a crucial role of the market maker in a quote-driven financial market is the continuous provision of liquidity. By guaranteeing market liquidity at the prices quoted, the market maker fills the gap that arises from asynchronous order arrival of buyers and sellers. Hence, the market maker facilitates the rapidity of exchange by offering narrow bid-ask spreads. In order-driven markets, however, liquidity is provided by the flow of orders from market participants (De Jong & Rindi, 2009). Here, a lack of liquidity due to an absence of two-sided trading interest or asynchronously arriving orders might result in bid and ask prices that are far apart. In such periods, order-driven markets perform poorly as transaction costs increase due to wide jumps in prices (Demsetz, 1968).

Unlike previous studies (e.g., Ozgit, 2005; Franck et al., 2010; Croxson & Reade, 2011) that compared the odds from top-division leagues or large tournaments collected at a

single point in time shortly before match start, this paper uses an extensive panel data set. The data covers over 17,000 soccer matches played worldwide with odds information from the bookmaker *Tipico* and the betting exchange *Betfair* over the 72 hours before match start. We find that bookmaker odds are significantly higher than betting exchange odds until 6 hours before match start for *home win* bets and until 3.5 hours before match start for *away win* bets. Thereafter, the bookmaker odds are significantly lower. Thus, the bookmaker is more competitive during earlier stages of the pre-play period whereas the betting exchange is more competitive shortly before match start.

The liquidity at the betting exchange significantly affects the odds differences. High liquidity at the betting exchange decreases the relative price competitiveness of the quote-driven market. However, if liquidity at the betting exchange is low, the quote-driven bookmaker market offers more favorable odds. Hence, the lack of liquidity leads to a lower price competitiveness at the order-driven market compared to the quote-driven market with unrestricted liquidity. Our findings are robust to a subsample analysis that considers only matches played in the 10 most popular leagues in the world, which are likely to attract a lion's share of the total betting volume.

Our evidence for the liquidity advantage of quote-driven market structures in the betting industry provides an additional explanation of the coexistence of bookmakers and betting exchanges. The liquidity advantage also rationalizes the decision of *Betfair* to start offering quoted odds in addition to the exchange based odds as of February 2013 (Betfair, 2013a). Our findings also help to explain the recent shift in financial market structures from pure quote-driven or pure order-driven structures into hybrid structures which combine the advantages of both models.

The remainder of this paper is organized as follows. In Section 2, we discuss the two market structures in the betting industry in more detail and review the relevant theoretical and empirical literature. In Section 3, we describe our data set containing odds of soccer matches available over the 72 hours before match start. Section 4 presents the empirical

analysis of the differences in price competitiveness between the two market structures. Section 5 concludes.

2 The Betting Industry

Similar to conventional assets and derivatives in financial markets, a bet is a state-contingent contractual claim on some future cash flow. This cash flow is determined by two parameters: (i) the outcome of the underlying event, such as a horse race, a soccer match or a political election, and (ii) the price of the contract, i.e., the posted odds (Sauer, 1998). Currently, the most common betting type is fixed-odds betting, where the cash flow of a successful bet is determined ax-ante. For example, if the decimal odds on the home team of a soccer match are 1.40, a one dollar wager pays \$1.40 and yields a return of 40% if the home team wins. Therefore, higher odds imply a higher payoff in the case of success but an accordingly lower winning probability.

Traditionally, betting markets were operated by bookmakers. Similar to market makers in financial markets, bookmakers serve as intermediaries between buyers (bettors willing to place a bet on a particular outcome) and sellers (bettors willing to place a bet on the opposite outcome). The bookmakers unilaterally determine the odds (i.e., the price) for a given betting contract at which they are willing to accept bets (Harris, 2003). In this market, the bookmakers supply all the liquidity and the transparency regarding the trading process is rather low as only the odds are publicly known (De Jong & Rindi, 2009). The odds quoted by the bookmakers already contain a commission or 'overround' which compensates them for providing liquidity and bearing the risk of unfavorable outcomes. Examples of well-established bookmakers are *Bwin*, *Ladbrokes*, *Tipico* and *William Hill*.

Since 2000, betting exchanges have evolved in the betting industry. They operate as order-driven markets, where buyers and sellers trade directly with each other in a continuous double auction without the intermediation of market makers. In this market structure, bettors can provide or take liquidity. Bettors who provide liquidity post a limit

order which indicates the terms at which they will trade. However, the execution takes place only if there is a corresponding order on the opposite side of the market. Otherwise, the limit order is placed in the limit order book until it is either executed or cancelled. Bettors who take liquidity submit a market order which is immediately executed at the best odds available (Harris, 2003; De Jong & Rindi, 2009). The transparency is higher at betting exchanges, as the limit order book is publicly known and the trading volume as well as the last traded odds are recorded. Betting exchanges facilitate trading activity by providing an electronic platform on which supply and demand is matched and collect a commission on the net winnings of successful bets (Franck et al., 2013). Examples of larger betting exchanges are *Betfair*, *Betdaq* and *World Bet Exchange*.

Earlier studies which compare the two market structures suggest that the betting exchange market is superior to the traditional bookmaking market in several ways. Koning and van Velzen (2009) argue that a fundamental advantage of betting exchanges is that they do not take any trading position. Because betting exchanges just charge the winners a certain commission, a steady flow of income independent from the match outcomes is guaranteed. This exposes betting exchanges to minimal risk. In contrast, traditional bookmakers are continuously exposed to risk and lose on some events when they misjudge the probabilities or when they are over-exposed to the event that occurs (Davies et al., 2005). Furthermore, bookmakers need informed specialists who monitor the market and actively manage the odds. Therefore, the information costs of the bookmakers are considerably higher than those of betting exchanges, which simply provide the trading platform (Davies et al., 2005).

The study of Ozgit (2005) investigates bookmaker and betting exchange odds of 623 matches from the National Basketball Association (NBA) and finds that the net returns of bettors at the exchange are consistently higher. Similarly, Croxson and Reade (2011) compare the odds from both market structures during 22 matches of the Euro 2008 soccer championship and find superior returns at the betting exchange.

Moreover, Croxson and Reade (2011) show that the betting exchange provides more accurate odds in terms of information efficiency than the bookmaker. Using UK horse racing data, Smith et al. (2006) as well as Smith et al. (2009) compare the odds from the betting exchange *Betfair* with odds from traditional bookmakers. They find that betting exchange odds have more predictive value than the corresponding bookmaker odds and exhibit a lower favorite-longshot bias[1]. The study of Franck et al. (2010) compares the prediction accuracy of the odds from eight different bookmakers to the corresponding betting exchange odds from *Betfair* on soccer matches played in the top five European leagues. In line with the previous literature, the results of a univariate probit regression and several goodness-of-fit measures reveal a clear superiority of the betting exchange over the bookmaker market.

Given the arguments elaborated above, the ongoing success of the quote-driven bookmaker structure is surprising. Madhavan (2000) argues that network externalities due to the migration of trading volume to the market with lower costs should lead to a consolidation into a single market structure. However, there are also some arguments in the literature highlighting certain competitive advantages of the quote-driven market structure.

One advantage of actively managed odds is rooted in the bookmaker's profit maximizing response to incoming betting demand. When the incoming volume demand is asymmetrically distributed due to sentimental preferences of bettors, bookmakers can increase their profits by distorting their odds. Levitt (2004) demonstrates that bettors have a systematic preference for favorite teams and shows that a monopolistic bookmaker for NFL games can substantially increase his profits by shortening the odds for bets with a higher demand. By contrast, Forrest and Simmons (2008) and Franck et al. (2011) find that bookmakers offer more favorable odds for bets on popular teams. They argue that because demand in European betting is likely to be elastic, a risk-neutral bookmaker is

[1]The favorite-longshot bias is the well-documented empirical regularity that favorites win more often than implied by their odds and longshots win less often (Cain, Law, & Peel, 2000).

able to increase his profit by trading off margins against the attraction of additional betting revenues. Whether bookmakers are able to exploit bettor sentiment seems to depend on the betting environment. A recent study of Flepp, Nüesch, and Franck (2012), for example, shows that bookmakers are not exploiting bettor sentiment in the over/under 2.5 goals betting market, even though the betting volume is highly concentrated on the *over* bet. In this setting, where risk considerations of bettors and bookmakers are negligible, bookmakers offer equal returns for both outcomes and collect their margins accordingly. Likewise, Page (2009) does not find any evidence of biased odds due to bettor sentiment.

Another advantage of the bookmaker market is the knowledge of the participants' identity. According to Franck et al. (2013), this allows bookmakers to take the expected future trading behavior of their customers into account. Therefore, bookmakers sometimes offer over-favorable odds as an element of their promotional activities to attract new customers. Once bettors have opened an account, they tend to stick with the given bookmaker even under unfavorable conditions. This pays off the initial 'loss leader' bet offered by the bookmaker. The intentionally distorted odds of the bookmaker exhibit lower information efficiency than exchange-based odds, which results in inter-market arbitrage opportunities in 19.2% of the matches in the top five European soccer leagues considered.

Croxson and Reade (2011) hypothesize that bookmakers continue to be successful because bettors face learning costs when switching to the betting exchange structure. The exchange interface, with its limit order book, different odds and the options to back (i.e., betting on a certain outcome) or lay (i.e., betting against a certain outcome) a bet, may discourage bettors who are used to betting at a traditional bookmaker. At the same time bookmakers offer incentives like free bets to dissuade customers from leaving.

Ozgit (2005) provides a trade-size explanation. He argues that the superior net returns found at the betting exchange do not account for the size of the wagers. He finds that large wagers exceed the volume available at the best odds in the limit order book. Thus,

the remaining amount of the wager is executed at the second best or third best odds, which eliminates the higher returns rapidly.

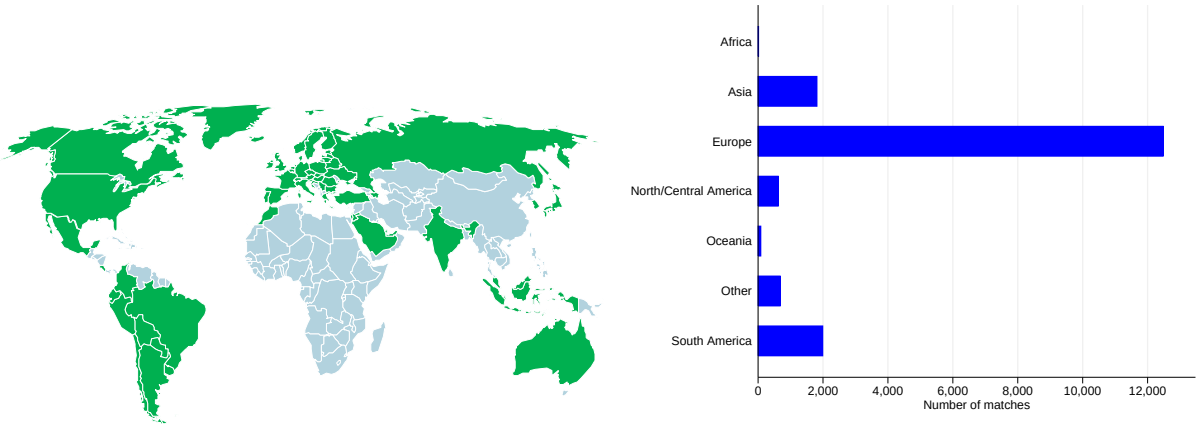
In this paper, we investigate a different source of competitive advantage for the quote-driven market structure: the benefit arising from the continuous liquidity provision of the bookmaker. According to Demsetz (1968), a key function of market makers in financial markets is the supply of immediacy by continuously quoting odds and providing liquidity to the asynchronous arrival of orders from investors. This presence reduces temporal imbalances in order flow and increases the rapidity of exchange. By contrast, a lack of liquidity at the order-driven structure normally provided by the flow of orders from market participants leads to relatively high bid quotations and relatively low ask quotations, which increases both transaction and waiting costs.

3 Sample and Data

Our data set consists of decimal betting odds from the bookmaker *Tipico* and the betting exchange *Betfair* on the *winner* betting contracts on *home win*, *draw* and *away win* of soccer matches. *Tipico* is one of the leading bookmakers in Europe. Through its online portal and more than 1,000 betting shops across Europe, the company offered odds on 1.76 million betting contracts and handled over 790 million bets from customers in 2012 (Tipico Co. Ltd., 2013). *Betfair* is the largest and most liquid betting exchange. In 2012, the betting exchange had over 4 million registered customers and processed more than 7 million transactions on an average day, which is more than the transactions of all European stock exchanges combined (Betfair, 2012).

The data is provided by *Tipico* and covers 17,689 matches from over 400 leagues across more than 60 countries played between March 2012 and October 2012. Figure 1a highlights the countries represented in the data. Within each country, we observe matches from different divisions. For example, data from England includes matches from the *Premier League* (level 1), *Championship* (level 2), *League One* (level 3), *League Two*

(level 4), *Conference National* (level 5), *Conference National* (level 6) and *Conference North/South* (level 7) are available. Additionally, transnational tournaments such as the UEFA Champions League or Europa League, World Cup qualification matches or international friendly matches are also covered by the data set. Figure 1b displays the distribution of matches across continents. The lion's share of matches was played in European leagues, accounting for over 12,000 matches.



(a) Countries covered by the data set

(b) Number of matches across continents

Figure 1: Match coverage across countries and continents

We observed the decimal odds during the 72 hours before match start.[2] The odds information of the bookmaker and the betting exchange is taken simultaneously and the time of collection is recorded accurately to the second. The frequency at which the odds were collected depended on the time remaining until match start, ranging from every 3 hours between 72 and 48 hours before match start to every 5 minutes during the final 3 hours before match start. Table 1 shows the complete algorithm according to which the odds information was collected. Normally, the actual time point of the odds collection differs slightly from the defined algorithm. We round those observation to the nearest timestamp

[2]As not all matches have odds data available as early as 72 hours before play, a higher number of matches are observed at shorter times before match start. For 72 hours before match start, we observed 5,724 matches and at match start we observed 17,689 matches.

Table 1: Odds collection algorithm

Hours before match start	72-48	48-15	15-6	6-3	3-0
Time between odds observations	3 hours	1 hour	15 minutes	10 minutes	5 minutes

Notes: The table shows the odds collection frequency algorithm according to which odds information has been recorded.

according to the algorithm in order to equalize all timestamps across the matches in the dataset.[3]

Figure 2 displays the odds information available for the *home win* event bet from the match of *Liverpool* vs. *Manchester United* played on September 23, 2012, clearly showing how the frequency of observations increases as the time before match start diminishes.

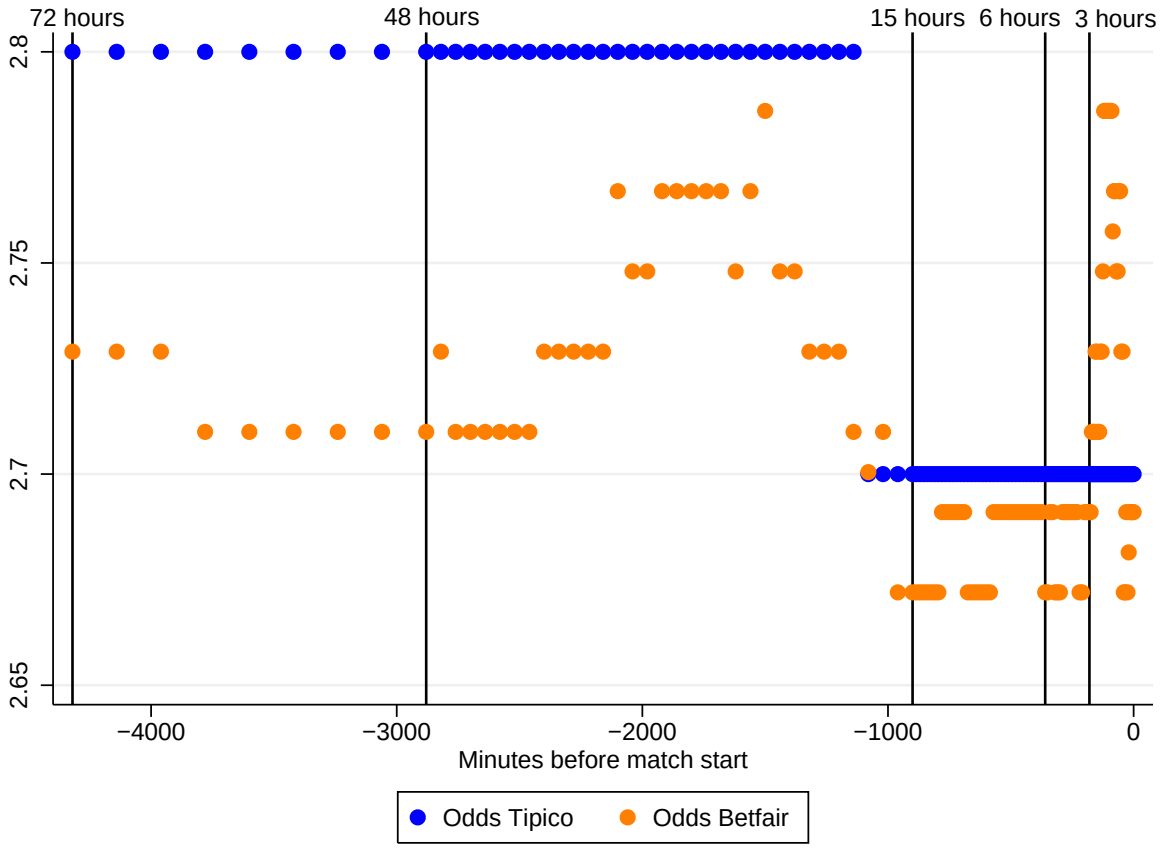


Figure 2: Decimal odds on *home win* event bet (Liverpool vs. Manchester United, September 23, 2012)

[3]Note that this rounding procedure only affects the time point of the odds collection. The original timestamps of *Tipico* and *Betfair* data are identical. For example, if the original timestamp is 48h2m31s before match start, the timstamp for this data pair is rounded to 48h0m0s.

This systematic applies to all matches in our dataset. In this example, the bookmaker changes his quoted odds only once, whereas the odds available at *Betfair* exhibit a higher variation. This pattern is typical for many matches in our data set: while the bookmaker changes his odds about twice on average, the betting exchange odds change about 31 times on average.

In total, we observe 1,875,430 pairs of odds from the bookmaker and the betting exchange for each of the three events *home win*, *draw* and *away win*. Additionally, the data set contains the cumulative trading volume per match at the betting exchange.

To accommodate differences between more and less heavily demanded matches we form a subsample consisting of matches played only in the top 10 soccer leagues in the world. These leagues include the *1. Bundesliga* (Germany), *Premier League* (England), *La Liga* (Spain), *Serie A* (Italy), *Serie A* (Brazil), *Liga MX* (Mexico), *MLS* (USA), *Eredivisie* (Netherlands), *Ligue 1* (France) and the *Primera Division* (Argentina) (World Soccer, 2013). Matches played within those popular leagues are likely to attract substantially higher betting volume at both market structures due to a larger fan base, television broadcasts or media presence, for example. This subsample consists of 1,441 matches, leading to 181,084 pairs of odds-observations from the bookmaker and the betting exchange over the three-day period.

4 Empirical Analysis

Previous studies primarily relied on the comparison of odds from top-division leagues and large tournaments collected at a single point in time shortly before match start. Our data set permits us to analyze the dynamics of price competitiveness over the 72 hours before match start and over a large scope of different leagues. We begin our empirical analysis by assessing the relative competitiveness of the bookmaker and the betting exchange market over time and proceed by studying the role of liquidity in explaining the differences in price competitiveness.

4.1 Price Competitiveness

Our measurement of price competitiveness is based on the objective benchmark of the odds. As identical betting contracts are offered on both market structures simultaneously, better odds should attract a higher number of bettors, ceteris paribus (Pope & Peel, 1989; Croxson & Reade, 2011). For the ease of interpretation, we convert the decimal odds into prices, which are the reciprocal of the decimal odds (e.g., $p = \frac{1}{1.40} \approx 0.714$). These prices represent the amount of money a bettor has to invest in order to collect \$1 for a winning bet (Forrest & Simmons, 2008). Hence, a lower price for an identical betting contract is superior to a higher price.

In the bookmaker market, the commission is already included in the odds quoted by the bookmaker. For each match i, event $e \in \{home\ win,\ draw,\ away\ win\}$ and time t before match start, the price offered by the bookmaker is defined as

$$p_{iet,BM} = \frac{1}{odds_{iet,BM}} \tag{1}$$

where $odds_{BM}$ refers to the decimal odds quoted by the bookmaker. Betting exchanges usually charge a commission on net winnings that is not included in the odds offered. Hence, the net price at the betting exchange is calculated as

$$p_{iet,BE} = \frac{1}{\Big[\underbrace{(odds^{back}_{iet,BE} - 1)}_{\text{net winnings}} \cdot (1 - c)\Big] + 1} \tag{2}$$

where $odds^{back}_{BE}$ refers to the best decimal back odds, i.e., the odds of a bet on a certain outcome, available at the betting exchange and c refers to the commission. The commission at *Betfair* varies between 2% and 5% on net winnings, contingent on the betting activity of a bettor. Thereby, the commission decreases the more money a bettor has wagered in

the past (Betfair, 2013b). In this paper, we employ the standard commission of 5% to compute a lower bound for the net returns from *Betfair*.[4]

At each point in time, the prices from the two market structures are collected simultaneously. Therefore, we start our analysis by conducting a nonparametric Wilcoxon signed-rank test of the net prices. Panel A of Table 2 reports the results for prices collected 72 hours before match start for the *home win*, *draw* and *away win* events separately. For

Table 2: Comparison of net prices

Panel A: Wilcoxon signed-rank test of net prices 72 hours before match start

	Home win			Draw			Away win		
	p_{BM}	p_{BE}	z	p_{BM}	p_{BE}	z	p_{BM}	p_{BE}	z
Mean	0.469	0.510	-25.70***	0.288	0.333	-30.26***	0.319	0.365	-20.72***
SD	0.152	0.181		0.039	0.136		0.137	0.199	
N	5,724	5,724		5,724	5,724		5,724	5,724	

Panel B: Wilcoxon signed-rank Test of Net Prices at Match Start

	Home win			Draw			Away win		
	p_{BM}	p_{BE}	z	p_{BM}	p_{BE}	z	p_{BM}	p_{BE}	z
Mean	0.483	0.473	56.25***	0.277	0.268	67.39***	0.331	0.324	54.17***
SD	0.176	0.175		0.046	0.059		0.164	0.167	
N	17,689	17,689		17,689	17,689		17,689		

Notes: The table presents the results of a nonparametric Wilcoxon signed-rank test on the difference in net prices from the bookmaker (p_{BM}) and the betting exchange (p_{BE}) indicated by the z-statistic. Panel A shows the results three days before match start. Panel B shows the results at match start. In all tests, *, **, and *** denote significance at the 10%, 5% and 1% levels, respectively.

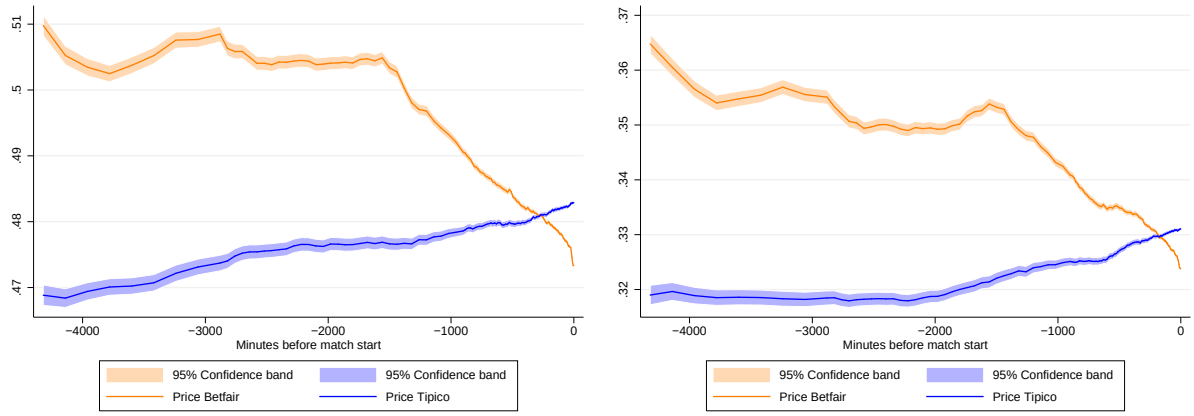
all three events, the prices offered by the bookmaker are significantly lower than the prices offered by the betting exchange. Thus, the bookmaker offers a superior product to bettors at this point in time. The difference in prices is considerable. On the *home win* event for example, the average prices from bookmaker and the betting exchange are 0.469 and 0.510, respectively which results in an additional average payout of the bookmaker to bet-

[4]It is reasonable to assume that most of the bettors betting at *Betfair* are paying 5% in commission, as a discount in the commission requires very high betting activity. According to the *Betfair* commission rule, a bettor has to wager at least $112,500 per week in order to reach the 2% commission rate (Betfair, 2013b).

tors of \$0.17 for every dollar invested in case of a successful bet.[5] This results contradicts the findings from previous studies which imply that prices from the betting exchange are always superior.

Panel B of Table 2 compares the prices at match start. Now, the prices offered at the betting exchange are clearly superior to the prices offered by the bookmaker. This finding is consistent for all three events within a match. The results from Table 2 provide first evidence that the prices offered by the bookmaker are competitive in earlier stages of the pre-play betting period but not at match start.

To get a complete picture of the dynamic of price competitiveness we test the difference in prices for each point in time available in the data set over the 72 hours before match start. Figure 3 shows the average prices over time including 95% confidence bands resulting from simple t-tests. The bookmaker's prices are consistently more attractive over a long



(a) Home win

(b) Away win

Figure 3: Prices from the bookmaker and the betting exchange over time (all leagues)

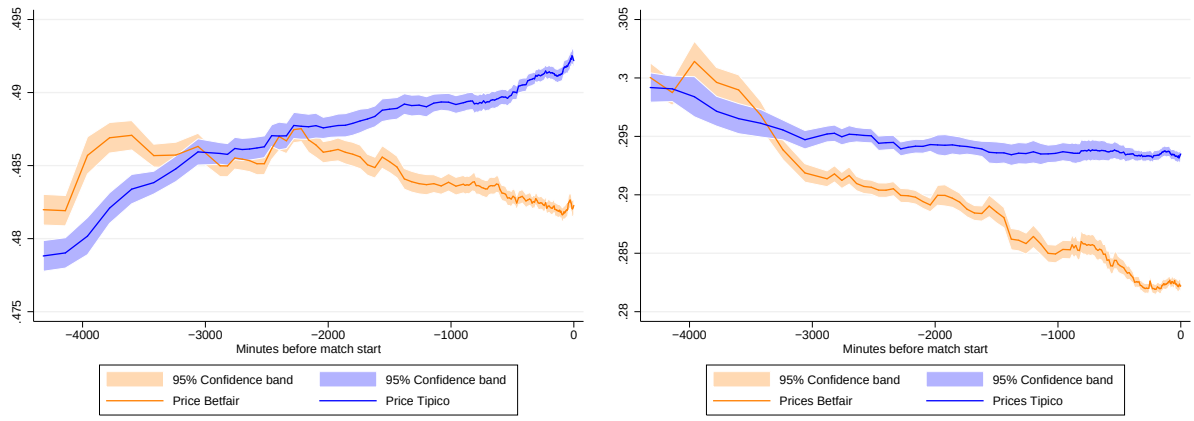
period of time during earlier stages in the pre-play period. For the *home win* event (Figure 3a), the average prices of the bookmaker continue to be significantly lower until about 6 hours before match start. During the 6 hours before match start, the prices from the betting exchange improve dramatically and offer better value than the bookmaker prices. A similar picture arises for the *away win* event depicted in Figure 3b, with the switching

[5] $\Delta return = return_{BM} - return_{BE} = \left[\left(\frac{1}{p_{BM}}\right) - 1\right] - \left[\left(\frac{1}{p_{BE}}\right) - 1\right] = \left[\left(\frac{1}{0.469}\right) - 1\right] - \left[\left(\frac{1}{0.510}\right) - 1\right] \approx 0.17$

point of price competitiveness taking place about 3.5 hours before match start. The results for the *draw* event are similar with a switching point of 3.3 hours before match start.

In a robustness check, we compare the net returns to bettors over time as an alternative measure of price competitiveness. Again, we find that the bookmaker market is more competitive in earlier betting periods, whereas the betting exchange market offers superior value shortly before match start.

Next, we investigate the comparative price competitiveness within the subsample of popular matches from the top 10 leagues worldwide. Price competitiveness is crucial for these matches, because they attract a large share of the betting volume on soccer matches. Figure 4 displays the net prices over time for matches played in the top 10 leagues. Again, the prices for the *home win* event (Figure 4a) are significantly lower at the bookmaker market in the early betting period but higher in the later betting period compared to the prices from the betting exchange. The switching point, however, is shifted in time, with prices being superior at the betting exchange from 34 hours before match start. A similar conclusion is drawn from the *draw* event with a switching point at 47 hours before match start. For the *away win* event (Figure 4b) the betting exchange prices are superior from



(a) Home win

(b) Away win

Figure 4: Prices from the bookmaker and the betting exchange over time (top 10 leagues)

54 hours before match start. Before this point of time, the bookmaker prices are lower than betting exchange prices, however, the difference is not statistically significant.

Overall, a clear picture emerges from the comparison of the average net prices over time. The bookmaker offers lower and thus more favorable prices to bettors in earlier stages of the pre-play betting period. The price advantage of the bookmaker is considerable, lasting on average until 6 hours before match start for *home win* bets and until 3.5 hours before match start for *away win* bets, respectively. Even for matches played only in the top 10 leagues worldwide, the bookmaker price remains competitive, although the switching point at which betting exchange prices become superior occurs much earlier before match start. As such, bettors who do not want to wait until shortly before match start to place their bets are better off betting at the bookmaker market on average.

4.2 Liquidity Provision

Having considered the price competitiveness of the quote-driven bookmaker market and the order-driven betting exchange, we proceed by studying the role of liquidity as a moderating factor in explaining the dynamics of price competitiveness over time. Liquidity is an important characteristic of well-functioning markets and permits the trading of large quantities quickly at low costs (Harris, 2003). While liquidity in the quote-driven market is guaranteed by the bookmaker, liquidity in the order-driven market depends on the flow of orders from market participants (De Jong & Rindi, 2009). Hence, we concentrate on the development of betting exchange liquidity because a lack of liquidity in the order-driven market could affect the cost of immediacy and thus the price competitiveness (Demsetz, 1968).

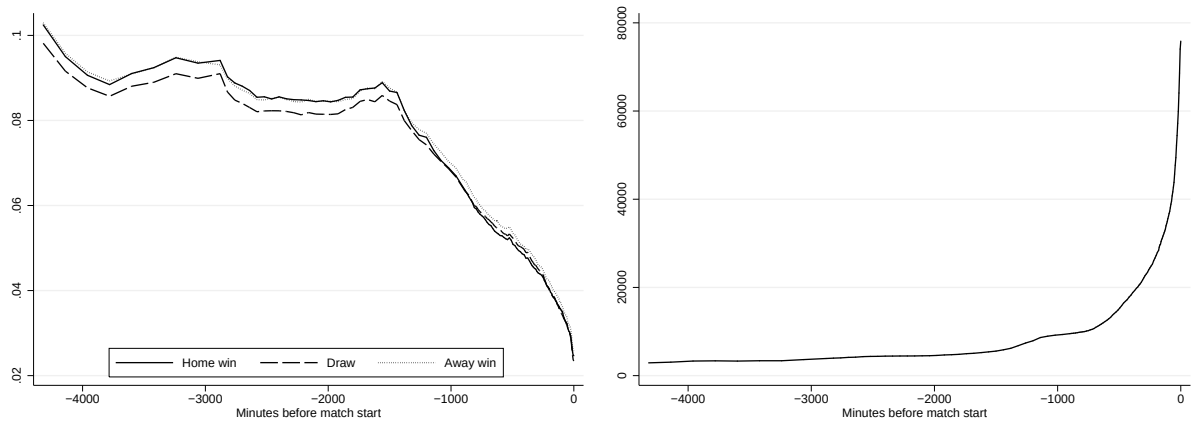
A common measure of liquidity in financial studies is the quoted spread (e.g., Amihud & Mendelson, 1986). The quoted spread is the difference between the lowest ask price and the highest bid price (Chordia, Roll, & Subrahmanyam, 2008). A small quoted spread

indicates high market liquidity, because the transaction costs are lower. We calculate the quoted spread ($QSPR$) as

$$QSPR_{iet,BE} = \frac{1}{odds^{back}_{iet,BE}} - \frac{1}{odds^{lay}_{iet,BE}} \tag{3}$$

where p^{back} refers to the best ask price and p^{lay} to the best bid price available at the betting exchange.

Another measure of liquidity employed in the literature is the trading volume (Chordia, Roll, & Subrahmanyam, 2001). Thus, we use the cumulative trading volume (VOL) per match as basis for our second liquidity proxy. Figure 5a displays the development of liquidity based on the average quoted spread over the 72 hours before match start for the three events separately. Interestingly, the quoted spreads remain relatively stable



(a) Average quoted spread ($QSPR$)

(b) Average trading volume (VOL)

Figure 5: Betting exchange liquidity over time

until around 24 hours before match start. Thereafter, they fall sharply, from an average quoted spread of 0.086 at 24 hours before match start to 0.025 at match start. A similar pictures arises for the liquidity based on the cumulative trading volume over time (see Figure 5b). The trading volume remains low until around 24 hours before match start and increases exponentially thereafter. Given this evolution of the trading volume, we use the logarithmized cumulative trading volume ($LnVOL$) in our further analysis.

To investigate the relative price competitiveness we take the difference between the bookmaker price and the betting exchange price offered at each point in time and define this difference Δp as

$$\Delta p_{iet} = p_{iet,BM} - p_{iet,BE} \tag{4}$$

A positive value of Δp indicates that the bookmaker offers a higher price and is less competitive than the betting exchange. Conversely, a negative value of Δp indicates that the bookmaker market offers lower prices and is more competitive.

To examine the link between price competitiveness and liquidity, we estimate for each event e the following fixed effects panel model

$$\Delta p_{it} = \alpha_i + \beta_1 \cdot Liquidity_{it} + \beta \cdot \Gamma_{it} + \epsilon_{it} \tag{5}$$

where *Liquidity* is either measured by the quoted spread ($QSPR$) or by the logarithmized trading volume ($LnVOL$). To capture a possible time trend in the data we include a set of hourly dummies (Γ) in the model. This allows us to control for any time-related price differences in a flexible way. The constant α_i controls for time-constant differences across matches.

The estimation results based on standard error corrected for heteroskedasticity and autocorrelation are presented in Table 3. Columns (1), (3) and (5) of Table 3 report the coefficients for the quoted spread of the *home win*, *draw* and *away win* events, respectively. All three coefficients are negative on the 1% significance level. We find that illiquidity (i.e., a higher quoted spread) significantly decreases the relative price competitiveness at the betting exchange market. Columns (2), (4) and (6) of Table 3 report the estimated coefficients for the trading volume. For each of the three events, we find a positive effect of liquidity on the price difference, indicating an improvement of the price competitiveness at the betting exchange relative to the bookmaker market. In all models, dummy variables

Table 3: Fixed effects panel analysis of price differences (all leagues)

	Dependent variable: Δp					
	Home win		Draw		Away win	
	(1)	(2)	(3)	(4)	(5)	(6)
$QSPR$	-0.562***		-0.696***		-0.688***	
	(0.005)		(0.003)		(0.005)	
$LnVOL$		0.003***		0.005***		0.004***
		(0.0003)		(0.0003)		(0.0003)
Hourly dummies	Yes	Yes	Yes	Yes	Yes	Yes
F(56, 17,672)	492.78***	70.81***	1614.96***	74.21***	745.50***	63.66***
R^2 overall	70.37%	10.21%	88.42%	13.40%	78.11%	10.69%
N	1,857,741	1,857,741	1,857,741	1,857,741	1,857,741	1,857,741
N of groups	17,673	17,673	17,673	17,673	17,673	17,673

Notes: The table reports the coefficients estimated from a fixed-effects panel model with standard errors corrected for heteroskedasticity and autocorrelation. Standard errors are reported in parentheses. The dependent variable is the price difference Δp between the two market structures. Matches from all leagues in the data set are included for the estimation. In all models, *, **, and *** denote significance at the 10%, 5% and 1% levels, respectively.

for each hour within the 72-hour period control for a potential general time trend which could affect the price differences.

Taken together, our findings imply that higher liquidity is associated with higher price competitiveness at the betting exchange. In periods where liquidity is low at the betting exchange, however, the guaranteed liquidity provision at the bookmaker market leads to significantly more favorable prices.

In order to investigate the robustness of our results we include the bookmaker price $p_{it,BM}$ in Equation (5) as a control variable. The reasoning behind this is that changes in the bookmaker price might influence the relation between liquidity and the price difference. However, the previous findings do not change in any significant way. Additionally, an estimation of Equation (5) with the difference between the net returns to bettors from both market structures as dependent variable leads to the same conclusion.

We extend our analysis by studying the effect of liquidity provision on price competitiveness on the subsample consisting of matches from the top 10 leagues worldwide. The estimated coefficients are presented in Table 4. The results from this estimation are

statistically very similar to those in Table 3. However, the effect from liquidity on the price difference seems to be less pronounced, indicating that the liquidity advantage of the bookmaker market is smaller for the very popular matches.

Table 4: Fixed effects panel analysis of price differences (top 10 leagues)

	Dependent variable: Δp					
	Home win		Draw		Away win	
	(1)	(2)	(3)	(4)	(5)	(6)
$QSPR$	-0.497***		-0.499***		-0.665***	
	(0.039)		(0.037)		(0.041)	
$LnVOL$		0.004***		0.003***		0.005***
		(0.0006)		(0.0004)		(0.0006)
Hourly dummies	Yes	Yes	Yes	Yes	Yes	Yes
F(56, 17,672)	24.87***	6.69***	22.98***	10.70***	28.08***	7.02***
R^2 overall	34.48%	0.57%	43.75%	2.16%	51.45%	0.59%
N	181,084	181,084	181,084	181,084	181,084	181,084
N of groups	1,441	1,441	1,441	1,441	1,441	1,441

Notes: The table reports the coefficients estimated from a fixed-effects panel model with standard errors corrected for heteroskedasticity and autocorrelation. Standard errors are reported in parentheses. The dependent variable is the price difference Δp between the two market structures. Only matches from the top 10 leagues worldwide are included in the estimation. In all models, *, **, and *** denote significance at the 10%, 5% and 1% levels, respectively.

5 Conclusion

This paper investigates the coexistence of bookmakers and betting exchanges in the betting industry. Said to exhibit superior odds, less operational risk, lower information costs and higher prediction accuracy, betting exchanges are considered a superior business model to traditional bookmaking. Nevertheless, bookmakers continue to be successful.

We test how liquidity affects the relative price competitiveness of the two market structures. Liquidity in the quote-driven market is continuously provided by the bookmaker. However, liquidity in the order-driven market is determined by limit order submissions from other bettors. We find that the bookmaker offers more favorable prices than the betting exchange until 6 hours before match start for *home win* bets and until 3.5 hours

before match start for *away win* bets, and less favorable prices thereafter. These price dynamics in the earlier betting period have been overlooked by the literature so far.

A panel regression analysis demonstrates that the price competitiveness of the betting exchange depends crucially on liquidity. Our results imply that a lack of liquidity at the betting exchange causes large gaps between bid and ask prices and thus less competitive betting exchange prices. In such situations, bookmaker prices are superior because liquidity is permanently supplied by the bookmaker.

Altogether, our paper shows that the order-driven betting exchange structure is not necessarily superior to the quote-driven bookmaker structure, as the active management of the sportsbook offers a distinct liquidity advantage. This finding helps to explain the ongoing coexistence of the two structures, as early betting volume should migrate to the more competitive bookmaker market.

Our analysis sheds some light on the recent shift of financial markets into hybrid structures. The London Stock Exchange (LSE) and the Nasdaq market for example, moved from quote-driven systems to a hybrid structure where the order book is supplemented by market makers (Friederich & Payne, 2007). Furthermore, the New York Stock Exchange (NYSE) is characterized by elements of both market structures (Madhavan, 2000). Empirical financial studies suggest that market makers are particularly valuable in hybrid structures when liquidity at the order book is low (e.g., Madhavan & Sofianos, 1998; Friederich & Payne, 2007; Venkataraman & Waisburd, 2007). As such, the hybrid market structure combines the advantages of both the quote-driven and order-driven structures. This might be one of the reasons why *Betfair* has started a sportsbook offering quoted fixed odds in addition to the exchange based odds as of February 2013 (Betfair, 2013a), moving essentially to a hybrid market structure.

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