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## Gender behavior in betting markets

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### Abstract

We extend gender research on risk behavior to betting markets. Our data set consists of all 5,136,660 bets in New Zealand from 2006 to 2009 and allows assigning each bet to individual bettors. Women are much more prone to the favorite-longshot bias and suffer higher losses. Usually, betting on longshots is associated with higher variance of return, but we find that bet sizes are disproportionately decreasing in odds. Hence, the average risk when betting on longshots is in fact lower. This observation reconciles our findings with gender research on risk preferences and leads to new insights on the favorite-longshot bias.

Keywords: behavioral economics, behavioral finance, gender research, betting markets

JEL classification: D14, D81, G11

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## **1. Introduction**

In this paper, we extend gender research on risk behavior to betting markets. We utilize a data set consisting of all 5,136,660 bets placed in New Zealand between April 2006 and August 2009. The data set is unique as, by contrast to all previous research it consists not only of odds and results, but also includes the individual attributes of bettors such as age and gender, and assigns each bet to an individual. This allows us to extend gender research on risky choices to betting markets which has not been possible yet due to a lack of information on individual betting behavior.

We find that women bet lower amounts, less frequently, are much more prone to the favorite-longshot bias, and face considerably higher average losses. We show that these results are consistent with the state of the art in gender research on risk behavior if and only if one takes into account that bet sizes are disproportionately decreasing in odds.

Gender research has shown that women are more risk averse and less optimistic than men, and the literature widely agrees that investment strategies of females are more conservative than those of males. Most evidence is experimental (see Eckel and Grossman 2008 for an overview), and there is less evidence on gender behavior in real financial markets. This is due to the fact that investors have different time horizons and hold diversified portfolios, so that information on whole portfolios and a sufficiently long observation period would be needed to analyze behavior in financial markets, and this data is hardly available. This problem is considerably smaller with betting markets.

Compared to financial markets, betting markets are simpler as different bets are usually uncorrelated, and because returns are realized for all bettors at the same time. This makes betting markets a promising research object for analyzing risk preferences. Consequently, betting markets have attracted considerable attention, and data on odds and outcome have been utilized to analyze whether expected utility theory or prospect theory is superior in explaining the data (see the overview in Jullien and Salanié 2008). To the best of our knowledge, however, individual data on betting behavior has not been available yet, and betting data could hence not have been exploited for analyzing differences in gender behavior. The present paper contributes to the following lines of literature:

First, we confirm the most fundamental result of betting research which is the existence of a favorite-longshot bias. This bias expresses that average returns on favorites are higher than those on longshots (see the overviews in Ottaviani et al. 2008, and Snowberg and Wolfers 2008). When defining favorites as the bottom fifty percent lowest odds placed

and longshots as the other fifty percent, losses with longshots are on average around 88% higher than those with favorites.

Second, the overwhelming part of the literature has implicitly assumed that betting on longshots leads to higher risk, captured for instance by the variance of returns, than betting on favorites. For simple arithmetic reasons, this is true when assuming that bet sizes are independent of odds. But this assumption is both implausible and counterfactual as few bettors set huge amounts on longshots. In fact, we find that bet sizes are so largely decreasing in odds that the variance of returns is also decreasing in odds. Thus, when measuring risk by the variance of returns, the average risk of all bets placed on longshots is in fact lower than the average risk of all bets placed on favorites. This sheds a new and different light on the relation between risk preferences and the favorite-longshot bias.

Third, our data set is the first one that allows analyzing which groups drive the favorite-longshot bias, and we find gender and experience to be crucial. As already mentioned, there is a large gender difference in that females bet more on longshots than men do. Other than that, lack of experience is important. We approximate the experience of bettors for each single bet by two variables, the number of bets placed so far, and the total amount already spent. Average odds are decreasing in both experience measures. Moreover, when considering exclusively the one percent of all bettors who have invested the highest overall amounts, then average odds are about 23.8% lower than those for the whole data set. This result is qualitatively robust with respect to other definitions of subgroups. Apparently, large investors are aware that betting on favorites provides, on average, higher returns than investing on longshots. The fact that average odds of all bets made by women are far higher than those placed by men is partially explained by lower experience, but even after controlling for both experience proxies, the gender dummy is highly significant.

Fourth, combining our finding that women bet much more on longshots with the fact that bet sizes are disproportionally decreasing in odds, shows that our results support the widely acknowledged result of gender research that women are more risk averse than men are. This is worth being emphasized: At first glance, one might have presumed that women bet more on favorites since the risk is *ceteris paribus* higher when betting on longshots. But as the impact of odds on risk is overcompensated by the degree at which bet sizes are decreasing in odds, women face on average lower risk than men do.

Fifth, betting success is closely related to betting on favorites, however not completely so. Experience leads to higher returns, channeled in both a direct and an indirect way. Experienced bettors count more on favorites, and this increases the return in an indirect way,

but experience remains significantly positive even after controlling for odds. This residual can be interpreted as the direct effect of experience. Average losses of all bets made by females are much higher for three reasons: First, women are less experienced which has the negative indirect effect of betting more on longshots, and the negative direct effect that remains after controlling for odds. Second, women bet more on longshots when controlling for experience. And third, women suffer higher losses than men do even when controlling for odds *and* for experience. As this can neither be attributed to the favorite-longshot bias nor to experience, we could so far offer only highly speculative explanations for the residual impact of gender.

The remainder of the paper is organized as follows: In section 2, we relate our paper to the literature. Section 3 presents the data. In section 4, we explain betting behavior, and in section 5 we turn to betting success. Section 6 considers reduced data sets where we exclude large investors and high-frequent bettors to make sure that the lower exposure of male to the favorite-longshot bias is not only a statistical artifact of the higher percentage of men in the subgroup of semi-professional bettors. Section 7 concludes and points to further research.

## **2. Relation to the literature**

Our paper is related to the literature on betting markets and to gender research on risk behavior. The literature explaining the favorite-longshot bias can be categorized in preference based and perception based. Based on expected utility theory, the favorite-longshot bias was always explained with locally risk-seeking preferences by implicitly assuming that bet sizes are independent of odds. The simplest perception based explanation for the bias draws on the descriptively robust finding of prospect theory that individuals are systematically over-weighting small probabilities (see Ottaviani et al. 2008).

Empirical attempts of separating between the two approaches utilize the shapes of the odds-return figures (see the seminal paper by Jullien and Salanié 2000), and most papers support the perception model rather than the model based on expected utility theory (see the overview in Jullien and Salanié 2008). Snowberg and Wolfers (2008) extend to combinatorial bets for all horse races in the US between 1991 and 2001 and confirm that misperception models outperform preference models based on risk attitudes. As an exemption, Gandhi (2008) has recently challenged the predominant view by emphasizing that previous results were driven by the assumption that all bettors have identical risk preferences (so called “representative bettor approach”). He finds that expected utility theory performs empirically better when assuming instead that risk-seeking (casual) bettors responsible for the favorite-

longshot bias co-exist with risk-averse (professional) bettors entering the market to benefit from the first group's behavior.

Let us recall from the introduction that, in our data set, the average risk of bets placed on longshots, measured by the variance, is smaller than the average risk of bets placed on favorites as bet sizes are disproportionately decreasing in odds. This makes any explanation of the favorite-longshot bias based on risk-seeking preferences questionable. To the best of our knowledge, Bradley (2003) and Kopriva (2009) are the only other papers accounting for the impact of different bet sizes on risk. While Bradley (2003) derives a theoretical model based on prospect theory<sup>1</sup> which explains why bet sizes are decreasing in odds, Kopriva (2009) is the only other paper we are aware of that analyzes the relation between odds and bet sizes empirically. By using data from betfair.com, he finds a negative correlation as in our data set. As there are no other papers having individual betting data, there are no other studies that analyze the impact of gender or experience on behavior or success in betting markets.

Turning to gender research on risk behavior, it is widely agreed upon that women are more risk averse than men (see Byrnes et al. 1999 for an overview on psychological research, and Eckel and Grossman 2008 or Croson and Gneezy 2009 for overviews on the economic literature). This holds for gamble experiments (Eckel and Grossman 2002, Holt and Laury 2002), trading games (Powell and Ansic 1997), investment scenarios (Bajtelsmit and VanDerhei 1997, Jianakoplos and Bernnasek 1998) and observations from share markets (Hinz et al. 1997 and Sunden and Surette 1998).<sup>2</sup> These findings are consistent with our finding that women bet more on longshots if and only if one accounts for the negative correlation of odds and bet sizes.<sup>3</sup>

Interestingly, experiments by Harbaugh et al. (2002) and Fehr-Duda et al. (2006) show that the difference in the risk premiums demanded by women and men is higher when winning probabilities are high. This may be caused by either differently shaped utility func-

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<sup>1</sup> Prospect theory has been applied successfully for many different phenomena in gambling and finance; see Barberis and Huang (2001) who explain value premiums by loss aversion, Kouwenberg and Ziemba (2007) for the behavior of hedge-fund managers, Barberis and Huang (2008) for the willingness to pay for positively skewed securities, and Dittmann et al. (2010) who show that stock options in CEO compensation can much better be explained by prospect theory than by standard risk aversion.

<sup>2</sup> By using the Socioeconomic Panel (SOEP) which is a representative sample of about 22,000 people in Germany and by conducting an experiment with 450 individuals from the SOEP, Dohmen et al. (2010) recently found that the risk-related questions in the sample are a good predictor of actual behavior and that women are more risk-averse than men.

<sup>3</sup> Barber and Odean (2001) find that men are less successful than women on share markets since they trade too often, and the authors attribute this behavior to overconfidence.

tions or by different misperceptions of probabilities, but in any case it would show up empirically in a higher percentage of bets made on longshots.

Next, it is instructive to relate our gender findings to the research on optimism and pessimism, and to the theory of disappointment aversion. Only recently, the literature aims at contrasting optimism and pessimism, which are usually defined with respect to different beliefs on the probabilities of outcomes, from risk preferences. With data from the Survey of Consumer Finances (SCF), Puri and Robinson (2007) approximate optimism as the difference between a person's subjective life expectancy and their (average) objective life expectancy. They report that males are significantly more optimistic, that risk preferences and optimism are not significantly correlated, and that the different behavior of genders is driven by optimism rather than by risk preferences. Jacobsen et al. (2010) find that men hold, on average, around 15% more equity than women do (see also Dominitz and Manski 2007) and argue accordingly that the results can better be explained by differences in optimism than by differences in risk attitudes.

How could pessimism rather than optimism lead to betting on longshots? Advancements of prospect theory such as the theory of disappointment aversion<sup>4</sup> confirm that people contemplating risks suffer more from identical losses when these are unexpected, and hence prefer alternatives with lower disappointment potential. This supports the intuition that disappointment is related to odds, and players might avoid betting on favorites simply because the disappointment in case of losing is disproportionately increasing in winning probabilities. If women are consistently more pessimistic than men are, and if the relative gender difference in pessimism is independent of probabilities, then it can easily be shown that women would indeed demand relatively higher odds for favorites than men do.<sup>5</sup> Hence, combining gender research on optimism with the theory of disappointment aversion may also contribute to explaining why women bet more on longshots. Of course, similar results would follow when assuming instead that the degree of disappointment aversion itself is higher for women.

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<sup>4</sup> See already Bell (1985) and Gul (1991). Köszegi and Rabin (2006, 2007) develop an axiomatic theory of reference-dependent risk preferences which contains observations of prospect theory and predictions of expected utility theory as special cases.

<sup>5</sup> This is briefly illustrated in the Appendix.

### 3. Data

In close cooperation with the ‘New Zealand Racing Board’ (NZRB) which is the only licensed betting agency in New Zealand, we have compiled a data set consisting of all 5,136,660 bets placed at the agency between April 2006 and August 2009. As submitting individual data such as name, gender and age is obligatory for betting in New Zealand, we can observe all individual betting histories for the period covered by our data set. The first row in table 1 shows that 91% of all bets are placed by men, but there are nevertheless 435,662 bets placed by women. As most events have more than two possible outcomes, average odds are relatively high and show a considerable difference between bets placed by men and women with average odds of 8.34 and 9.56, respectively. Average losses of women are 17.73% compared to average losses of men of 14.32% .

**Table 1**

To illustrate the impact of odds on the return of bets, we distinguish between favorites defined as the bottom fifty percent lowest odds placed and longshots defined by the other fifty percent. As shown in table 1, the return on favorites is -9.97% compared to -18.67% for longshots for men, and -12.13% compared to -23.13% for women respectively. Hands the descriptive statistics already reveals a large favorite-longshot bias.

Disaggregating by sports shows that women are almost always less successful than men are, with football being the only exception. Furthermore, average odds of bets placed by women are higher with the exceptions of golf and tennis. The disaggregation is important as average odds are much higher for sports with many outcomes, and considering different sports hence shows that the higher susceptibility of females to the favorite-longshot bias cannot be explained by the fact that men and women are interested in different sports. Finally, the last column shows average bet sizes which are invariably higher for men.<sup>6</sup>

Note that averages in table 1 are taken over bets. When taking instead averages over bettors, then each bettor enters with the same weight, and bets of infrequent bettors are hence overrepresented. Table 2 gives descriptive statistics for bettors and shows that there are around six times more male than female bettors. The average amount invested by men is relatively high with more than 4000 NZ\$,<sup>7</sup> but this can mainly be attributed to some bettors

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<sup>6</sup> “Other sports” in Table 1 captures all sports such as Athletics, Netball and Aquatics for which the number of bets placed in our data set is below 100.000.

<sup>7</sup> The exchange rate to the US\$ fluctuated over the observation period, but the average rate was around 65 US cent for one NZ\$.



investing surprisingly large amounts. Consequently, the median is much lower with 141 NZ\$. Due to the fact that averages are now taken over bettors instead of bets, and since frequent bettors are more successful, average losses are now 28.52% for men and 34.42% for women, respectively.

**Table 2**

#### **4. Betting behavior**

We now start the econometric analysis by investigating betting behavior. In all regressions, we separate our data set in parimutual bets and non-parimutual bets as the literature has found the favorite-longshot bias to be very robust for parimutual betting, but less so for non-parimutual betting. For non-parimutual betting, individuals know the exact odds in advance whereas the total handle minus the take-out rate is divided among all successful bettors for parimutual betting. As the two modes may therefore attract individuals with different risk preferences, separating between them seems reasonable. In all regressions, we use fixed effects for the different sports where greyhounds and baseball serve as reference categories for parimutual and non-parimutual betting, respectively. For gender, women serve as reference category.

Table 3 shows our benchmark regression for odds. The first three columns refer to parimutual betting, and the next three columns to the non-parimutual betting mode.

**Table 3**

Columns 1 and 4 document results without experience. In accordance with descriptive statistics, we find an important gender difference with about two percentage points for parimutual and almost one percentage point for non-parimutual betting. Age reduces odds significantly for both betting modes.

As mentioned in the introduction, we distinguish between two experience proxies. ExperienceA measures for each bet the total amount invested so far in 1000NZ\$. ExperienceB is the number of bets already placed by a bettor.<sup>8</sup> ExperienceA reduces odds for both betting modes, i.e. individuals who have already invested large amounts bet more on favorites. By contrast, the impact of the total number of bets already made (ExperienceB) differs between the two betting modes: For parimutual betting, ExperienceB decreases odds of bets

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<sup>8</sup> We do not see any possibility to account for the fact that bettors may have been in the market before our data set starts, but as there seems to be no systematic bias, this should not distort our results in a meaningful way.

placed, but the opposite holds for non-parimutual betting. The two experience measures are correlated with coefficients of 0.44 and 0.095 for parimutal and non-parimutual betting, respectively, but considering them separately yields qualitatively identical results.

In the introduction, we have emphasized that odds and bet sizes are negatively correlated. Table 4 summarizes the correlation coefficients for the two betting modes, in general and disaggregated by gender.

#### **Table 4**

Presumably, most bettors decide simultaneously upon bet sizes and on which outcome they bet, and thereby implicitly upon the variance of the return. As to analyze the impact of odds on the risk of bets chosen, we explain the variance by odds and our usual explanatory variables gender, age and experience. Again, the first (last) three columns refer to parimutual (non-parimutual) betting.

#### **Table 5**

Columns 1 and 4 show that, for both betting modes, the variance is decreasing in odds. Thus, bet sizes are so largely shrinking in odds that this overcompensates the direct effect on the variance. Moreover, the average variance of bets placed by women is lower compared to those placed by men. For non-parimutual betting, the gender dummy and odds change signs when controlling for experience. The reason is that most highly experienced bettors are men who invest large amounts on bets with relatively low odds. Hence, both the size effect and the gender effect are now absorbed by ExperienceA. As expected, ExperienceA itself has a large positive impact on the variance when controlling for odds while ExperienceB has a negative impact expressing that high frequent bettors invest lower amounts per bet.

## 5. Betting success

Tables 6 and 7 show the results for the two betting modes.

### Table 6

### Table 7

In the first columns of tables 6 and 7, we consider only gender and age as explanatory variables and find that average losses of men are more than 3 percentage points lower for both betting modes. The second columns show that experience consistently increases average returns. Odds have negative signs capturing the favorite-longshot bias. Interestingly, bet sizes have positive signs even after controlling for odds and experience which means that bettors in fact do have superior knowledge in cases where they decide to invest large amounts. Of course, the overall explanatory power of the model captured by  $R^2$  is low which is owed to the simple fact that betting success is to a large extent necessarily driven by chance.

## 6. Robustness checks

A potential problem concerning our gender findings is that there are a non-negligible number of large investors realizing higher average returns than casual bettors. As the percentage of male in this subgroup is higher compared to the whole data, this may distort the impact of gender. To account for this, we redo all of our regressions by excluding the one-percent of bettors who have invested the highest overall amounts in the period covered by our data set, as well as by excluding the one percent of bettors who placed the highest overall number of bets. The one-percent threshold is kind of arbitrary, but we have duplicated all regressions with 3%- and 5%-limits and results are qualitatively the same .

Table 8 first gives descriptive statistics for the two subgroups excluded in our robustness checks.

### Table 8

While the fraction of male in the whole data set is 84.6%, it increases to more than 96% when considering only the 1-percent of bettors who have invested the highest overall amounts. The average amount invested by this subgroup is high with around 240000 NZ\$, but as this is driven by a handful of large investors, the median is much lower with 109000 NZ\$. The borderline investor at the 1-percent-threshold has spent 52712 NZ\$ (about

30000US\$), so that arguing that individuals below this threshold are non-professional bettors seems sensible.

### **Table 3a**

Table 3a shows that the impact of gender on odds of bets placed is now slightly smaller for parimutual betting, but even more pronounced for the non-parimutual betting mode. Hence, the gender difference with respect to odds is not driven by the subgroup of more or less professional male bettors.

### **Table 5a**

In contrast to the benchmark regression, the variance is now significantly increasing in odds, thereby expressing that bet sizes are only decreasing in odds to a disproportionately low extent. This is no surprise as we have already found in table 5 that odds change sign once we control for ExperienceA which suggested that the bettors excluded in table 5a invest large amounts on favorites. As for the whole data set, the variance of bets placed is on average higher for men.

### **Table 6a**

### **Table 7a**

Tables 6a and 7a show that the gender impact is somewhat smaller for both betting modes when the one percent largest investors are excluded, but gender results are qualitatively the same as in our benchmark regressions. Notably, ExperienceB is now significantly negative throughout which should not be overrated for two reasons, though: first, the coefficients are small, and second, they become insignificant when we exclude ExperienceA.

In our second robustness check, we exclude instead the one percent players who have placed the highest number of bets. Results are then even closer to those in the benchmark regressions which is straightforward as the overall amount invested seems to be a better proxy for professional betting than the number of bets. We restrict attention to mentioning the differences, and provide tables on request. Again, we find that the gender dummy in explaining odds is slightly less pronounced for parimutual betting with a coefficient of -1.82, but even higher for non-parimutual betting with -1.41. As in the benchmark regressions and in contrast to the first robustness check, the variance is decreasing in odds for both betting modes.

Finally, the gender coefficients for success are now 0.026 and 0.042 for paramutual and non-paramutual betting, respectively. As expected, the impact of experience shrinks, but is either positive or insignificant in all specifications.

## 7. Conclusion

Our data set consisting of more than five million bets made in New Zealand between August 2006 and April 2009 is first that has information on gender, age and experience for each individual bet. This allows extending gender research on risk behavior to betting markets. We find that women bet much more on longshots than men do. When assuming that bet sizes are independent of odds, this would imply that the average risk of bets placed by women were also higher. Hence, when following the standard literature explaining the favorite-longshot bias with locally risk seeking behavior by assuming identical bet sizes for all odds, our results would mean that women are more risk-seeking than men are. This would contradict the robust finding that women are more risk averse than men.

However, our results in fact coincide with gender research. As the data set contains also the size of each bet, we can calculate the average variance for all odds. As bet sizes are disproportionally decreasing in odds, the variance is also lower when betting on longshots. Consequently, we also find that the average risk of bets placed by women is lower compared to men. This strongly confirms the view of a recent paper by Kopriva (2009) that, when inferring preferences from betting behavior, it is inevitable to account for the fact that bet sizes are decreasing in odds.

When interpreting our results, two caveats are in order. First, it is evident that people acting on betting markets are not representative for the whole population. This means that our results are highly informative for betting behavior, but do not necessarily extend to gender differences in general. This limitation is shared with all empirical papers on gender differences in financial markets as individuals acting on the share market, for instance, also differ considerably from the whole population.<sup>9</sup> However, our prior was that females acting on sports betting markets are likely to be more “male like” than other women, so that one might expect that data from betting markets underestimates rather than overestimates gender differences. Still, we find that women face lower risk than men do, and this supports general insights on risk behavior and on differences in optimism and pessimism.

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<sup>9</sup> This points to an advantage of experimental research and explains why field data and experimental research is equally important.

The second caveat refers to our two experience measures, the total amount invested and the number of bets placed so far. We find a strong positive relationship between experience and success, but we did not so far aim at separating between selection effects (heterogeneity of bettors) and learning effects. In other words, we have not disentangled yet if smarter individuals bet more or if betting more increases the knowledge about the probability distribution over outcomes. This requires considering individual betting histories in detail, and we do not want to compound this question with the current paper that focuses on gender aspects. For this paper, the experience measures are mainly important to make sure that our gender results are not driven by differences in experience.

Finally, readers familiar with betting research may wonder why we do not contribute to the string of the empirical literature which estimates if the data can be better explained by expected utility theory with locally risk-seeking preferences on the one hand or by models based on prospect theory on the other hand. There are mainly two reasons for this: first, it is obvious that the favorite-longshot bias can hardly be explained by locally risk-seeking preferences when the average risk of bets is in fact decreasing in odds. Second, the literature estimates these models based on odds and outcomes and, in the case of Kopriva (2009) also based on overall amounts invested on different odds (representative bettor approach). However, our data set allows for a much more detailed analysis as we can assign each bet to individuals, so that there is no justification for sticking to the representative bettor approach. By contrast, in order not to waste our information, we need to estimate preferences for different individuals or at least for different subgroups. Basically, we did not want to confound this kind of long-term research with our gender results on risk behavior which we suppose to be interesting itself.

In doing so, one might also need to account for a change in preferences. In a recent notable paper, Barberis (2010) has applied prospect theory to analyze the casino gambling behavior of individuals over time. He shows that players overweighting small probabilities derive positive expected utility from gambling when they leave the market as soon as they start losing. He assumes, however, that players change preferences after having started to play, and distinguishes different types of individuals according to their capability of committing to the ex ante preferred strategy. It will be interesting to see in our data set how the decision to leave the market depends on the accumulation of gains and losses over time.

## Appendix: Pessimism, disappointment and incentives to bet on longshots.

In the end of the introduction, we have argued that pessimism may increase the incentive to bet on longshots rather than on favorites when the disappointment aversion is sufficiently high. To illustrate this, assume a longshot with a winning probability of  $q$  and with odds of  $Q = 1/q$ , and a favorite with a winning probability of  $p$ . Furthermore, assume that the disappointment when losing with longshots is simply the bet size which we normalize to 1, but  $F > 1$  when losing a favorite bet. This captures the basic insight that disappointment is lower when losing was expected anyway.

Now suppose that an optimist estimates the winning probabilities correctly while a pessimist consistently discounts by  $\alpha < 1$ , i.e. assumes probabilities of  $\alpha q$  and  $\alpha p$ .<sup>10</sup> Hence, he is equally pessimistic for all events. Then, the favorite-odds  $P$  required for a non-pessimistic bettor to be indifferent between betting on favorites and on longshots are

$$p(P - 1) - (1 - p)F = q(Q - 1) - (1 - q)$$

and hence  $P = \frac{1}{p}(F + p + Fp + Qq - 1)$ , while the pessimistic bettor is indifferent for odds  $\tilde{P}$  implicitly given by

$$\alpha p(\tilde{P} - 1) - (1 - \alpha p)F = \alpha q(Q - 1) - (1 - \alpha q)$$

which gives  $\tilde{P} = \frac{1}{p\alpha}(F + p\alpha - Fp\alpha + Qq\alpha - 1)$  and hence

$$\tilde{P} - P = \frac{1}{p\alpha}(1 - \alpha)(F - 1) > 0 \text{ as } F > 1 \text{ while } \alpha < 1.$$

Thus, for any longshot-odds given, the odds the pessimist demands for the favorite are higher.

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<sup>10</sup> Of course, we could also assume a positive bias for an optimist, all that matters is that the two types have different beliefs.

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## Tables

**Table 1: Descriptive statistics on bets and returns**

		Obs.	Odds	Return	Return on favorites (50%-Threshold)	Return on longshots (50%-Threshold)	Bet sizes
All Bets	Men	4669745 (91%)	8.32	-14.32%	-9.97%	-18.67%	53.11
	Women	435662 (9%)	9.56	-17.73%	-12.13%	-23.13%	21.24
Greyhounds 3%	Men	161982 (92%)	7.77	-17.54%	-8.62%	-25.29%	43.21
	Women	13547 (8%)	9.62	-17.61%	-7.05%	-26.64%	19.13
Horse Races 37%	Men	1690261 (92%)	10.54	-12.53%	-9.58%	-13.56%	44.9
	Women	149033 (8%)	12.55	-15.63%	-10.26%	-17.68%	27.67
Baseball 2%	Men	120118 (95%)	2.20	-9.57%	-9.47%	-13.79%	122.98
	Women	6320 (5%)	2.46	-9.63%	-8.87%	-46.96%	41.46
Basketball 5%	Men	216710 (93%)	2.40	-7.93%	-7.26%	-17.60%	104.19
	Women	15885 (6%)	2.95	-8.66%	-8.27%	-14.65%	46.3
Cricket 5%	Men	245435 (93%)	4.20	-14.12%	-8.50%	-26.13%	52.08
	Women	19852 (7%)	4.70	-17.05%	-11.23%	-30.85%	11.92
Football 7%	Men	329749 (94%)	7.69	-14.72%	-8.91%	-25.41%	39.42
	Women	21992 (6%)	9.85	-12.65%	-8.55%	-20.06%	22.18
Golf 3%	Men	124989 (95%)	25.45	-21.60%	-7.74%	-26.59%	22
	Women	6189 (5%)	24.42	-26.69%	-10.86%	-33.24%	12.06
Rugby League 14%	Men	634688 (89%)	7.43	-17.00%	-13.52%	-20.92%	43.99
	Women	75845 (11%)	8.74	-20.94%	-17.27%	-24.18%	13.26
Rugby Union 17%	Men	789023 (90%)	7.69	-17.41%	-11.44%	-25.66%	51.96
	Women	90828 (10%)	8.80	-22.45%	-15.17%	-31.19%	14.29
Tennis 3%	Men	152878 (89%)	2.83	-13.17%	-9.78%	-40.57%	110.99
	Women	19782 (11%)	2.67	-13.55%	-10.20%	-53.40%	19.25
Others 4%	Men	203912 (93%)	5.29	-12.00%	-7.40%	-28.08%	65.49
	Women	16389 (7%)	7.55	-17.16%	-8.24%	-41.04%	23.91

**Table 2: Descriptive statistics on bettors**

	Number of bettors	Number of bets				Total amount invested				Age	Return
		Average	Median	Min	Max	Average	Median	Min	Max		
<b>Male</b>	59139	78.96	12	1	14538	4194	141	5	24900000	38.0	-28.52%
<b>Female</b>	10722	40.63	5	1	13573	863	45	5	711455	41.2	-34.42%

**Table 3: Odds of bets placed <sup>a</sup>**

	Parimutual			Non-Parimutual		
Gender	<b>-1.925***</b> (-47.63)	<b>-1.764***</b> (-43.59)	<b>-2.017***</b> (-43.10)	<b>-.972***</b> (-21.16)	<b>-.939***</b> (-20.44)	<b>-1.414***</b> (-28.16)
Age	<b>-.0781***</b> (-86.70)	<b>-.0788***</b> (-87.52)	<b>-.0790***</b> (-87.63)	<b>-.0029***</b> (-2.64)	<b>-.0022**</b> (-1.97)	<b>-.0015</b> (-1.39)
ExperienceA		<b>-.0024***</b> (-25.16)	<b>-.0024***</b> (-3.35)		<b>-.00049***</b> (-9.70)	<b>-.0160***</b> (-6.41)
ExperienceB		<b>-.5169***</b> (-40.42)	<b>-1.299***</b> (-14.10)		<b>.1621***</b> (16.41)	<b>-.2539***</b> (-9.31)
Gender*ExperienceA			<b>.00011</b> (0.14)			<b>.0155***</b> (6.21)
Gender*ExperienceB			<b>.8009***</b> (8.61)			<b>.5174***</b> (17.64)
Const.	<b>13.128***</b> (282.01)	<b>13.326***</b> (285.84)	<b>13.567***</b> (262.07)	<b>26.691***</b> (346.48)	<b>26.548***</b> (342.52)	<b>26.937***</b> (339.65)
Number of Obs.	1667894	1667894	1667894	2831849	2831849	2831849
R-squared	0.0091	0.0115	0.0115	0.0401	0.0402	0.0404

<sup>a</sup> In all regressions, coefficients are bold and t-values are in brackets. \*, \*\*, and \*\*\* denote significance at the 10%, 5% and 1% level, respectively.

**Table 4: Correlation coefficients of odds and bet sizes**

	Both Genders	Female	Male
All bets	-0.0177	-0.0239	-0.0181
Parimutual bets	-0.0544	-0.0607	-0.0553
Non-parimutual bets	-0.0138	-0.0185	-0.0141

**Table 5: Variance of bets**

	Parimutual			Non-Parimutual		
Odds	<b>-439.7*</b> (-1.71)	<b>96.3</b> (0.38)	<b>1015.9</b> (1.45)	<b>-2897.0***</b> (-4.22)	<b>2134.1***</b> (3.46)	<b>-1306.9</b> (-0.74)
Gender	<b>79422.3***</b> (5.92)	<b>78072.4***</b> (5.83)	<b>90915.8***</b> (5.61)	<b>309931.4***</b> (5.74)	<b>-578719***</b> (-11.92)	<b>-608840***</b> (-12.02)
Gender*Odds			<b>-1060.7</b> (-1.41)			<b>3922.6**</b> (2.09)
Age	<b>255.3</b> (0.86)	<b>576.1*</b> (1.95)	<b>573.0*</b> (1.94)	<b>-981.0</b> (-0.77)	<b>-1016.6</b> (-0.89)	<b>-1002.1</b> (-0.87)
ExperienceA		<b>3609.2***</b> (116.37)	<b>3608.9***</b> (116.36)		<b>43842.0***</b> (818.38)	<b>43842.5***</b> (818.38)
ExperienceB		<b>-222293***</b> (-52.53)	<b>-222333***</b> (-52.54)		<b>-833954***</b> (-80.43)	<b>-834365***</b> (-80.45)
Const.	<b>57677.9***</b> (4.33)	<b>54233.9***</b> (4.07)	<b>42899.0***</b> (2.76)	<b>38674.3</b> (0.74)	<b>297328***</b> (6.24)	<b>324183***</b> (6.57)
Observations	1667894	1667894	1667894	2831849	2831849	2831849
R-squares	0.0000	0.0005	0.0005	0.0000	0.1913	0.1913

**Table 6: Betting success (parimutual betting)**

Gender	<b>.0306***</b> (3.94)	<b>.0256***</b> (3.29)	<b>.0165**</b> (2.12)	<b>.0138</b> (1.53)
Age	<b>-.00025</b> (-1.45)	<b>-.00022</b> (-1.28)	<b>-.00064***</b> (-3.71)	<b>-.00062***</b> (-3.60)
ExperienceA		<b>.00015***</b> (8.08)	<b>.00012***</b> (6.26)	<b>.00065***</b> (4.60)
Experience B		<b>.0113***</b> (4.60)	<b>0.0096***</b> (3.86)	<b>-.0297*</b> (-1.68)
Odds			<b>-.0049***</b> (-32.97)	<b>-.0049***</b> (-32.97)
Bet Sizes			<b>.0296***</b> (2.90)	<b>.0292***</b> (2.87)
Gender*ExperienceA				<b>-.00054***</b> (-3.79)
Gender*ExperienceB				<b>.0398**</b> (2.22)
Const.	<b>-.1576***</b> (-21.09)	<b>-.1638***</b> (-21.82)	<b>-.1015***</b> (-13.09)	<b>-.0988***</b> (-11.12)
Observations	1667894	1667894	1667894	1667894
R-squared	0.0000	0.0001	0.0008	0.0008

**Table 7: Betting success (non-parimutual betting)**

Gender	<b>.0337***</b> (7.66)	<b>.0337***</b> (7.64)	<b>.0325***</b> (7.37)	<b>.0372***</b> (7.72)
Age	<b>.00025**</b> (2.41)	<b>.00026**</b> (2.51)	<b>.00016</b> (1.56)	<b>.00015</b> (1.49)
ExperienceA		<b>.000018***</b> (3.73)	<b>0.000005</b> (0.81)	<b>.00045*</b> (1.88)
Experience B		<b>.0023**</b> (2.44)	<b>.0026***</b> (2.71)	<b>.0040</b> (1.54)
Odds			<b>-.0021***</b> (-37.34)	<b>-.0021***</b> (-37.29)
Bet Sizes			<b>.0055***</b> (3.03)	<b>.0054***</b> (2.99)
Gender*ExperienceA				<b>-.00045*</b> (-1.86)
Gender*ExperienceB				<b>-.0022</b> (-0.80)
Const.	<b>-.1873***</b> (-44.20)	<b>-.1891***</b> (-44.03)	<b>-.1726***</b> (-39.97)	<b>-.1768***</b> (-38.09)
Observations	2831849	2831849	2831849	2831849
R-squared	0.0000	0.0000	0.0005	0.0005

**Table 8: Large Investors and high-frequency bettors**

	Number of bettors	Fraction of male	Number of bets	Amount (Average)	Amount (Median)	Odds	Bet size	Return
All bettors	70400	0.847	73.0	3684.9	50	8.42	50.50	-0.146
Highest amounts (1%)	704	0.966	1135.1	241535.8	109230	6.41	212.80	-0.089
Highest number of bets (1%)	702	0.913	2044.8	87951.5	29784	7.60	43.01	-0.120

**Table 3a: Odds without large investors**

	Parimutual			Non-Parimutual		
Gender	<b>-1.704***</b> (-37.82)	<b>-1.397***</b> (-31.01)	<b>-1.524***</b> (-28.46)	<b>-1.065***</b> (-20.68)	<b>-.9653***</b> (-18.70)	<b>-1.188***</b> (-19.54)
Age	<b>-.0769***</b> (-75.03)	<b>-.0765***</b> (-74.84)	<b>-.0764***</b> (-74.71)	<b>-.0059***</b> (-4.81)	<b>-.0058***</b> (-4.72)	<b>-.0062***</b> (-4.99)
ExperienceA		<b>-.1709***</b> (-74.95)	<b>-.1421***</b> (-13.67)		<b>-.0869***</b> (-30.36)	<b>.00014</b> (0.01)
ExperienceB		<b>.5621***</b> (14.34)	<b>-.3757*</b> (-1.95)		<b>.7995***</b> (23.07)	<b>-.6725***</b> (-4.73)
Gender*ExperienceA			<b>-.0296***</b> (-2.78)			<b>-.0915***</b> (-7.01)
Gender*ExperienceB			<b>.9798***</b> (4.97)			<b>1.569***</b> (10.70)
Const.	<b>10.505***</b> (174.95)	<b>11.033***</b> (182.93)	<b>11.149***</b> (169.89)	<b>3.345***</b> (34.66)	<b>3.494***</b> (35.86)	<b>3.706***</b> (36.31)
Number of Obs.	1367190	1367190	1367190	2385045	2385045	2385045
R-squared	0.0083	0.0143	0.0143	0.0354	0.0357	0.0358

**Table 5a: Variance of bets**

	Parimutual			Non-Parimutual		
Odds	<b>589.8***</b> (7.42)	<b>704.5***</b> (8.84)	<b>280.5</b> (1.32)	<b>140.5***</b> (5.65)	<b>155.4***</b> (6.25)	<b>52.4</b> (0.76)
Gender	<b>10748.4***</b> (2.56)	<b>6480.4</b> (1.54)	<b>411.7</b> (0.08)	<b>4039.1**</b> (2.01)	<b>1201.7</b> (0.60)	<b>246.9</b> (0.12)
Gender*Odds			<b>492.5**</b> (2.14)			<b>118.3</b> (1.59)
Age	<b>-302.8***</b> (-3.20)	<b>-350.6***</b> (-3.70)	<b>-349.0***</b> (-3.68)	<b>-52.6</b> (-1.11)	<b>-79.2*</b> (-1.66)	<b>-78.5*</b> (-1.65)
ExperienceA		<b>5874.9***</b> (27.56)	<b>5882.4***</b> (27.59)		<b>2465.0***</b> (22.16)	<b>2466.7***</b> (22.17)
ExperienceB		<b>-89728***</b> (-24.52)	<b>-89791.1***</b> (-24.54)		<b>-25510.6***</b> (-18.86)	<b>-25537***</b> (-18.87)
Const.	<b>4098.4</b> (0.99)	<b>3033.2</b> (0.72)	<b>8331.5*</b> (1.71)	<b>1947.6</b> (1.01)	<b>2290.3</b> (1.16)	<b>3127.8***</b> (1.54)
Observations	1367190	1367190	1367190	2385045	2385045	2385045
R-squares	0.0001	0.0007	0.0007	0.0000	0.0002	0.0002

**Table 6a: Betting success without large investors (parimutual betting)**

Gender	<b>.0276***</b> (3.36)	<b>.0231***</b> (2.81)	<b>.0158*</b> (1.92)	<b>.0109</b> (1.12)
Age	<b>-0.000009</b> (-0.05)	<b>-.000024</b> (-0.13)	<b>-.00044**</b> (-2.37)	<b>-.00044**</b> (-2.35)
ExperienceA		<b>.0029***</b> (6.95)	<b>.0019***</b> (4.41)	<b>.0029</b> (1.51)
Experience B		<b>-.0182**</b> (-2.54)	<b>-.0134*</b> (-1.83)	<b>-.0475</b> (-1.35)
Odds			<b>-.0051***</b> (-32.53)	<b>-.0051***</b> (-32.54)
Bet Sizes			<b>.0493</b> (1.20)	<b>.0490</b> (0.233)
Gender*ExperienceA				<b>-.0010</b> (-0.51)
Gender*ExperienceB				<b>.0356</b> (0.99)
Const.	<b>-.1708***</b> (-21.71)	<b>-.1768***</b> (-22.18)	<b>-.1097***</b> (-13.26)	<b>-.1052***</b> (-10.98)
Observations	1367190	1367190	1367190	1367190
R-squared	0.0000	0.0001	0.0008	0.0008

**Table 7a: Betting success without large investors (non-parimutual betting)**

Gender	<b>.0296***</b> (6.21)	<b>.0268***</b> (5.62)	<b>.0257***</b> (5.38)	<b>.0335***</b> (5.96)
Age	<b>.00025**</b> (2.25)	<b>.00029**</b> (2.53)	<b>.00019</b> (1.64)	<b>.00019*</b> (1.68)
ExperienceA		<b>.0023***</b> (8.60)	<b>.0018***</b> (6.53)	<b>.0019</b> (1.57)
Experience B		<b>-.0109***</b> (-3.39)	<b>-.0065**</b> (-1.98)	<b>.0133</b> (1.01)
Odds			<b>-.00192***</b> (-32.49)	<b>-.0019***</b> (-32.46)
Bet Sizes			<b>.0782***</b> (4.44)	<b>.0780***</b> (4.42)
Gender*ExperienceA				<b>-.00010</b> (-0.08)
Gender*ExperienceB				<b>-.0214</b> (-1.57)
Const.	<b>-.1916***</b> (-42.02)	<b>-.1960***</b> (-42.23)	<b>-.1806***</b> (-38.64)	<b>-.1879***</b> (-34.63)
Observations	2385045	2385045	2385045	2385045
R-squared	0.0000	0.0001	0.0005	0.0005