Risk-Taking in Tournaments: Evidence from Horse-Racing Tipsters*

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Abstract

In this paper, we analyze risk-taking behavior in rank-order tournaments. Using daily horse-racing prediction data made by professional tipsters involved in two tournaments with distinct rules, we find a monotonic negative relationship between interim performance and risk-taking. We also analyze the empirical derivatives of the relationship between rank and risk-taking. Consistently with the theory, we find that the strength of the relationship between rank and risk-taking depends on the distance between the ranks, and on the return of risky strategies relative to the return of safe strategies.

Keywords: Risk-Taking, Tournaments, Betting Markets.

JEL codes: J4, D81.

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1 Introduction

Relative compensation schemes are widely used to compensate workers. A vast literature, starting with Lazear and Rosen (1981) and Nalebuff and Stiglitz (1983), has modeled agents' behavior when compensation is based on relative performance instead of absolute performance. In particular, the tournament compensation system has attracted a lot of interest. In a tournament, or winner-take-all contest, several agents compete for the highest output, and the winner gains a prize set by the principal. Although the literature is mostly focused on effort choices, several studies have analyzed the incentives for risk-taking in tournaments. This issue is relevant, since, in many cases, the main strategic decision is about how much risk to take, instead of how much effort to exert. For instance, choosing between risky and safe assets is arguably the most important decision a fund manager has to make. For financial analysts and forecasters in general, risk-taking consists in making an original prediction instead of a conservative one. In rank-order tournaments, the risk-taking decisions are important because they have an impact on the variance of the output and on the probability of overtaking better ranked agents.

In this paper, we analyze two tournaments of professional horse-racing tipsters to examine the risk-taking incentives in rank-order tournaments and test a number of theoretical predictions. We use information from the two leading French horse-racing newspapers (Paris Turf and Tiercé Magazine), which organize yearly contests of professional tipsters. These tipsters publish every day a list of horses that they expect to be the most competitive during the race. Tipsters score points based on the accuracy of their predictions. We analyze the 2004 contests, for which 340 races and about 176,000 horses were tipped.

We believe that our dataset is well-suited for the analysis of risk-taking behavior in tournaments. First, it exactly represents the structure of a tournament. There is indeed a clearly defined number of contestants competing for the top ranks. All contestants know exactly who they compete with, and their relative performance is known at all time. By comparison, both the performance benchmark and relative performance are difficult to measure accurately within mutual funds. The second advantage of using tipsters data is that the information on risk-taking and interim performance is available on a daily basis. Hence, we can estimate the relationship between rank and risk-taking using appropriate dynamic panel techniques. This gives us a better estimate than by assuming that contestants adjust risk only once a year after observing their mid-year performance. Finally, we can directly observe risk-taking by measuring the distance between the forecast and the public information.[1] This implies that in our dataset risk-taking is a choice variable. By comparison, studies based on mutual funds do not observe intended risk-taking, and instead use tracking error or return volatility. This measures realized risk, which does not distinguish between intended risk and unexpected risk, due to changes in the risk of the portfolio components. In this paper, we directly measure intended risk-taking.

Interestingly, there is no theoretical or empirical consensus on the relationship between ranks and risk-taking. Bronars (1986) and Acker and Duck (2006) show that interim losers should adopt risky strategies in order to maximize the probability of reaching a good position. Interim winners, on the opposite, should take low risk in order to lock in their positions. Hvide (2002) shows that this intuitive result holds when agents have to choose both effort and risk-taking. A number of empirical findings are consistent with that prediction. For instance, Brown et al. (1996) and Goraiev et al. (2001) analyze the risk-taking behavior of mutual funds and find that interim performance is negatively related to risk-shifting. Hence, interim losers tend to adopt riskier strategies. Kempf and Ruenzi (2007) and Li and Tiwari (2006), find similar results. Interestingly, Taylor (2003) shows that bottom-ranked agents can instead end up taking less risk. He develops a model of competition between mutual funds and finds that interim performance is positively related to risk-taking. Makarov (2008) analyzes a model with several competing funds and obtains the same result. On the empirical side, Qui (2003) and Busse (2001) find that fund managers that are ranked above the median fund in their category increase total risk more than below-median funds. Nieken and Sliwka (2008) try to reconcile Bronars (1986) with Taylor (2003). They show that the sign of the relationship between interim performance and risk-taking essentially depends on the

[1] Risk-taking is measured by the distance between a forecast and the public information. We attribute a low level of originality to a forecast that is close to public information and *vice-versa*. We proxy public information by ranking -per race- each horse on his likelihood of winning the race. This likelihood is measured by a set of twelve publicly known variables such as the form of the horse, the jockey quality, etc. In doing this, we get an ordered list of horses from the most likely to win to the least likely.

correlation between the outcomes of risky strategies. If the returns of risky strategies are weakly correlated, interim losers will gamble more than interim winners. If the correlation is high,[2] and risk-taking is sufficiently rewarded, the interim winner will choose the risky strategy and the interim loser will choose the safe strategy. We find a negative relationship between risk-taking and rank, which is not surprising given the very large number of possible horses combinations.

The second objective of this paper is then to analyze, for the first time to our knowledge, the empirical derivatives of the relationship between rank and risk-taking. The goal is to test the predictions of Nieken and Sliwka (2008). They first show the importance of the distance between the ranks. When the interim loser is far behind the interim winner, s/he has no other option than to take very high risks. Hence, the relationship between risk-taking and performance is very negative when the size of the lead is large. Second, they find that the return of risky strategies relative to the return of the safe strategies affects the strength of the relationship between rank and risk-taking. When the risky strategies are relatively attractive, the leader may also take high risk, which make the impact of rank on risk-taking weaker. When the risky strategy is relatively unattractive, the leader will play safe, but the interim loser will not.

The daily nature of the data and the fact they we have two tournaments with different rules allows us to test both predictions. Consistently with the theory, we find that, in both tournaments, the relationship between rank and risk-taking is stronger when the lead is large, i.e. when it becomes difficult for bottom-ranked tipsters to gain ranks. Second, we analyze the impact of the tournament rules. One of the tournament (Tiercé Magazine) rewards risk more than the other one (Paris Turf). Consistently with the theory, we find that, when risk-taking is rewarded, both leaders and losers are induced to take risks, which weakens the relationship between rank and risk-taking.

The paper is organized as follows. Section 2 presents the data. Section 3 introduces the empirical model and hypotheses. The results are presented in Section 4, and Section 5

[2] This is the case when there is a limited number of risky strategies available. For instance, when there is just one safe stock and one risky stock to choose from, all fund managers choosing the risky strategy will obtain the same return.

concludes.

2 Data and variables

2.1 Data

The data has been collected from Tiercé Magazine and Paris Turf, the two leading French horse-racing newspapers. Tiercé Magazine and Paris Turf publish every day the predictions of professional horse-racing tipsters. There are 30 tipsters in Tiercé Magazine and 35 in Paris Turf, and all predict the same series of races. A prediction (or tip) is an ordered list of eight horses that the tipster expects to be the most competitive during the race. For instance, a {5, 6, 12, 1, 4, 3, 20, 13} tip means that the tipster expects horse #5 to finish first, horse #6 to finish second and so on. We have collected all the predictions made in 2004. Given that there is a total of 340 races, there are in total more than 176,000 horses tipped. Note that the 340 races are the same in the two contests. In each newspaper the tipsters take part in an annual contest that starts on January 1^{st} and finishes on December 31^{st}. After each race, each tipster scores a number of points based on the accuracy of the tip. On December 31^{st}, the tipster with the highest score is the contest winner and receives a sizeable prize money.

2.2 Contest rules

In Paris Turf a tipster scores points if all of the top 3 finishers are among the eight horses tipped. Additional points are scored if the tip is particularly accurate, i.e. if all of the top 4 or 5 finishers are in the tip. The points are also doubled if the tip forecasts the top finishers in the exact order. For example, consider a race involving eight horses as in Table 1. Column 1 sorts horses from first favorite to the least favorite. Consider for simplicity that tips are made of five horses, and imagine that the race result is {8, 3, 5, 1, 4} as in Column 2. Tipster 1 scores no points because he fails to include the second finisher in his tip. Tipster 2 scores 16 for predicting the top 3 finishers. The 16 points is the sum of the horses rank in the pre-race favorites list, i.e. $8 + 3 + 5$. Tipster 3 scores 32 points because the top 3 are in the exact order.

Table 1 : Paris Turf Rewards Rules

Pre-race favorites	Race Outcome	Tipster 1	Tipster 2	Tipster 3
1	8	2	5	8
2	3	1	3	3
3	5	8	6	5
4	1	6	8	6
5	4	7	7	7
6				
7				
8				
Points		0	16	32

In Tiercé Magazine tipsters are rewarded not just for accuracy, but also for risk-taking or originality. The scoring rules can be summarized as follows. First, points are scored if all of the top 3 finishers are included in the tip.[3] Second, and as in Paris Turf, additional points are scored when the race was difficult to predict (measured by the number of successful bettors). The difference with Paris Turf is that there is a third criterion that strongly rewards Tiercé Magazine's tipsters for risk-taking. Indeed, more points are scored if fewer tipsters predicted the top 3 finishers. The maximum points increase is 500% in the case no other tipster predicts the race in the right order.

In both contests there is a clear trade-off between being original and hopefully score big, or play safe and score a small amount of points with higher probability. However Tiercé Magazine's rules do induce more risk-taking, as we show in Section 2.3. Note that for bottom-ranked tipsters, tipping a longshot is the only way to make catch the leaders. The trade-off regarding the composition of the tip is therefore similar to the trade-off faced by a fund manager having to choose the composition of a portfolio.

A crucial feature of our data is that ranks become sticky with time. Figure 1 illustrates the growing rank stickiness between the first and the final race of the year for a random tipster. Figure 2 shows in the case of Paris Turf that tipsters gain or lose ranks more frequently at the beginning than at the end of the year. Tiercé Magazine follows the same pattern of growing rank stickiness. This growing stickiness will allow us to test one of Nieken and Sliwka's (2008) main prediction.

[3] As in PT, tipsters score extra points if the tip is particularly accurate, i.e. if when they include in the tip the 4^{th} and 5^{th} finishers.

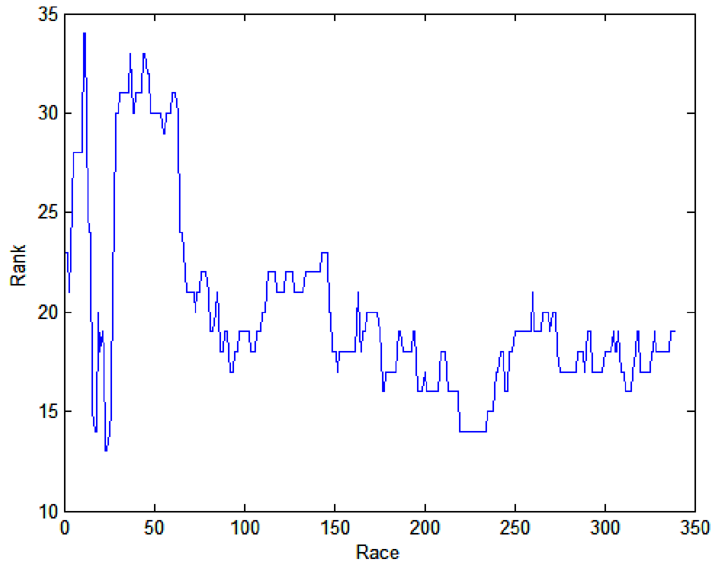


Figure 1: Example of the evolution of the rank of a given tipster (Paris-Turf).

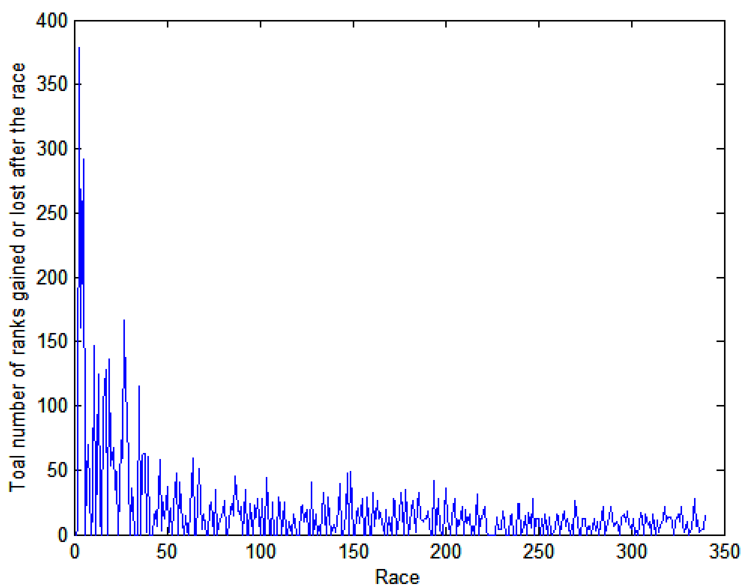


Figure 2: Total number of ranks gained of lost after each race

2.3 Measurement of risk-taking

We measure risk-taking by the distance between each prediction and public information. If, for instance, a tip includes all the pre-race favorites and no longshots, then risk-taking is minimal. Risk-taking is higher if a tip includes instead several longshots. Since we want to measure intended risk-taking, our measure has to be a choice variable. We therefore need to proxy the public information that is available to all tipsters before they make their tips. This excludes using the odds as an indication of which horses are the favorites. Indeed, tipsters release their tips the day before the race, and the odds are not revealed before the morning of the race.

In order to proxy public information, we use twelve publicly available dummy variables to estimate each horse's ability. The twelve dummy variables include whether or not the horse is suited to the track, whether or not he is on form, whether or not his jockey performs well, etc. We sum the twelve dummies and rank horses according to this statistics. This ordered list constitutes what we call consensus forecast, or public information. It is known by all tipsters, because these twelve dummies are published before tipsters make their forecasts. Naturally, this does not capture all the public information available, but this does not affect the results since we only need a measure of intended deviation from a set of publicly available variables.

Table 2 illustrates the calculation of risk-taking. We calculate the Spearman footrule distance between the forecast vector and the public information vector. Imagine that the forecast is the ordered list $\{5, 6, 1, 13, 14, 12, 9, 2\}$. The public information column shows how these eight horses are ranked in the consensus forecast. The last column is the absolute difference between the rank of the horse in the forecast and his rank in the consensus forecast. The sum of these differences (14 in this example) is our risk-taking variable.

Table 2: Measurement of risk-taking

Horse number	Rank in forecast	Rank in public information	Absolute rank difference
5	1	3	2
6	2	4	2
1	3	5	2
13	4	1	3
14	5	2	3
12	6	6	0
9	7	8	1
2	8	7	1
		Total:	**14**

This measure of originality/risk-taking depends both on the horses chosen by the tipster (favorites versus longshots) and on their respective rank in the forecast.

Table 3 displays some descriptive statistics of risk-taking. The first observation is that there is a substantial variability across races. Hence, as shown below, we control for races fixed effects in the regression. The second observation is that risk-taking is higher in Tiercé Magazine than in Paris Turf. This is consistent with the observation that the Tiercé Magazine rules reward more risk-taking.

Table 3 : Risk-taking Statistics

	Mean	S.D.	Min	Max
By tipster :				
Tiercé Magazine	30.59	1.72	28.36	35.89
Paris-Turf	28.11	1.64	27.7	34.51
By race :				
Tiercé Magazine	30.59	6.6	13.1	49.6
Paris-Turf	28.11	6.52	13.75	52.32

3 Methodology

We consider the following dynamic panel data model:

$$RT_{i,t} = \alpha + \beta RT_{i,t-1} + PERF^{'}_{i,t}\gamma + X'_{i,t}\delta + \eta_i + \nu_{i,t} \qquad (1)$$

where i denotes the tipster ($i = 1, ..., 30$ for Tiercé Magazine, $i = 1, ..., 35$ for Paris Turf), and t denotes the race ($t = 1, ..., 340$). We estimate the model for each tournament separately. $RT_{i,t}$ is the risk-taking of tipster i per horse (i.e. total risk-taking divided by the number of horses in the race) in race t. $PERF_{i,t}$ is a set of variables that measure the tipster's performance in the contest up to race t. These variables are potentially endogenous with respect to $RT_{i,t}$, since the well ranked tipsters are typically those who take fewer risks. $X'_{i,t}$ is a vector of exogenous variables and controls, η_i is an unobserved individual-specific time-invariant effect, and $\nu_{i,t}$ is a disturbance term.

Note that $T = 340$ is large and larger than $N = 30$ or 35. This has implications for the selection of an appropriate estimation technique. In this setting, the usual approaches to estimating a fixed-effects model – FE or LSDV – are known to generate a biased estimate of the coefficients. The GMM Arrelano-Bond (1991) estimator is for datasets with many panels (large N) and few periods (small T), and it is therefore not suited either. Indeed treating variables as predetermined or endogenous quickly increases the size of the instruments matrix. GMM with too many overidentifying restrictions may perform poorly. Baltagi and Griffin (2001) suggested alternative -consistent- IV approaches such as the Anderson-Hsiao (1982). The Anderson-Hsiao approach, or first-differenced 2SLS (FD-2SLS), consists in applying a 2SLS procedure to model (1) taken in first-difference. By first-differencing the data, we remove tipsters fixed-effects, and then correct for potential endogeneity of $PERF$ using the instruments that will be described below. The expanded model is:

$$\Delta RT_{i,t} = \beta \Delta RT_{i,t-1} + \gamma_{1r}\Delta RANK_{i,t} + \gamma_{2r}\Delta RANK_{i,t} \times TIME_t + \gamma_3 \Delta PTS_{i,t} \qquad (2)$$

$$+\delta_1 \Delta OCP_{j,t-1} + \delta_2 \Delta HORSEQUAL_t + \delta_3 \Delta HORSEVAR_t + \epsilon_{i,t}$$

where $RANK_{i,t}$ is the rank of tipster i at time t. A positive sign for γ_{1r} would indicate that bottom-ranked contestants take higher risk than top-ranked contestants. $RANK_{i,t} \times TIME_t$ captures the increasing/decreasing effect of rank over time. As illustrated in Figure

2, ranks become sticky over time, meaning that the gap between the top-ranked and bottom-ranked tipsters grows over time. Hence, following Nieken and Sliwka's (2008) prediction, we expect bottom-ranked tipsters to take more risk later in the year, i.e. $\gamma_{2r} > 0$. $PTS_{i,t}$ is the number of points scored since the beginning of the year, i.e. the absolute performance of the tipster up to race t. By contrast, $RANK_{i,t}$ measures relative performance. Controlling both for rank and points is justified because these variables are only weakly correlated. The γ_3 coefficient indicates, having controlled for relative performance, the impact of absolute performance on risk-taking. The final indicator of relative performance, $OCP_{j,t-1}$, is the proportion of scoring tipsters in the previous race. When $OCP_{j,t-1} = 0$ no one else scored at $t-1$, and when $OCP_{j,t-1} = 1$ all the tipsters scored at $t-1$. δ_1 therefore captures each tipster's relative performance in the previous race. This measure of contemporary relative performance would be significant when, for instance, tipsters feel pressured to score when the other tipsters did score in the previous race.

Both $HORSEQUAL_t$ and $HORSEVAR_t$ are race specific variables. The variability of risk-taking between races is quite large (minimum 0.91, maximum 2.69), which could be explained by the variability of the quality of public information. When there are for instance clear favorites, the race is relatively easy to forecast and originality is expected to be low. These variables are thus proxy quality of public information. $HORSEQUAL_t$ measures the average quality of the horses. This variable is the average score of the horses listed in the public information variable described above. When it is high, the horses are on average strong contenders. Since high quality horses are typically better known, the race outcome is less uncertain and there should be less risk-taking. Hence, we expect $\delta_2 < 0$. As for $HORSEVAR_t$, it is defined as the variance of the quality between horses. A high value indicates that there are clear favorites, which should induce less originality. Therefore, we expect $\delta_3 < 0$.

We also estimate a second version of the model:

$$\Delta RT_{i,t} = \beta \Delta RT_{i,t-1} + \gamma_{1g} \Delta GAP_{i,t} + \gamma_{2g} \Delta GAP_{i,t} \times TIME_t + \gamma_3 \Delta PTS_{i,t} \qquad (3)$$

$$+\delta_1 \Delta OCP_{j,t-1} + \delta_2 \Delta HORSEQUAL_t + \delta_3 \Delta HORSEVAR_t + \epsilon_{i,t}$$

The difference between the second version of the model and the first version is that we replace $RANK$ by GAP. The variable GAP refers to the points gap, i.e. the ratio of the leader's points on tipster's i points. The higher is the point gap, the more we expect tipster i to take risk. Hence, we expect $\gamma_{1g} > 0$. GAP offers a more precise, continuous, measure for the size of the lead than $RANK$.

The model is estimated using robust standard errors (Huber-White-sandwich estimator of variance) and a cluster on tipsters. The latter option specifies that the observations are independent across groups (clusters), but not necessarily within groups. In this panel context, it is reasonable to assume that observations on the same individual (cluster) in two different time periods are correlated, but observations on two different individuals are not.

4 Results

The results are shown in Table 4. The most significant finding is the positive coefficient for $RANK$, which indicates that tipsters become more original as they lose ranks. This result is consistent with the theoretical prediction (Bronars 1986 ; Acker and Duck, 2006) that interim winners lock in their position by relying more on the public information, and interim losers adopt riskier strategies in order to gain ranks. Interestingly, $RANK$ is positive but insignificant for Tiercé Magazine.

In order to investigate more deeply the effect of the rank, we have also run the regression by replacing $RANK$ with a series of rank dummies (30 and 35 for Tiercé Magazine and Paris Turf respectively). The results are displayed in Figures 3 and 4. The positive relationship between rank and risk-taking is obvious in both contests. Slope coefficients are significant in both graphs and the slope in the case of PT is 2.66 times steeper than in this of TM. The quality of the fit is particularly good for Paris Turf (R-squared = 67%) ; it is much weaker for Tiercé Magazine (R-squared = 32%)[4]. Note that when we replace $RANK$ with GAP, the effect remains positive as expected.

Although the two contests are similar, we have argued above that Tiercé Magazine's rules

[4] The F-test statistic for overall significance of the model is $F(1, 28) = 13.31$. The p-value for this test is 0.0011.

reward risk-taking more than Paris Turf's. Unsurprisingly, we have found (see Table 3) that Paris Turf's tipsters are indeed more conservative (risk-taking of 28.11 vs. 30.59 for Tiercé Magazine). This difference between the two contests allows us to test directly a prediction of Nieken and Sliwka (2008). They show that when the reward for risk-taking is large, taking risks is the best option not just for bottom-ranked tipsters, but for the top-ranked tipsters as well. Hence, risk-taking becomes widespread and the effect of the rank shrinks. This is exactly what we find in Table 4 and Figure 4. We therefore find direct evidence that the tournaments' rules affect the relationship between interim performance and risk-taking.

The third result is the positive coefficient for $RANK \times TIME$ ($\gamma_{2r} > 0$) which indicates that the impact of the rank is larger at the end of the tournament than at the beginning. Recall that, according to the theory, this impact of the rank should be larger when ranks are sticky. Intuitively, bottom-ranked tipsters must adopt more extreme strategies when it becomes more difficult to catch up the leaders. Early in the year, tipsters are clustered together. Late in the year there are significant gaps between tipsters and time is running out for the bottom-ranked tipsters. The positive $RANK \times TIME$ coefficient is therefore consistent with the prediction that the risk-taking differential between the ranks increases with time.

Regarding the control variables, both regressions show that the level of risk-taking increases with absolute performance (PTS). This suggests that a tipster is more likely to take risk if s/he was successful. The various endogeneity tests (see Table 5) on this variable showed that we were right to adopt a two-step estimation procedure. Indeed, not controlling for the endogeneity of this variable results in an opposite sign for this coefficient. On the opposite, the same tests rejected the hypothesis of an endogeneity of $RANK$ or GAP. This can be explained by the fact that this variable gets sticky over time, whereas risk-taking does not. All overidentification tests (Hansen J) conducted on both regressions failed to reject the null hypothesis that the instruments are valid instruments, i.e. uncorrelated with the error term $\epsilon_{i,t}$, and that the excluded instruments are correctly excluded from the estimated equations. The instrumental variables that we have used in these regressions for $\Delta PTS_{i,t}$ are $\Delta PTS_{i,t-2}$, $\Delta PTS_{i,t-3}$, $\Delta PTS_{i,t-4}$ and $RT_{i,t-2}$, $RT_{i,t-3}$, $RT_{i,t-4}$ for $\Delta RT_{i,t-1}$. Adding longer lags to this list of instruments did not improve the results and decreased the performance of the Hansen's overidentification tests. The power of our set of instruments has been tested with the Kleibergen-Paap (2006) rk Wald F statistic which is the generalization of the Cragg-Donald (1993) statistic in the presence of non i.i.d errors. The results for these different tests show that the instruments are not weak and valid.

The positive coefficient for $OCP_{j,t-1}$ (δ_1) indicates that tipsters take more risk if their competitors did well in the previous race. A possible interpretation is that tipsters feel the pressure to perform and score big points when their peers did well recently.

Table 4 : FD2SLS regressions of Risk-Taking against Performance

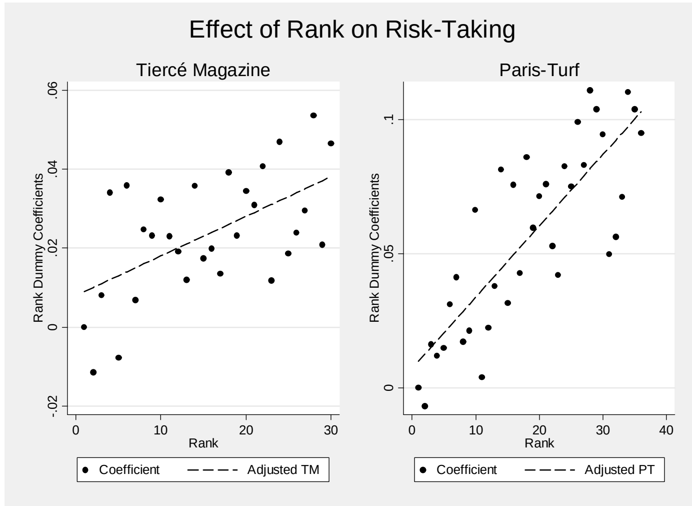
(Dependent variable : $\Delta RT_{i,t}$)

	Tiercé Magazine		Paris Turf	
$\Delta RT_{i,t-1}$	-0.0151	-0.0274*	-0.0552***	-0.0445***
	(0.0148)	(0.0147)	(0.0141)	(0.0130)
$\Delta POINTS_{i,t}$	0.00140**	0.00115*	0.0128***	0.0112***
	(0.0006)	(0.0006)	(0.0039)	(0.0031)
$\Delta RANK_{i,t}$	0.0239	-	0.0514***	-
	(0.0167)	-	(0.0188)	-
$\Delta RANK_{i,t} \times TIME_t$	0.000319**	-	0.000596***	-
	(0.0001)	-	(0.0002)	-
$\Delta GAP_{i,t}$	-	0.000424	-	0.00129
	-	(0.0004)	-	(0.0011)
$\Delta GAP_{i,t} \times TIME_t$	-	2.49e-06**	-	1.75e-05***
	-	(1.04e-06)	-	(2.83e-06)
$\Delta OCP_{j,t-1}$	0.205***	0.203***	0.216***	0.226***
	(0.0267)	(0.0294)	(0.0270)	(0.0252)
$\Delta HORSEVAR_t$	-0.427***	-0.424***	-0.347***	-0.351***
	(0.0170)	(0.0131)	(0.0230)	(0.0202)
$\Delta HORSEQUAL_t$	-0.0418***	-0.0438***	-0.0396***	-0.0420***
	(0.0067)	(0.0065)	(0.0078)	(0.0074)
Constant	-0.0552**	-0.0599*	-0.135***	-0.140***
	(0.0229)	(0.0326)	(0.0414)	(0.0372)
Observations	9893	9893	11585	11585

*** p<0.01, ** p<0.05, * p<0.1 ; Robust standard errors in parentheses, cluster on tipsters.

Excluded instruments : $\Delta PTS_{i,t-2}$, $\Delta PTS_{i,t-3}$, $\Delta PTS_{i,t-4}$, $RT_{i,t-2}$, $RT_{i,t-3}$, $RT_{i,t-4}$

Finally, the two race information variables, $HORSEQUAL$ and $HORSEVAR$, are as



expected negative and highly significant. δ_2, the $HORSEQUAL$ coefficient suggests that good horses are better known by the tipsters, which leads to less uncertainty on the race outcome, and less risk-taking. δ_3 the $HORSEVAR$ coefficient indicates that tipsters become more conservative when there are strong favorites in the races.

Table 5: Endogeneity and overidentification tests

	Tiercé Magazine		**Paris Turf**	
	RANK	*GAP*	*RANK*	*GAP*
Endogeneity tests (C-statistic):				
POINTS	5.870	4.627	8.785	8.197
	(0.0154)	(0.0315)	(0.0030)	(0.0042)
RANK or GAP	2.010	0.210	3.477	0.497
	(0.1562)	(0.6469)	(0.0622)	(0.4808)
Hansen's overidentification test	2.962	2.830	4.599	4.684
	(0.5643)	(0.5867)	(0.3309)	(0.3213)
Weak identification test:				
Kleibergen-Paap rk Wald F statistic	32.451	74.661	10.171	17.488
Relative Bias*	<5%	<5%	<10%	<5%

* We refer here to the Stock and Yogo (2005) weak ID test critical values

5 Conclusion

Using high frequency data on professional horse racing tipsters coming from two distinct tournaments, we have analyzed the risk-taking behavior in rank-order tournaments. The tipsters participate to an annual contest and are ranked on the basis of the accuracy of their tips. We find that performance affects the level of risk taken by the tipsters. Specifically, bottom-ranked tipsters increase their level of risk in order to catch the leaders. We also test two theoretical predictions on the derivatives of the relationship between rank and risk-taking. Consistently with the theory, we find that the strength of the relationship between rank and risk-taking depends on the size of the lead. Indeed, the risk adjustment of bottom ranked tipsters is stronger when the gap that separates them from the leader grows. Finally, we find that the relationship between rank and risk-taking depends on the return of risky strategies relative to the return of safe strategies. When the return of risky strategies increases, high risk-taking is the best option of all contestants and the relationship between rank and risk-taking flattens.

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