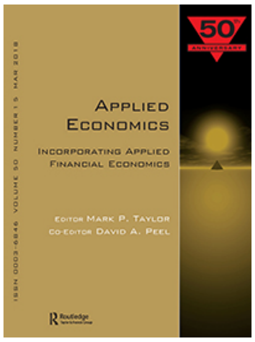

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The contingent effect of social capital on performance of professional athletes: life cycle stages and changes in regulation as moderators

Nobuya Fukugawa

Graduate School of Engineering, Tohoku University, Sendai, Japan

ABSTRACT

Motorboat racing is a sport organized as public gambling in Japan. As well as physical strength and driving technique, skills to adjust equipment are critical for racers to win a race. Based on the contingency theory of social capital, this study analysed comprehensive panel data of motorboat racers and revealed that bonding and bridging social capital had different impacts on performance according to life cycle stages of racers and changes in regulation. First, bonding social capital has a positive impact on performance when racers are less experienced and most need psychological aid stemming from strong ties. Second, bridging social capital has a positive impact on performance when racers are more experienced and have accumulated absorptive capacity to learn efficiently from diverse sources of knowledge. Third, both bonding and bridging social capital lose their explanatory power after the changes in regulation that shifted ownership of propellers from racers to the authority, which could mitigate the significance of the formation of small groups among racers to share cost and knowledge regarding the improvement in propellers. Research and managerial implications of the findings are discussed.

KEYWORDS

Social capital; contingency theory; social networks; sports; performance analysis; knowledge spillovers; Japan; motorboat racing; panel data; public gambling

JEL CLASSIFICATION

L83; Z13; C23

I. Introduction

Economic agents are embedded in social structures, networks, and relationships, be they formal or informal. Examples include nations, local communities, industrial clusters, trade associations, labour contracts, friends, and families. Some characteristics of the networks generate social capital, thereby enabling economic agents to extract benefits in the form of access to information about new opportunities and resources as well as psychological aid (Abell, Crouchley, and Mills 2001; Davidsson and Honig 2003). Thus, social capital is considered to compensate for limited internal resources of economic agents, and there is a consensus that social capital has positive effects on performance at micro (individual or firm), meso–macro (industrial or regional), and macro (social) levels (Tsai and Ghoshal 1998; Bjørnskov 2012; Laursen, Masciarelli, and Prencipe 2012a). One of the important streams in recent research on social capital is the contingency theory that considers several moderators affecting the impacts of social capital on performance, such as technological regimes and phases of growth or development (Gabbay 1997; Coviello 2006; Elfring and Hulsink 2007). This concept highlights that different types of social capital exert different effects on performance according to circumstances economic agents are in.

In sport studies, a growing number of papers addressed how sport could contribute to generating social capital, leading to social cohesion (Nicholson and Hoye 2008; Numerato 2008; Persson 2008; Seifried and Clopton 2013; Marlier et al. 2014; Okayasu, Kawahara, and Nogawa 2015; Yamamura 2015), including a 'dark side' of social capital (Numerato and Baglioni 2012). In this context, the impact of social capital on performance appears to be important for the analysis of professional athletes in individual sports because they would find benefits from social capital more valuable than those in team sports where social capital is likely to be developed spontaneously. Furthermore, previous research suggests that the impact of social capital on performance of professional athletes can be moderated by other factors. In this regard, there have been no empirical studies examining how internal and external factors moderate the relationship between social capital and performance of professional athletes in

CONTACT Nobuya Fukugawa fukugawa@tohoku.ac.jp Graduate School of Engineering, Tohoku University, Sendai, Japan

individual sports. This study attempts to fill such a research gap.

Taking motorboat racers in Japan as a sample occupation, this study adopts the contingency theory of social capital to analyse how the relationship between social capital and performance of professional athletes in individual sports is affected by internal and external factors. Specifically, this study establishes comprehensive panel data of motorboat racers and examines determining factors in racers' performance, focusing on not only physical factors like reflexes, but also social capital, such as small groups to share knowledge about driving strategies and costs of investment for the improvement in propellers. This study employs two proxy variables for social capital which represent the concept of bonding and bridging social capital, respectively. One proxy variable (*douki*: the number of racers who graduated from the training institute in the same race season) is associated with bonding social capital conducive to psychological aid, which is most needed by inexperienced racers, coming from homogenous networks that are rich in strong ties. Another proxy variable (*shibu*: the number of racers in the same regional division) is associated with bridging social capital which is helpful to the efficient transfer of novel information coming from diverse networks where weak ties are likely to develop. The impact of bonding and bridging social capital on performance can be contingent on internal and external factors. This study incorporates two moderators, life cycle stages of racers (internal factor) and changes in regulation (external factor), to examine the impacts of different types of social capital on performance under different environments.

The remainder of this article is organized as follows. Section II reviews previous literature on the investment into networks, social capital formation, and the return to social capital. Hypotheses are developed in light of the arguments of the relationship among network characteristics, social capital, and performance. Section III describes the data, variables, and a regression model employed for empirical analysis. Section IV shows empirical results. Section V connects findings to the previous literature and interprets what this study adds to the understanding of the relationship between social capital and performance. Section VI concludes the article and refers to agenda of future research. Basics about motorboat racing in Japan are summarized in the Appendix.

II. Hypotheses

Network characteristics and social capital

Social capital is formed through networks and accrues returns as a result of investment. Previous studies discuss which aspects of networks generate social capital (Gulati, Lavie, and Madhavan 2011; Stam, Arzlanian, and Elfring 2014) and identify several elements influential in social capital formation: resources held by network contacts, types of interactions, and the position in a network. First, social resource theory argues that resources embedded in a network affects social capital that one can extract from the network (Lin, Vaughn, and Ensel 1981; Lin 2001). A network comprising heterogeneous individuals with different backgrounds enables network contacts to establish a timely access to necessary resources (Birley 1985). Diverse networks also enable network contacts to learn from various types of sources of knowledge. However, other studies grounded in the concept of absorptive capacity (Cohen and Levinthal 1990; Hansen 1999) highlight the value of homogeneous networks. They argue that knowledge sharing is difficult when network contacts share little recognition on the issue (Nahapiet and Ghoshal 1998) and demonstrate a greater disparity in absorptive capacity (Han, Han, and Brass 2014). Others argue that homogeneity in terms of technological and commercial capabilities among firms makes collaborations for cost sharing reasonable (Irwin and Klenow 1996), taking an example of SEMATECH, a consortium formed by a number of large semiconductor companies to save investment cost into physical and R&D assets (Irwin and Klenow 1996). SEMATECH enabled participating firms to conduct product development that otherwise could not have been initiated.

Second, some studies consider networks as a cluster of personal interactions and connect different types of interactions (i.e. dense and sparse interactions) to different types of social capital formation. On the one hand, Granovetter (1973) argues in his seminal paper that weak ties lead to innovations and discrete changes in professional life (e.g. job change). This is because links to people from distant social circles tend to bring novel information and diverse knowledge to the network contact. On the other hand, Granovetter also emphasizes that strong ties formed among socially proximate individuals facilitate embeddedness in a network, promoting transfer of tacit knowledge (Granovetter 1985; Uzzi 1997). Unlike weak ties that enable one to establish access to novel information, strong and homophilous ties increase availability of extant resources (McPherson, Smith-Lovin, and Cook 2001; Batjargal 2003). However, some studies argue that excessively embedded ties may deter innovation as they tend to be exclusive and reduce the accessibility to new knowledge (Grabher 1993; Portes and Sensenbrenner 1993).

Third, other studies consider that the position in a network affects social capital formation of network contacts through either competition or cooperation. Burt highlights that mediating exchanges between network contacts who are not directly connected increases timely access to, and control over, external resources (Burt 2005). Such a unique network contact which links others that otherwise would have been fragmented in the network has been termed as a bridge (Harary, Norman, and Cartwright 1965, 158). Burt refers to a bridge as a structural hole and emphasizes that occupying a structural hole accrues competitive advantage to the network contact, adding social capital to network contacts (Burt 1988, 1992; Batjargal 2010). In contrast, grounded in exchange theory (Blau 1964), Coleman considers cohesive networks in which network contacts are directly connected and structural holes are absent as a source of social capital (Hansen 1999). His theory of network closure highlights that closed networks and redundant ties generate trust, social support, and norms of reciprocity that enable collaborations among network members (Coleman 1988, 1990; Obstfeld 2005). Based on a comparison between structural holes and network closure, Kogut (2000) classifies benefits extracted from networks into 'Burt rent' and 'Coleman rent', which represent social capital associated with different types of network structures.

These views of network characteristics (i.e. heterogeneous and homogenous resources, weak and strong ties, and structural holes and network closure) as a source of social capital are not mutually exclusive, but intertwined with each other. Weak ties are associated with structural holes in that they imply non-redundant networks promoting innovation because of the efficient transfer of novel information and better access to diverse resources. Coleman's argument implies that homogenous networks among socially proximate individuals, characterized as strong and overlapping ties, are advantageous in the transfer of tacit knowledge, which plays a key role in innovation. These intertwined views on network characteristics accruing social capital can be integrated into bonding and bridging social capital (Oh, Chung, and Labianca 2004; Oh, Labianca, and Chung 2006). Bonding social capital refers to the ability of individuals to extract benefits from resources embedded in an internal network, which is rich in strong, overlapping ties among socially proximate individuals and characterized by few structural holes. Bridging social capital refers to the ability of individuals to extract benefits from resources embedded in an external network, characterized by a wide range of connections across diverse boundaries and rich in global structural holes. They bring about different types of benefits to network contacts: bonding social capital provides psychological aid while bridging social capital facilitates access to novel information.

The contingency theory

As previous literature suggests, the relationship between network characteristics and social capital formation is not linear (Lechner, Frankenberger, and Floyd 2010). On the one hand, excessively diverse resources in a network may imply a greater knowledge disparity which makes knowledge sharing, and thus innovation, difficult. On the other hand, excessively embedded ties may deter innovation as they tend to be exclusive and reduce the accessibility to new knowledge. Therefore, different network characteristics can have different impacts on performance of network contacts. This confirms inconclusive empirical findings about types of social capital accruing positive returns. Some studies provide statistical evidence supporting Burt rent and positive impacts of weak ties (Baum, Calabrese, and Silverman 2000; Shane and Cable 2002) while other studies support Coleman rent and positive impacts of strong ties (Krachhardt 1992; Ahuja, 2000; Godoe 2000). In fact, some studies stress that it is important for firms' survival and innovation to take a balance of arm's-length and embedded ties (Uzzi 1996; 1997), of weak and strong ties (Ruef 2002), and of closure and bridging ties (Baum, McEvily, and Rowley 2012).

Theoretical and empirical attempts have been made to understand seemingly conflicting findings in an integrated manner. March (1991) argues that strong ties are advantageous in the exploitation of existing knowledge while weak ties are advantageous in the exploration of new knowledge. Hansen (1999) argues that contradictions in the existing network literature are recognized as compatible when the types of knowledge searched and transferred are considered. Elfring and Hulsink (2003) argues that new technology-based firms need to develop strong and weak ties according to entrepreneurial phases (i.e. discovering opportunities, securing resources, and establishing legitimacy) and innovation environment (i.e. radical or incremental). In sum, opposing views are not necessarily conflicting, but play different roles (Burt 2000).

These arguments provide a basis for the contingency theory taking account of moderators affecting how social capital impacts on performance under different settings. First, some studies argue that the impact of social capital on performance changes as firms and individuals grow (Gabbay 1997; Coviello 2006; Elfring and Hulsink 2007). Hite and Hesterly (2001) indicate that cohesive networks and strong ties are complementary to performance in the emergence period of new firms while sparse networks and weak ties are complementary to performance in the early growth period of new firms. Rothaermel and Deeds (2004) show that characteristics of affiances (i.e. exploitative or explorative alliances) affect technical and commercial success in innovation of biotechnology start-ups, but such effects become insignificant as start-ups grow. Second, other studies consider that technological regimes and industrial contexts firms are in influence whether strong or weak network relationships enhance firm performance. Rowley, Beharens, and Krackhardt (2000) show that strong ties and cohesive networks are complementary to performance in the exploitative environment, such as the steel industry, while weak ties are complementary to performance in the explorative environment, such as the semiconductor industry. Third, the impact of social capital on performance can be moderated by the phase of economic development as well. In emerging economies with the absence of a reliable government and established rules of law, firms will have to rely more on strong ties to procure resources and protect their property from arbitrary extortion or expropriation (Xin and Pearce 1996). In contrast, in established economies, reliable information is abundant and publicly available through impersonal channels, enabling network contacts to rely on weak ties (Uzzi 1997; Luo 2003).

Impacts of social capital on performance under different environments

In light of discussions above, this study sees bonding and bridging social capital as key determinants of performance of motorboat racers and examines the contingency theory where different types of social capital are expected to have different impacts on performance in different circumstances.

This study introduces two proxy variables for bonding and bridging social capital: *douki* and *shibu*. *Douki* is the number of active racers who graduated from the training institute in the same race season. This is considered as a proxy variable for social capital for the following reasons. The most distinctive feature about motorboat racing is that no racers had experienced motorboat racing before the entrance to the training institute. This makes a clear contrast to other sports where athletes normally have experiences in that sport before they become professional, such as at schools and clubs. Thus, racers learn everything from scratch at the training institute. This makes mutual learning among trainees important for the improvement in skills of racers, of which impact should be increasing with the number of trainees who entered the institute in the same race season. Another important fact that makes motorboat racing unique is that this sport event is organized as public gambling. To eliminate the leakage of insider information, during the race, racers are secluded in a racecourse and not allowed to carry on communication devices, such as cell phones, to accommodation facilities. Similarly, the trainees are kept isolated during the training period and restricted to make contact with an external world, which definitely incubates close ties among the trainees.

Therefore, *douki* is considered as a network comprising homogenous contacts densely connected by overlapping ties, facilitating bonding social capital. Such network characteristics are conducive to a higher level of psychological aid which is most needed by inexperienced racers. In light of the contingency theory, the impact of *douki* on performance is considered to be higher when racers have less race experiences. Therefore, it is hypothesized that

H1: Experience negatively moderates the relationship between bonding social capital (*douki*) and performance.

Another proxy variable for social capital is the number of active racers in the same regional division (*shibu*). After graduating from the training institute, racers are assigned to a specific *shibu* among 18 regional divisions and most racers choose a *shibu* which is the closest to their hometown. More colleagues, including senior racers, at a *shibu* could imply a larger and more diverse spillover pool for racers to learn from various types of racers in terms of experiences and skills. This would facilitate acquiring novel information on adjustments of equipment and driving technique, and sharing extant information on characteristics of racecourses and strategies according to racecourses. Such a diverse source of knowledge is beneficial as racers are assigned to races held all over Japan and have to prepare equipment and adopt driving strategy according to racecourses which greatly vary in terms of location and natural conditions.

Therefore, *shibu* is associated with bridging social capital, enabling racers to learn from a pool of knowledge heterogeneous in terms of skills and to acquire novel information on driving technique and strategies, preparation for equipment according to characteristics of racecourses. Such benefits from networks would be greater when racers are more experienced because discovering, evaluating, assimilating, and exploiting novel knowledge requires one to accumulate a certain level of absorptive capacity (Cohen and Levinthal 1990). Therefore, it is hypothesized that

H2: Experience positively moderates the relationship between bridging social capital (*shibu*) and performance.

Before April 2012, racers were allowed to own propellers, transform them using tools before and during the race day, and select the best one for the race (see Appendix). After the changes in regulation, propellers are owned by the Japan Motorboat Racing Association (JMRA) and randomly allocated to racers before every race starts. The improvement in propellers requires investment into physical assets like a workshop. As it is difficult for novice racers to bear the costs of investment, they normally participate in small groups to share the cost. Furthermore, taking part in small groups enables novice racers to share knowledge about driving technique, racecourses, and race strategy as they are exposed to diverse sources of knowledge in the group. Such a small group can be associated with both bonding and bridging social capital as participants can be racers from both *douki* and *shibu*. The abolishment of propeller ownership could have made small group formation irrelevant to performance improvement. If the formation of small groups is closely associated with either bonding or bridging social capital, changes in regulation could have negatively affected the relationship between social capital and performance as racers were not motivated to invest their time and effort into such a network after the changes in regulation. Regarding bridging social capital conducive to knowledge sharing, it is hypothesized that

H3: The changes in regulation negatively moderate the relationship between bridging social capital (*shibu*) and performance.

As previously stated, homogeneity in terms of technological and commercial capabilities among firms makes collaborations for cost sharing reasonable (Irwin and Klenow 1996). Social capital stemming from this type of network enables network contacts to make an investment that otherwise could not have been initiated. If small groups are associated with bonding social capital conducive to cost sharing, the changes in regulation could have negatively affected the relationship between bonding social capital and performance. However, the significance of psychological aid through bonding social capital would not be affected by the changes in regulation. Such a mixed effect would make the moderating effect of changes in regulation on the relationship between bonding social capital and performance statistically insignificant. Therefore, it is hypothesized that

H4: The changes in regulation do not affect the relationship between bonding social capital (*douki*) and performance.

III. Method

Data

The JMRA discloses the latest information of all active racers before each race season starts, so that bidders can understand the characteristics and recent performance of each racer. Based on this information, I have established unbalanced panel of all active racers, from May 2001 to April 2017, which includes 32 race seasons (=2*16. See Appendix for the organization of the race.) and 2408 racers. The panel is unbalanced because some racers retire while others enter after graduating from the training institute.

Performance indicator

It is reasonable to measure performance of racers using their revenue from winning a race. The economic value of winning a race significantly varies according to race grades (see Appendix). It is impossible from the publicly available data to know which racer was assigned to which race. There is, however, a clear association between racers' tiers and race grades in which racers are likely to participate. Every race season, all racers are newly classified into four tiers according to their performance in the previous race season. The top tier is called A1. Candidates for A1 must participate in at least 90 races, hold false starts and disqualifications at most 0.7% of the races they participated in, rank second or higher in 30% of the races they participated in, and rank third or higher in 40% of the races they participated in. Among such candidates, racers with top 20 percentile winning rate are classified into A1. Needless to say, A1 racers are the most popular among bidders, and thus are assigned by the JMRA to more races and races with higher prize. Average A1 racers participate in 102 races (maximum value = 196) in a race season while average B2 races are assigned to 51 races. Only A1 racers are allowed to participate in SG and G1. A2 and B1 are tiers where less demanding thresholds are adopted. Among candidates for each tier, racers with next 20 and 50 percentile winning rates fall into A2 and B1, respectively. The rest of the racers are classified into B2. B2 racers are assigned to exclusively general races. New graduates from the training institute have to start from B2. Injured racers and those who were disqualified due to false starts and serious violation of regulation will not be assigned to any race for a while, which could cause a drastic change in tier in the next race season. Therefore, dummy variables representing four ties are incorporated into the regression model.

Figure 1 shows the distribution of wins in any grade of races in a race season. This study employs the number of wins in any grade of races as a dependent variable for two reasons. First, racers can earn revenue by winning races other than a final. There are a number of races, e.g. qualifying sessions and semi-finals, before a final is held. An average racer joins 101 races in a race season (6 months) as shown in descriptive statistics. It is true that the amount of prize of other races than a final is even smaller. However, stacking such a prize could compensate a significant proportion of their total income, even if they cannot win in a final during a race season. Second, as shown in descriptive statistics, the number of wins in any grade of races is not characterized by excess of zeros, and thus can be analysed using a negative binomial regression model. This makes it possible to employ panel technique which cannot be addressed by a zero-inflated negative binomial

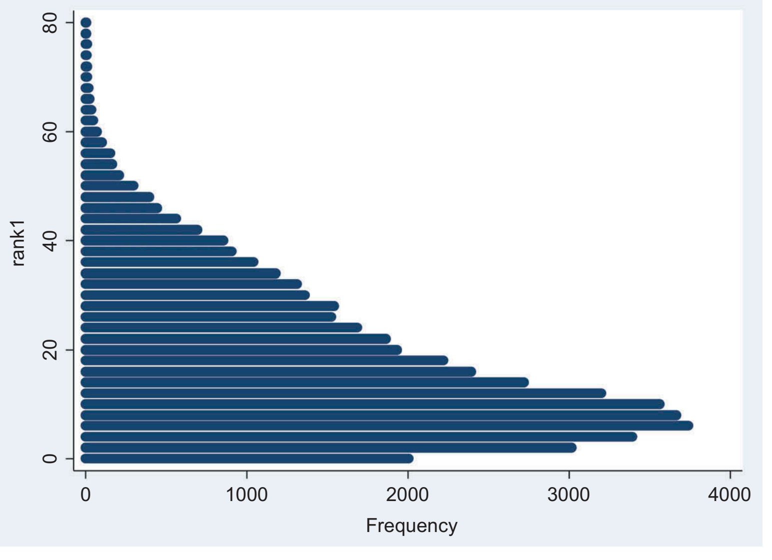

Figure 1. The number of wins in any grade of races in a race season: May 2001– April 2017.

regression model, which is appropriate when using the number of wins in a final.

Estimation strategy

This study employs a negative binomial regression model for estimation because of the characteristics of count data available for this study with over-dispersion.[1] Performance is measured at the racer level while social capital is measured at the temporal (*DOUKI*) and regional (*SHIBU*) level. Therefore, clustered SEs are computed for estimation. The regression model is presented as

$$\begin{aligned} Y_{it} = \alpha + \beta_1 EXP_{it} + \beta_2 EXP_{it}^2 + \beta_3 SCOCAP_{it} \\ + \beta_4 SOCAP_{it}^2 + \beta_5 EXP_{it} * SOCAP_{it} \\ + \beta_6 CTRL_{it} + u_i + v_t + \varepsilon_{it} \end{aligned} \quad (1)$$

where Y denotes the number of wins in any grade of races of a racer, i, in a race season, t. Performance is assumed to be determined through racers' experience (*EXP*) and its quadratic term (EXP^2), social capital (*SOCAP* consisting of *DOUKI* and *SHIBU*), quadratic terms of social capital ($SOCAP^2$), interaction terms between experience and social capital variables (*EXP*SOCAP*), and control variables (*CTRL* consisting of *START, FLYING, WEIGHT, WEIGHT*^{2}, racer tier dummies, time dummies, and region dummies). Unobservable time-invariant individual effects (u) refer to personality, such as mental toughness. Unobservable time effect (v) refers to exogenous shocks to all racers, such as a change in climate, which are controlled for by time dummies.

Independent variables

As explained in the Appendix, there are three key capabilities of racers to win the race: to reach the starting line just in time; to turn the first corner quickly in the first lap; and to appropriately adjust engines and propellers. First, making the best start is one of the critical factors for the racers to win the race. The independent variable to describe this factor is time to reach the starting line (*START*). The smaller the value is, the more likely the racer will win the race. Therefore, negative coefficients are predicted for this variable.

Second, no data are available to directly measure driving technique to turn a corner quickly, which is the second critical factor in winning the race (see Appendix for this reason). However, it is reasonable that as racers are more experienced, they will learn to turn a corner more skilfully. A driving technique called monkey turn enables racers to turn a corner without slowing down the speed. Meanwhile, this technique risks turnover of the boat when turning the corner and unpredicted accidents further caused by the followers rushing into the corner. Turnover in the race could be lethal as the racer who is thrown out of a boat could be hit by the body or propellers of following boats when the racer flows on water. It has been considered too dangerous to teach inexperienced trainees a monkey turn at the training institute, and trainees had been prohibited to attempt a monkey turn during the training period, though teaching this driving technique has recently been allowed in the training institute only for highly talented trainees. Thus, the only way for the racers to acquire this skill has been to accumulate experiences in actual races and personal training after graduating the training institute. Therefore, I incorporated into the regression model the number of race seasons since the graduation from the training institute (*EXP*) as a proxy variable for capabilities to turn a corner quickly. To examine a non-linear relationship, a quadratic term (EXP^2) is added to the regression model. Another proxy variable to represent driving technique is the number of races that the racer recorded premature starts (*FLYING*). As driving technique improves, racers are able to make a better start and a quicker turn without taking risks of premature starts and disqualification due to turnover.

Social capital variables

Third, as discussed in Section II, a proxy variable for bonding social capital is the number of active racers who graduated from the training institute in the same race season (*DOUKI*). *Douki* is considered to provide novice racers psychological aid, which would improve their performance because mental toughness, which cannot be operationalized in the

[1]Comparisons between conditional means and variances reveal that over-dispersion is present, which means that a negative binomial model is preferable to a Poisson model. Descriptive statistics are provided in Table A1.

data, is another critical factor for racers to win the race. A proxy variable for bridging social capital is the number of active racers in the same regional division (*SHIBU*). It is not possible from the data to identify a *shibu* with which each racer is affiliated. Thus, it is assumed that racer's hometown, which is available from the data, is identical to a prefecture where his or her *shibu* is located. If there are no regional divisions in racers' hometown, it is assumed that the racer would choose a *shibu* which is the closest from their hometown and the largest in terms of size. For instance, racers from Hokkaido are assumed to be affiliated with Tokyo division. I confirmed that this assumption was appropriate by referring to information disclosed at the JMRA's website on regional divisions with which racers who are from prefectures without racecourses are affiliated. To examine a non-linear relationship, quadratic terms ($DOUKI^2$ and $SHIBU^2$) are added to the regression model.

In the light of the contingency theory highlighting different impacts of social capital on performance under different conditions, interaction terms between experience and social capital are added to the regression model. As H1 suggests, *EXP*DOUKI* is expected to have negative coefficients because the value of strong and overlapping bonds formed among homogenous individuals is higher when racers are less experienced and most need psychological aid. As H2 suggests, *EXP*SHIBU* is expected to have positive coefficients because mutual learning among peers with a different level of skills and experiences are more effective when racers are more experienced and retain sufficient knowledge about the adjustments of equipment and characteristics of racecourses. A quadratic term of social capital variables is introduced to the regression model to test a non-linear relation between social capital and performance (McFadyen and Cannella 2004; Laursen, Masciarelli, and Prencipe 2012b; Growiec and Growiec 2014).

Control variables

Three binary variables representing A1, A2, and B1 are included the regression model to control for variations in economic value of races in which the racer is likely to participate (*A1*, *A2*, and *B1*). It is clear that lighter racers are advantageous, which suggests certain advantages held by female racers against male racers, other things being equal. Weight, therefore, is used as a time-variant control variable (*WEIGHT*). To examine a non-linear relationship between weight and performance, a quadratic term of weight ($WEIGHT^2$) is added to the regression model. Table A1 shows descriptive statistics and Table A2 shows correlation matrix.

IV. Results

Table 1 shows estimation results by gender. All the models show that racers' experience curve is non-linear. Specifically, race experience has a positive effect on performance until it reaches at a specific threshold while it exhibits a negative effect on performance beyond the threshold. Models 2 and 3 show that the threshold for male racers is approximately 65 race seasons (=6097/(2* 47)) while it is 50 (=6278/(2* 63)) for female racers. This means that, other things being equal, a new male graduate from the training institute, at 19 years old in many cases, could improve performance till approximately 52 years old (=19 + 65/2). This clearly demonstrates the characteristics of motorboat racing as a sport in which relatively old athletes remain active. In fact, there is a 70-year-old male racer (more than half century-long experiences!) and a 57-year-old female racer, as of 2017.

The results show that bonding social capital (*DOUKI*) exhibits positive effects on performance in most models. The quadratic term of bonding social capital has negative coefficients in many models. This means that the relationship between bonding social capital and performance is inverse U-shaped. Specifically, the performance-improving effect of bonding social capital lasts 57 race seasons (=5872/(2*52)) in the case of male racers. As shown in Table A1, race experience of male racers ranges from 1 to 111 and the mean is 31. Therefore, the performance improvement effect of bonding social capital persists beyond the period of a rookie. This suggests the possibility that psychological aid coming from bonding social capital remains important for racers with a certain level of experience, too. Another interpretation is that *douki* acts as a source of bonding social capital which provides psychological aid in the initial phase of racers' growth and gradually changes its nature so as to offer different benefit to experienced racers. Coefficients of

Table 1. Estimated fixed-effects negative binomial regression models (dependent variable = the number of wins in any grade of races).

	1 All	2 Male	3 Female	4 All	5 Male	6 Female
N	47,892	43,006	4885	47,892	43,006	4885
Experience	0.060**	0.061**	0.063**	0.033**	0.033**	0.039**
	0.002	0.002	0.009	0.001	0.001	0.004
Experience^2	−0.047**	−0.047**	−0.063**	−0.033**	−0.033**	−0.047**
	0.001	0.001	0.005	0.001	0.001	0.003
Douki	0.055**	0.059**	0.060†			
	0.006	0.007	0.033			
Douki^2	−0.050**	−0.052**	−0.109†			
	0.011	0.011	0.057			
*Experience*Douki*	−0.071**	−0.075**	−0.072**			
	0.005	0.005	0.024			
Shibu				0.002**	0.003**	−0.002
				0.001	0.001	0.002
Shibu^2				−0.089**	−0.097**	0.050
				0.020	0.020	0.081
*Experience*Shibu*				0.057†	0.067†	−0.008
				0.035	0.036	0.141
Start	−0.048**	−0.051**	−0.028**	−0.048**	−0.050**	−0.028**
	0.001	0.001	0.003	0.001	0.001	0.003
Weight	0.114**	0.203**	−0.013	0.111**	0.200**	−0.007
	0.020	0.024	0.066	0.020	0.024	0.066
Weight^2	−0.001**	−0.002**	−0.000	−0.001**	−0.002**	−0.000
	0.000	0.000	0.001	0.000	0.000	0.001
Flying	−0.069**	−0.071**	−0.042**	−0.068**	−0.071**	−0.042**
	0.003	0.003	0.010	0.003	0.003	0.010
A1	1.980**	1.890**	2.305**	2.011**	1.924**	2.319**
	0.017	0.018	0.046	0.017	0.018	0.046
A2	1.713**	1.631**	1.967**	1.736**	1.657**	1.978**
	0.016	0.018	0.044	0.016	0.018	0.044
B1	1.250**	1.174**	1.475**	1.266**	1.193**	1.480**
	0.016	0.017	0.041	0.016	0.017	0.041
_cons	−2.025**	−4.352**	0.811	−0.863	−3.106**	1.492
	0.549	0.669	1.689	0.542	0.665	1.622

Level of statistical significance: ***p* < 0.01; * *p* < 0.05; † *p* < 0.1.
SEs are under coefficients.
The results of time dummies and regional dummies are not reported.

bonding social capital and their interaction terms with experience take predicted signs, which is significantly negative. This implies that bonding social capital positively affects racers' performance when they are inexperienced, and thus most need for psychological aid coming from strong bonds among peers with shared background. Therefore, the results lend support to H1.

Bridging social capital (*SHIBU*) exhibits positive effects on performance in the models for all racers and male racers. The quadratic term of bridging social capital has negative coefficients in those models. This means that the relationship between bridging social capital and performance is inverse U-shaped. In the models for all racers and male racers, coefficients of bridging social capital and their interaction terms with experience take predicted signs, which is significantly positive. This implies that bridging social capital facilitates the transfer of novel information from diverse spillover pool, and this effect becomes prominent as racers become more experienced and have accumulated absorptive capacity to exploit knowledge spillovers. However, such a relationship does not hold true for female racers. Therefore, the results lend partial support to H2.

The results provide robust evidence that making a good start (*START*) is critical for winning a race, while making a premature start (*FLYING*) decreases the probability of winning a race. Regarding the results of premature start, one may think that attempting to cross the starting line too fast may increase the risk of making a premature start which deteriorates performance. However, within the sample in the same race season, there is no significant correlation between the two. This implies that racers who make a good start and those who make a premature start are different groups. Skilful racers appear to be well-trained so as to cross the starting line at full speed without making a premature start.

It is no wonder that the results of male racers exhibit little difference with those of all racers as most of the racers are male. Contrary to the results of bonding social capital, bridging social capital turns out to be unimportant for the improvement in female racers' performance. This finding suggests the possibility that small groups creating bridging social capital to share knowledge and cost to improve propellers tend to be formed exclusively by male racers. If this is the case, as female ratio is approximately 10%, female racers might have been deprived of opportunities to form this type of social capital. Therefore, the result does not necessarily suggest the absence of positive impacts of bridging social capital on female racers' performance. In fact, the result may indicate that female racers are exposed to less opportunities to extract benefits from bridging social capital due to the nature of social capital formation.

The striking difference between male and female racers is the significance of weight. The results imply that the relationship between weight and performance is inverted U-shaped. The optimal weight is approximately 50 kg (=203/(2*2)). This means that male racers heavier than that are less likely to win a race. As excessive weight reduction damages health conditions of racers, there is the lower limit of weight that male racers have to weigh at least 50 kg and female racers have to weigh at least 47 kg. If weight of a racer is lighter than the threshold, his or her boat has to load additional weights. The results suggest that very minute weight control as close to the lower limit as possible is more critical for male racers in winning in a race.

As predicted from Table 1, the number of wins for A1 racers are approximately 7.2 (=exp(1.98)) times higher than that for B2 racers. The premium of being A1 racers against B2 racers is approximately 1000% (=exp(2.305)) for female racers. In 2013, the money-title winner who was an A1 racer earned 198 million yen. In the same year, average income, including awards and participation fee, of A1 and B2 racers was 33 million yen and 5 million yen, respectively. This means that the disparity of revenue between A1 and B2 racers is 39.6 (=198/5). Therefore, the disparity in revenue appears to be even larger than that in talent. This suggests superstar phenomenon in this sport where 'relatively small numbers of people earn enormous amounts of money and dominate the activities in which they engage' (Rosen 1981, 845). Specifically, A1 racers who are more likely to win a race tend to participate in races with higher prize, and a very small number of racers have the lion's share of total prize.

Table 2 compares the results of the same regression model between two subsamples: (1) racers who received training at Motosu and Yamato; (2) before and after the changes in regulation regarding propeller ownership.

The first subsamples are generated to examine how different training institutes moderated the impact of bonding social capital on novice racers' performance differently. The training institute was moved in 2001 from Motosu in Yamanashi Prefecture to Yamato in Fukuoka Prefecture (see Appendix for the training system). This is because the Motosu Lake became frequently icy in winter due to climate change, which made training in winter difficult. The new training institute appreciated the privacy of the individual such that the trainees were given individual cabins, as opposed to a large room where the trainees in Motosu used to domicile, which might have affected the formation of bonding social capital among trainees. The training environment has been greatly improved in terms of facilities and training method. For instance, more trial races have been arranged for trainees in the new training institute, which could affect the relationship between experience and performance. The results make clear contrast between Motosu and Yamato. Regarding experience curve, racers who were trained at Motosu improve performance till they experience 72 (=4869/(2*34)) race seasons, then their performance starts to decline. For those who were trained at Yamato, the threshold is 38 (=16,700/(2*220)) race seasons. The difference in the rising region may be affected by the fact that it has been 16 years and 32 race seasons since the training institute had moved to Yamato. However, unreported result shows that slope of experience curve is steeper for the racers who received training at Motosu. Regarding bonding social capital, coefficient of an interaction term with experience is significantly negative, as predicted by H1, for racers who were trained at Motosu, but it is insignificant for those who were trained at Yamato. The relationship

Table 2. Comparison regarding the training institute and changes in regulation (dependent variable = the number of wins in any grade of races).

	1 Motosu	2 Yamato	3 Ownership1	4 Ownership0	5 Motosu	6 Yamato	7 Ownership1	8 Ownership0
N	32,406	15,459	32,270	15,534	32,406	15,459	32,270	15,534
Experience	0.049**	0.167**	0.079**	0.081**	0.027**	0.163**	0.042**	0.067**
	0.003	0.006	0.003	0.008	0.002	0.005	0.001	0.004
Experience^2	−0.034**	−0.220**	−0.063**	−0.059**	−0.027**	−0.200**	−0.042**	−0.048**
	0.002	0.006	0.002	0.005	0.001	0.006	0.001	0.003
Douki	0.060**	−0.107**	0.071**	0.009				
	0.007	0.032	0.008	0.022				
Douki^2	−0.060**	0.154**	−0.061**	0.006				
	0.012	0.058	0.014	0.031				
*Experience*Douki*	−0.056**	−0.010	−0.097**	−0.041*				
	0.006	0.018	0.008	0.020				
Shibu					0.003**	−0.001	0.003**	0.001
					0.001	0.001	0.001	0.001
Shibu^2					−0.128**	−0.009	−0.072*	−0.052
					0.024	0.041	0.033	0.042
*Experience*Shibu*					0.055	0.125	−0.032	−0.103
					0.045	0.098	0.059	0.091
Start	−0.051**	−0.046**	−0.056**	−0.038**	−0.051**	−0.046**	−0.055**	−0.038**
	0.001	0.002	0.001	0.002	0.001	0.002	0.001	0.002
Weight	0.148**	−0.017	0.093**	0.047	0.149**	−0.017	0.088**	0.048
	0.023	0.041	0.024	0.040	0.023	0.040	0.024	0.040
Weight^2	−0.002**	−0.000	−0.001**	−0.001	−0.002**	−0.000	−0.001**	−0.001
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Flying	−0.075**	−0.054**	−0.067**	−0.081**	−0.076**	−0.054**	−0.067**	−0.081**
	0.003	0.005	0.003	0.005	0.003	0.005	0.003	0.005
A1	1.672**	1.916**	1.652**	2.034**	1.683**	1.926**	1.690**	2.040**
	0.023	0.026	0.020	0.033	0.023	0.026	0.020	0.033
A2	1.422**	1.635**	1.403**	1.756**	1.429**	1.644**	1.434**	1.761**
	0.023	0.024	0.019	0.032	0.023	0.024	0.019	0.032
B1	1.011**	1.196**	1.000**	1.373**	1.016**	1.201**	1.021**	1.377**
	0.022	0.022	0.018	0.031	0.022	0.022	0.018	0.031
_cons	−2.618**	3.098**	−1.386*	0.126	−1.505*	1.375	0.154	0.312
	0.636	1.180	0.676	1.149	0.627	1.088	0.664	1.090

Motosu: racers who were trained at Motosu = 1; Yamato: racers who were trained at Motosu = 0.
Ownership1: race seasons when propellers were owned by racers = 1; Ownership0: race seasons when propellers were owned by racers = 0 (owned by the JMRA).
Level of statistical significance: $^{**}p < 0.01$; $^{*}p < 0.05$; $^{\dagger}p < 0.1$.
SEs are under coefficients.
The results of time dummies and regional dummies are not reported.

between bonding social capital and performance is opposite between the two. It is inverse U-shaped for racers who were trained at Motosu while it is U-shaped for racers who were trained at Yamato. The declining region is 34 (=1067/(2*15)) race seasons, which is 17 years, meaning that bonding social capital negatively affects performance throughout the growth stage of novice racers who were trained at Yamato.

The second subsamples are introduced to assess how the impact of social capital on performance changed after the abolishment of propeller ownership by racers (see Appendix) which could mitigate the significance of small groups to share knowledge and cost regarding the improvement in propellers. The results exhibit clear contrast between before and after the changes in regulation. Before the changes in regulation, both *DOUKI* and *SHIBU* had a positive impact on performance while such a positive effect disappeared after the changes in regulation. Therefore, the results lend support to H3. The coefficient of an interaction term between *DOUKI* and experience remains significantly negative, as predicted by H1, after the changes in regulation. However, an interaction term between *SHIBU* and experience is insignificant regardless of the changes in regulation. It can be said that H4 is supported from the results because *DOUKI* loses its explanatory power after the changes in regulation, which suggests that cost sharing in small groups became insiginificant, while its interaction term still retains the predicted effect after the changes in regulation, which is to examine the impact of bonding social capital conducive to psychological aid on novice racers.

V. Discussion

Overall, the results lend support to the contingency theory of social capital. In other words, network requirements of economic agents change over time (Lechner, Dowling, and Welpe 2006; Slotte-Kock and Coviello 2010). First, the training period secluded from the external world incubates a dense network comprising strong, overlapping ties among trainees, which helps cultivate bonding social capital. Social capital of this type is conducive to psychological aid, which is the most beneficial when racers are inexperienced. Such a relationship depicted by H1 has been confirmed by the data of racers regardless of gender. This is consistent with previous findings that cohesive networks and strong ties improve performance in the emergence period of new firms while sparse networks and weak ties are complementary to performance in the early growth period of new firms (Hite and Hesterly 2001; Rothaermel and Deeds 2004).

Second, knowledge sharing is particularly effective when firms in collaborative activities are heterogeneous in terms of technological and commercial capabilities (Anand and Khanna 2000). Social capital of this type is conducive to the acquisition of novel and diverse knowledge, which is likely to be beneficial when racers are more experienced and have accumulated absorptive capacity. Such a relationship described by H2 has been confirmed by the data of all racers and male racers, but does not hold for female racers. It is true that diverse networks provide rich sources of information, but excessive diversity entails little shared knowledge base among network contacts. In fact, diverse resources in a network (i.e. knowledge variety) do not necessarily generate bridging social capital conducive to the efficient transfer of novel information. This is because the disparity in absorptive capacity (i.e. knowledge disparity) makes knowledge transfer difficult (Mowery, Oxley, and Silverman 1998; Han, Han, and Brass 2014). Such an inverse U-shaped relationship between bridging social capital and performance has been confirmed by the data of all racers and male racers.

Third, the results show that the impact of social capital on performance is contingent not only on internal factors like life cycle stages, but also on external factors like regulation. Before the changes in regulation, small groups used to be formed among racers to share the costs of investment into physical assets to transform propellers. Such a small group could foster knowledge sharing as well through fostering participants to learn from other participants. The changes in regulation shifting ownership of propellers from racers to the JMRA affected the impact of bonding and bridging social capital on performance as predicted by hypotheses. Bridging social capital associated with knowledge sharing became unimportant at least partially because of the changes in regulation, as predicted by H3. Bonding social capital associated with cost sharing among homogenous economic agents also became insignificant, but psychological aid stemming from strong ties remained conducive to performance improvement for novice racers, making the effect of bonding social capital on performance after the changes in regulation commingled, as H4 predicted. The results imply that network characteristics of small groups for the improvement in propellers may have affected types of social capital from which participating racers extracted benefits and exogenous shock like changes in regulation affected the relationship between social capital and racers' performance with some type of benefits like psychological aid remained intact.

The relationship between bonding social capital and performance is inverse U-shaped for racers who received training at Motosu while it is U-shaped for racers who were trained at Yamato. As predicted by H1, experience negatively moderates the relationship between bonding social capital and performance of racers who received training at Motosu, but this does not hold true for racers who were trained at Yamato. The relationship between bridging social capital and performance is inverse U-shaped for racers who received training at Motosu while there is no significant relationship between the two for racers who were trained at Yamato. This suggests that Motosu played an important role not only in human capital development, but also in social capital formation while Yamato did not. If racers' ability to form social capital is contingent on the training institute, management of the training institute should have a great influence not only on performance of racers, but on the business of the JMRA. In this regard, it has been known that performance of novice racers had significantly deteriorated since the training institute was moved in 2001 from Motosu to Yamato. In fact, the championship contended only among new racers was abolished in 2013 because the race was unpopular among bidders who became aware of low performance of new racers. Taking account of the fact that the training environment has been greatly improved in terms of facilities and training method, which appears to have helped novice racers perform better, it might have been organizational factors that had affected such a decline in performance among racers who were trained at Yamato. One interpretation of the result is the increasing difficulty in the formation of bonding social capital at Yamato. The new training institute appreciated the privacy of the individual such that the trainees were given individual cabins, as opposed to a large room where the trainees in Motosu used to domicile. However, this practice had been abolished as novice racers have to share a room with more experienced racers at the accommodation facilities adjunct to racecourses. Another possibility pertains to the change in the selection standard and the criteria of graduation. In 2008, the upper age limit has been altered from 21 to 30. Having more older trainees may have affected bonding social capital formation at the training institute and the rising region of experience curve.

The results provide another managerial implication regarding female racers. Bridging social capital did not affect performance of female racers. One interpretation is that small groups to share knowledge about racing and costs of investment into the improvement in propellers tend to be formed exclusively by male racers. If this is the case, female racers may have been deprived of opportunities to tap into social capital. Another interpretation of the result is that female networks may be homogenous in terms of gender, which might explain why female racers are less likely to extract benefits from social capital. Previous literature argues that female entrepreneurs include more women in their social networks while male entrepreneurs' networks are more gender-balanced (Brush 2006). Another study argues that such homophily in social networks might cause women's lower probability of starting business than men and lower performance of female entrepreneurs than male entrepreneurs (Renzulli, Aldrich, and Moody 2001). In this regard, the number of races contended only among female racers is increasing, which is good news for both female racers and bidders. Moreover, the ratio of female racers is increasing. While 11% of the racers are female in total as of 2014, approximately a quarter of the new graduates are female in the last five race seasons. This would gradually expand opportunities for female racers to form bonding and bridging social capital, enabling them to compete with male racers on an equal basis at least from the perspective of social capital formation.

VI. Conclusion

The contingency theory of social capital assumes different effects of different types of social capital on performance in different circumstances. This concept is important to understand variations in performance of professional athletes in individual sports whose playing career is limited and who are strongly motivated to improve performance. Using panel data of motorboat racers as a sample occupation, this study is the first to examine the contingency theory of social capital in sport. Internal and external factors are incorporated into the model as moderators affecting the relationship between social capital and performance of racers. Key findings can be summarized as follows. First, bonding social capital, measured by the number of racers who graduated from the training institute in the same race season, has a positive impact on performance and such a positive effect is particularly high among novice racers who are less experienced, and thus most need psychological aid coming from strong ties. Second, the impact of bridging social capital, measured by the number of motorboat racers in the same regional division, on performance is positively moderated by life cycle stages of racers. The impact of bridging social capital is higher as racers become more experienced and accumulate absorptive capacity. Third, exogenous shock like changes in regulation also moderates the effect of social capital on performance. Social capital formation was associated with small groups to improve propellers before the changes in regulation. The exogenous shock is predicted to moderate the relationship between bonding and bridging social capital and performance differently. Bridging social capital associated with knowledge sharing became unimportant at least partially because of the changes in regulation. Fourth, bonding social capital associated with cost sharing among homogenous economic agents also became insignificant, but psychological aid stemming from strong ties remained conducive to performance improvement for novice racers, making the effect of bonding social capital on performance after the changes in regulation commingled. This study adds to the previous literature on the contingency theory of social capital by demonstrating that internal (life cycle stages) and external (changes in regulation) factors moderate the relationship between social capital and performance through different routes. This study also provides several practical implications which have to do with the management of the training institution, races and social capital formation among female racers, and the design of incentive mechanisms for less motivated racers.

I conclude the article by referring to several limitations of this research and agenda for future research. First, an implicit assumption of this study was that social capital could be formed randomly within peer groups and two proxy variables for social capital could be regarded as exogenous. It is possible, however, that social capital is more likely formed around star racers. If this is the case, two proxy variables for social capital employed in this study may not have fully captured actual process of social capital formation. Future study should develop better proxy variable for social capital of racers based on interviews and questionnaire surveys. In doing so, care should be taken in delineating the mechanism where social capital leads to improved performance when social capital is endogenous and star racers are more likely to create richer social capital. Second, as previously stated, motorboat racing is characterized as outstanding length of athletes' career. The oldest male and female racer is at 70 and at 57, respectively, as of 2017. Future research should examine the determining factors in racers' career length. As racers age, bonding and bridging social capital measured as *douki* and *shibu* drastically decreases due to retirement. As this study addressed the case of propeller ownership, racers have to adjust themselves to new environments according to institutional and technological change. Racers who could overcome one change may not be able to do the same in the next change. Such a topic could be of interest to economists studying not only sport, but also business.

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ORCID

Nobuya Fukugawa http://orcid.org/0000-0001-9874-7417

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Appendix

Basics about motorboat racing[2]

Motorboat racing is a sport event organized as public gambling in Japan, legally established by the Motorboat Racing Act of 1951 (JMRA 2016). A motorboat racing is administrated by the JMRA and conducted in a big pool with a 600-m oval racecourse (Figure A1). Six hydroplanes race three laps around the course, which is generally over in about 2 min.

There are 24 racecourses in 18 prefectures and a regional division among racers is organized in each prefecture where a racecourse is located. The location of racecourses (river, sea, and lake) and natural conditions (wind, tide, and water quality) create the distinctive features of each racecourse. As racers in different regional divisions are assigned to races held all over Japan, racers are required to adopt strategy for preparation and driving according to racecourse characteristics.

To be a motorboat racer, applicants have to graduate from the only training institute in Fukuoka Prefecture after the 12-month training period. Although the ratio of graduates to enrolled trainees is not officially disclosed, it has been said that approximately half to 60% of the enrolled trainees could graduate from the training institute. As of May 2017, there are 1366 male racers and 208 female racers, ranging from 18 to 70 (57 for female) years old. There is no age retirement system in motorboat racing. However, if a racer cannot qualify a specific winning rate in a specific race season, the racer will not be assigned to any race for a specific period. New racers and racers who participated in 50 or less races are exempted from this rule. Most of the racers who are applied this rule voluntarily retire. There is another form of a recommendation to retire for racers with very high disqualification rate and very low winning rate.

The economic incentives

There are five race grades in the motorboat racing. The highest-grade races are called SG which is special grade and held eight times in a year where the prize is the highest in all races (25–100 million yen). Other races are categorized, according to the amount of prize, as G1 which is held 35 times in a year (prize is ≥ 4.5 million yen), G2 which is held eight times (prize is 4 million yen), G3 which is held approximately 30 times (prize is ≥1 million yen), and general races which are held almost every day (prize is ≥640,000 yen).

There are two race seasons in a year which last 6 months, starting in May and November, respectively. A typical race series lasts 6 days and consists of qualifying session among approximately 50 racers from day 1 to day 4, semi-final (day 5) among 18 qualified racers, and final (day 6) among six racers who ranked first or second in each semi-final race. Racers who could not reach the final participate in consolation final to determine their rank in the race series, making the number of races in which each racer participates roughly equal, which is eight. The number of races in which an average racer participates in a race season is 102. Racers who ended in fourth place or lower in a race receive participation fee, varying with race and rank, as long as they do not make false starts. Stacking of participation fee compensates income of racers who cannot earn prize.

Three key factors in winning the race

There are three key capabilities of racers to win the race: to reach the starting line just in time; to turn the first corner quickly in the first lap; and to appropriately adjust engines and propellers. Motorboat racing employs a unique starting system. At approximately 12 s before the clock (in Figure A1) reaches zero, the boats race up towards the start line at full speed. Boats must cross this line within 1 s after the clock reaches zero. If a boat crosses the starting line too early before the clock hits zero, it is called ‘flying’ (a premature start). If a boat crosses the starting line more than 1 s after the clock hits zero, it is called a late start. A boat that makes a false (be it premature or late) start is scratched from the race. Racers who made false starts are severely punished because bets on that boat are refunded, which decreases revenue of the JMRA. To pass the starting line ahead of all the others is critical because the waves made by the leading boat slow down the followers. As the

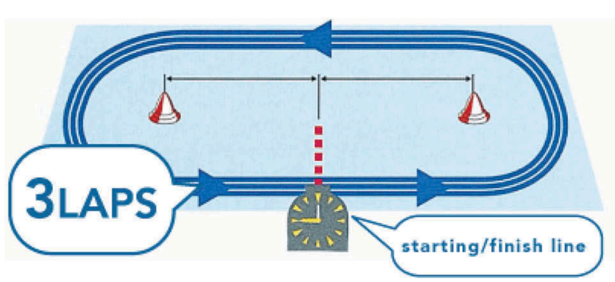

Figure A1. A motorboat racecourse.
Source: http://wwwa.boatrace.jp/en.html. Accessed 11 August 2017.

[2]Information is collected from the JMRA website (http://www.boatrace.jp/en.html, accessed 2 December 2016).

distance from the starting line to the first corner is short, it is difficult for the followers to detour the waves.

After passing the starting line, the most important moment to determine the winner comes when the boats turn the first corner. The racers stand up in the boat while steering left and kicking the steer-board side so that the boat will tilt. This driving technique is called a monkey turn which enables to minimize the resistance of water and turn the corner without slowing down the speed. After turning the first corner, the leading boat has a great advantage by making waves against the followers. Either jumping over the waves or detouring the waves makes it difficult for the followers to speed up and pass the leading boat.

Before April 2012, racers were allowed to own propellers, transform them using tools before and during the race day, and select the best one for the race. Racers needed to transform propellers so that the resistance of water would be minimized while maintaining the maximum thrust force for three laps, which creates trade-off. Furthermore, they have to take account of natural conditions and characteristics of racecourses. Specifically, the improvement in propellers requires investment into physical assets. For instance, it is necessary for them to have a workshop in a remote area because metal processing creates noise. As it is difficult for novice racers to bear the costs of investment, they normally participate in small groups to share cost. Such groups exert scale economies by sharing costs of physical investments. Division of labour could work in such groups when someone in the group is good at metal processing and another is good at experimentation, facilitating scope economies. Moreover, taking part in small groups also enables novice racers to share knowledge. Each racecourse has its own characteristics and race conditions vary according to weather, wind, tide, and time. Taking part in small groups helps novice racers efficiently acquire knowledge about how to adjust equipment so that it will work best according to the characteristics of the racecourse and natural conditions.

Table A1. Descriptive statistics.

Variables *Male racers*	Definition	*N*	Mean	SD	Min	Max
Y	The number of wins in any grade of races	43,298	17.73087	13.38935	0	79
Experience	The number of race seasons experienced	43,298	31.41884	19.70041	1	111
Experience^2	Quadratic term	43,298	1375.241	1480.235	1	12,321
Douki	Bonding social capital; see Section II	43,298	23.48134	7.517375	1	35
douki^2	Quadratic term	43,298	607.8829	308.3149	1	1225
Shibu	Bridging social capital; see Section II	43,298	111.3863	56.85908	17	225
shibu^2	Quadratic term	43,298	15,639.79	14,941.89	289	50,625
Start	Time to reach the starting line	43,113	19.29103	3.128605	0	62
Weight		43,298	53.77659	2.842803	44	71
Weight^2	Quadratic term	43,298	2900.003	311.4548	1936	5041
Flying	The number of races that the racer recorded premature start	43,298	0.4220056	0.575282	0	3
Female racers						
Y	The number of wins in any grade of races	5083	11.78281	12.39854	0	74
Experience	The number of race seasons experienced	5083	25.2048	17.46477	1	72
Experience^2	Quadratic term	5083	940.24	1053.239	1	5184
Douki	Bonding social capital; see Section II	5083	24.54653	6.160674	5	35
douki^2	Quadratic term	5083	640.4785	278.983	25	1225
Shibu	Bridging social capital; see Section II	5083	117.1546	61.19987	17	225
shibu^2	Quadratic term	5083	17,469.9	16,262.02	289	50,625
Start	Time to reach the starting line	4922	20.48517	3.941593	0	35
Weight		5083	47.71552	2.995361	39	64
Weight^2	Quadratic term	5083	2285.741	293.9428	1521	4096
Flying	The number of races that the racer recorded premature start	5083	0.438914	0.594773	0	3

Table A2. Correlation matrix.

	Y	*Experience*	*Experience*^{2}	*Douki*	*Douki*^{2}	*Shibu*	*Shibu*^{2}	*Start*	*Weight*	*Weight*^{2}	*Flying*
Y	1										
Experience	0.0168	1									
Experiance^2	−0.0807	0.9551	1								
Douki	0.1024	−0.7248	−0.7924	1							
Douki^2	0.0853	−0.6729	−0.7152	0.9783	1						
Shibu	−0.0665	−0.0183	−0.0109	−0.0284	−0.0397	1					
Shibu^2	−0.0691	−0.0203	−0.0138	−0.0254	−0.0368	0.986	1				
Start	−0.4943	0.1644	0.1944	−0.1889	−0.1724	0.0063	0.0053	1			
Weight	−0.0756	0.0531	0.0384	0.0125	0.0228	0.0065	0.0065	−0.0306	1		
Weight^2	−0.0834	0.0516	0.0363	0.0144	0.0245	0.0061	0.0063	−0.0259	0.9984	1	
Flying	−0.0188	−0.1554	−0.1358	0.0907	0.0875	0.008	0.0073	0.0104	−0.015	−0.0157	1