Is body mass human capital in sports? Outcome of globalization of sumo wrestling and generation of human capital in Japan

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ABSTRACT

Using a data set for all sumo wrestlers in the post-World War II period, this paper investigates how wrestlers' body mass index (BMI) is associated with wrestlers' winning rate and absence rate. Further, the effect of BMI is compared between an early period (before the emergence of foreign wrestlers) and latter period (after the emergence of foreign wrestlers). After accounting for endogenous bias using instrumental variables, the key findings are that (1) there is no positive relation between the BMI and winning rate in either the early or latter period and (2) there is a positive relation between the BMI and absence rate in the latter period but not in the early period.

JEL classification: L83; J24; N35; I15;

Keywords: Sumo wrestling, Body mass index, Human capital, International labor

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mobility; Immigrant

I. Introduction

Sumo wrestling is a traditional fighting sport in Japan and has been popular since the 18th century. Following World War II, sumo, like other professional sports, such as football (Berlinschi et al., 2013) and baseball (Schmidt and Berri, 2005), has become globalized. In 1968, Takamiyama became the first non-Asian to reach the top division (makuuchi)[1] in sumo. Twenty-five years later, in 1993, Akebono became the first foreign-born yokozuna (the highest rank in the top division). Both Takamiyama and Akebono were born in the United States. Since the retirement of Takanohana in 2003, there has been no domestic Japanese yokozuna. In 2012, 7.5% of sumo wrestlers were officially listed as foreigners, and 33% of wrestlers in the top division were foreigners[2].

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[1] There are six divisions in sumo: makuuchi (maximum of 42 wrestlers), jūryō (fixed at 28 wrestlers), makushita (fixed at 120 wrestlers), sandanme (fixed at 200 wrestlers), jonidan (approximately 230 wrestlers), and jonokuchi (approximately 80 wrestlers). In total, there are approximately 730 wrestlers attending each tournament. Wrestlers enter sumo in the lowest division, jonokuchi, and ability permitting, work their way up to the top division.

[2] In response to the increasing numbers of foreign wrestlers, in 1992, the Japan Sumo Association began regulating the inflow of foreign wrestlers (Nakajima 2003, 120).

Following these drastic changes, sumo has become an international sport in the 21st century.

Differences in the labor quality of sumo wrestlers might be due to technical skill and physical strength. Sumo does not have weight categories, and hence, an increase in body mass might result in higher performance. Hence, the body mass might be considered as human capital in the sumo labor market[3]. Furthermore, foreign wrestlers, especially those born in the United States, have a great advantage in terms of body mass. "Upon their initiation into the sumo world, foreign wrestlers are already equipped with a physique equivalent to that of wrestlers in the top division. They have trained in American football or basketball, and have been excellent players." (Nakajima 2003, 62). In other words, these foreign wrestlers were not obese even though their body mass was extremely high. As a consequence, competitive pressure increased, giving domestic sumo wrestlers a great incentive to increase body mass even though there were rigged matches (Duggan and Levitt 2002). On the other hand, extra weight seems to increase injury, which hampers the wrestler's performance. This

[3] To put it more precisely, through traditional training, the type of physique required for sumo wrestling can be considered as human capital specific to sumo (Nakajima, 2003, 63–66). However, owing to the limited data and difficulty of measuring physique, this paper uses the body mass index.

is the negative effect of body mass. Wrestlers are thought to train to obtain an optimum body mass that trades off these positive and negative effects. However, in 2000, the average body fat ratio was 38.4%, which is far higher than ideal for an athlete (Nakajima 2003, 59)[4]. "The upper weight limit of a Japanese wrestler with consideration of muscular strength was estimated to be 180 kg. That is, it is not appropriate from the viewpoint of exercise that a wrestler's weight exceeds 180 kg." (Nakajima 2003, 60). However, after the emergence of Takamiyama, there have been 18 wrestlers weighing in excess of 180 kg. The inflow of foreign wrestlers has led Japanese wrestlers to misestimate the optimum body mass.

Previous works on sumo (Duggan and Levitt 2002; West 2004) have focused on the norm or the rule shared in the closed sumo world. However, the sumo world has been under the influence of globalization and thus affected by an inflow of foreign-born labor. It is worth investigating the effect of the increasing number of foreign wrestlers on human capital accumulation of domestic wrestlers to explore the impact of immigrants in the labor market. Many works have investigated an individual's physical characteristics (or sporting activities) and their outcomes in the labor market (e.g.,

[4] The ideal body fat ratio is 10% and 13% for a soccer player and American football player, respectively.

Ewing 1998; Barron et al., 2000; Persico et al., 2004: Lechner, 2009; Rooth 2009; 2011; Böckerman et al., 2010). However, these works did not take international labor mobility into account. The sumo world is generally characterized as having been closed to strangers and so was not influenced from the outside until after World War II. That is, Japanese wrestlers are thought to have shared the social norm and behave according to the norm. On the other hand, the critical influence of international labor mobility has been observed in other professional sports (Schmidt and Berri, 2005; Berlinschi et al., 2013). Naturally, the question arises whether globalization affects the behavior of sumo wrestlers. Analyzing the sumo labor market can be regarded as a natural experiment of examining how inflow of heterogeneous labor affects a closed traditional labor market governed by the social norm.

To explore the question, using the career records of retired sumo wrestlers in the post-World War II period, in which there was a drastic change in the sumo labor market, this paper compares how the body mass index (BMI) is associated with the winning rate and absence rate of sumo wrestlers. Furthermore, this paper compares the relations before and after the emergence of foreign wrestlers.

The paper is organized as follows. Section 2 explains the data set and simple econometric framework. The results of the estimations and a discussion are provided in

Section 3. The final section offers concluding observations.

II. Data and methods

In this paper, I use the winning rate and absence rate to capture the performance of wrestlers. An increase in body mass is expected to improve wrestlers' performance. On the other hand, the BMI increases the probability of injury, thus lowering performance. Hence, it is an empirical question whether the body mass is positively associated with a wrestler's performance. This paper addresses this question.

2.1. Data

From information provided by Editorial of Sumo (2001) and Mizunoand Kyosu (2011), this paper constructs the records of 411 retired sumo wrestlers. Because of limited data availability, the data were only for wrestlers who advanced to the top division during the period 1945–2008 even though there are six divisions. The emergence of the first foreign-born wrestler in 1968 is regarded as a turning point. Accordingly, the wrestlers are classified as those who advanced to the top division in the period 1945–1967 and those who advanced in the period 1968–2008. There are 183 and 228 wrestlers in the early-period and latter-period categories, respectively. Data

comprise the year of birth, debut age in the top division, birth place, nationality, number of wins, number of losses, number of absences, height and weight. There are six Grand Sumo Tournaments (basho) each year. In each tournament, there are 15 bouts. In the case that the wrestler is injured and cannot fight, he can be absent from the tournament[5]. From the data, the winning rate, absent rate, and BMI are calculated.

Figure 1 illustrates the changes in the total number of foreign wrestlers, who belonged not only to the top division but also to other divisions. The figure shows that the number of foreign wrestlers has consistently increased since 1970. Table 1 compares mean values of various aspects of wrestler records between the two periods (i.e., 1945–1967 and 1968–2008). The table shows that the BMI in the latter period is 7.1 points higher than that in the early period, which is in line with other professional sports (Saint Onge et al., 2008). Table 2 shows that there were 11 foreign wrestlers and 217 domestic wrestlers in the latter period, and that the winning and absence rates of foreign wrestlers were higher than those of domestic wrestlers, although the difference in the absence rate is not statistically significant. The BMI of foreign wrestler was 9.4 points higher than that of domestic wrestlers. These findings jointly suggest that the

[5] There are various cases of absence. If a wrestler is injured before a tournament, he will be absent from 15 bouts. If he is injured after several bouts of the tournaments, he will be absent from the remaining bouts.

foreign wrestler's higher BMI increases his winning and absence rates. Hence, not only the quantitative increase in foreign wrestlers but also their qualitative superiority is thought to have affected domestic wrestlers.

Figures 2, 3 and 4 show the distributions of the BMI, winning rate and absence rate, respectively. The BMI is almost normally distributed except for outliers beyond 60. The winning rate is also almost normally distributed. Figure 4 reveals that most wrestlers have not been absent from any bout. Figure 5 shows the relation between the BMI and year of birth. The Hawaii-born Konishiki, whose BMI exceeded 80, had a distinctly large body mass. Musashimaru, who was also born in Hawaii, had the second-highest BMI of approximately 65. A cursory examination of Figure 5 shows that the BMI is positively associated with the year of birth, which is consistent with the improvement of physique in Japan (Yamamura 2012). Figure 6 suggests a positive association between the BMI and wining rate, which is in line with the inference that body mass can be regarded as human capital in sumo. Figure 7 suggests there is no relationship between the BMI and absence rate.

2.2. Econometric framework

I attempt to assess the effects of body mass on the winning rate and absence rate.

Following the description above, the estimated function takes the form

$$\textit{Winning rate (}\text{or } \textit{Absence rate)}_i = \alpha_0 + \alpha_1 BMI_i + \alpha_2 \textit{Top division age}_i + \alpha_3 \textit{Foreigner dummy}_i + u_i,$$

where *Winning rate (*or *Absence rate)*$_i$ represents the dependent variable for individual i. The regression parameters are denoted α and the error term u. The key independent variable is the BMI denoted *BMI*. Control variables are *Top division age* (the age of the wrestler when he debuted in the top division) and *Foreigner dummy* (a foreign-born wrestler takes a value of 1, and a domestic wrestler a value of zero).

If body mass helps improve a wrestler's performance, a wrestler with a higher BMI is more likely to win and is less likely to be injured. If this holds true, the sign of the coefficient of *BMI* is positive (or negative) when the dependent variable is *Winning rate* (or *Absence rate*). It seems appropriate to assume that the younger the wrestler is when he debuts in the top division, the more competent he is. This leads me to conjecture that the younger the wrestler is when he debuts in the top division, the higher his winning rate and the lower his absence rate. Accordingly, the sign of the coefficient of *Top division age* is expected to be negative (or positive) when the dependent variable is *Winning rate* (or *Absence rate*). After accounting for the BMI, *Foreigner dummy* captures the effect of non-body mass factors such as skill and

athletic ability.

Values of *Winning rate* and *Absence rate* range between 0 and 1. *Winning rate* is never 0 or 1, and the simple ordinary least-squares method (OLS) is thus used for its estimation. *Absence rate,* as seen in Figure 4, is never 1, whereas it takes a value of zero in many cases. Therefore, the Tobit model is used for estimation of *Absence rate.* Furthermore, in addition to estimations based on the full sample, for the purpose of comparing the periods before and after the emergence of foreign wrestlers in the top division, estimations were conducted for the early period (wrestler's debut in the top division is during 1945–1967) and the latter period (wrestler's debut in the top division is during 1968–2008).

2.2. Instrumental variables

There is possibly reverse causality in the relation between the BMI and dependent variables *Winning rate* and *Absence rate*. The lower the winning rate, the more the wrestler has an incentive to increase body mass to improve his performance. On the other hand, the higher the absence rate, the more the wrestler has an incentive to decrease his body mass to reduce the possibility that he is injured. Hence, endogenous bias inevitably occurs. It is thus necessary to control for the bias.

To control for the bias, the instrumental-variable two-stage method (IV 2SLS) and the instrumental-variable Tobit method (IV Tobit) are used in alternative estimations of *Winning rate* and *Absence rate*, respectively.

Outside the sumo world, it has generally been observed that the Japanese physique has improved in tandem with economic development (Yamamura, 2012). Therefore, the birth year of wrestlers is positively associated with *BMI* whereas it is related to neither *Winning rate* nor *Absence rate.* Accordingly, *Birth year* is included in the set of instrumental variables.

In addition, the degree of urbanization in the area of a wrestler's residence seems to be related to lifestyle and calorie intake. Lifestyle during childhood affects body mass, which is possibly maintained into adulthood. The place where a wrestler grows up is thus related to the wrestler's BMI. On the other hand, I assume that the circumstance of childhood is not directly associated with *Winning rate* or *Absence rate.* Generally, the Kanto area including Tokyo, Kanagawa, Saitama, and Chiba is considered an urban area in eastern Japan, while the Kansai area including Osaka, Hyogo, and Kyoto is considered an urban area in western Japan. *Kanto dummy* and *Kansai dummy* thus provide information about the birth place of wrestlers. To capture the long-running effect of birth place, *Kanto dummy* and *Kansai dummy* are added to the set of

instrumental variables.

III. Estimation results and their interpretation

Tables 3 and 4 (1) present results for *Winning rate*, while Tables 5 and 6 report results for *Absence rate*. Tables 3 and 5 present the results of OLS and Tobit estimations, respectively, whereas Tables 4 (1) and 6 provide the results of IV 2SLS and IV Tobit estimations, respectively. In each table, estimations based on the full sample are given in column (1), estimations based on the early-period sample are given in column (2), and estimations based on the latter-period sample are given in columns (3) and (4). *Foreigner dummy* is not incorporated in column (2) because, by definition, there was no foreign wrestler during the early period. Furthermore, results for the first stage obtained using the 2SLS model are presented in Table 4 (2).

I begin by discussing the results in column (1) of Table 3. The coefficient of *BMI* is positive and is statistically significant at the 1% level in column (1), indicating that higher body mass increases the winning rate. The significant negative coefficient of *Top division age* indicates that the younger the wrestler debuts in the top division, the higher his competence. This is congruent to the prediction. The coefficient of *Foreigner dummy* is positive and statistically significant, indicating that foreign

wrestlers are more likely to win even after accounting for *BMI.* The same results for *Top division age* and *Foreigner dummy* continue to be observed in columns (2)–(4). The coefficient of *BMI* is positive in columns (2)–(4). It is interesting to observe that *BMI* is statistically significant in column (2) but not in columns (3) and (4). This implies that higher body mass increased the winning rate in the early period but not in the latter period.

I now turn to the results obtained with 2SLS presented in Table 4 (1) and (2). An over-identification test can examine the exogeneity of instrumental variables. Test statistics are not significant in columns (1)–(4) and thus do not reject the null hypothesis that the instrumental variables are uncorrelated with the error term. Hence, the 2SLS method can be considered valid in all columns. Table 4(2) shows that, in line with expectation, the coefficient of *Birth year* is negative and statistically significant at the 1% level in all columns. In addition, consistent with expectation, significant positive correlation with *Kanto dummy* is observed in columns (1) and (2), although the correlation is not statistically significant in columns (3) and (4). In the second stage, the coefficient of *BMI* is positive in columns (1), (3) and (4), while it is negative in column (2). It is surprising to observe that *BMI* is not statistically significant with the exception of column (3). It follows from this that *BMI* has no effect on the winning rate when

considering the whole sample or early period. *BMI* seemingly increases the winning rate when *Foreigner dummy* is not included. However, once *Foreigner dummy* is included, *BMI* does not increase the winning rate. The insignificant effects of *BMI* and *Foreigner dummy* indicate that, contrary to expectation, neither the body mass nor the foreigner's athletic ability has been positively associated with the winning rate since the inflow of foreign wrestlers.

I now examine the absence rate in Table 5. *BMI* has positive correlation in columns (1), (3), and (4), whereas it has negative correlation in column (2). Furthermore, *BMI* is statistically significant at the 1% level in columns (3) and (4), while it is not statistically significant in columns (1) and (2). This implies that *BMI* is positively associated with the absence rate after the emergence of foreign wrestlers while it is not associated with the rate before the emergence of foreign wrestlers. With respect to control variables, *Top division age* has significant positive correlation in all columns, which is inconsistent with the prediction. In my interpretation, wrestlers learn how to reduce the likelihood of injury through experience, thus reducing the absence rate.

Table 6 presents the results for an over-identification test of the exogeneity of instrumental variables. Test statistics are not significant in columns (1)–(4) and thus do not reject the null hypothesis that the instrumental variables are uncorrelated with the error term.

Hence, the IV Tobit method can be considered valid in all columns. It is interesting to observe that the coefficient of *BMI* is negative and is statistically significant in column (2). Its absolute value is 0.017, implying that the absence rate declines by 1.7% when the BMI increases by 1 point. Wrestlers are inclined to withdraw from a tournament because of serious injury. Therefore, an increase in *BMI* can be considered to improve the physical strength and prevent injury or reduce the extent of injury, thus reducing the absence rate. On the other hand, as exhibited in columns (3) and (4), *BMI* continued to have a positive coefficient and be statistically significant at the 1% level. Its absolute value is about 0.009, implying that the absence rate rises by 0.9% when the BMI increases by 1 point. This can be interpreted as implying that obesity resulted in wrestlers being injured in bouts, thus increasing the absence rate. In summary, an increase in *BMI* possibly reduces the probably of injury up to a certain optimum level, but increases the probability beyond that level.

Overall, contrary to expectation, the body mass is not associated with the winning rate, while it has a critical influence on the absence rate, although whether the influence is positive or negative depends on the situation. The combined results of Tables 3–6 suggest that the inflow of foreign wrestlers has led to domestic Japanese wrestlers becoming obese, which eliminates the positive effect of body mass on the

performance of Japanese domestic wrestlers. In comparison with Westerners, Japanese people are generally shorter and have a disadvantage relating to physique. Hence, Japanese wrestlers have a comparative advantage in terms of technique and agility. Hence, to compete with foreign wrestlers, Japanese wrestlers should train to improve technique or improve agility, rather than increase body mass. However, Japanese wrestlers have not adopted such a strategy. Therefore, the inflow of immigrants having a different type of human capital has enhanced accumulation of human capital that is not suitable to domestic wrestlers.

IV. Conclusion

Since the 1970s, an increasing number of foreigners have entered the sumo labor market, leading sumo to become an international sport. In particular, wrestlers born in the United States have a great advantage in terms of physique over domestic Japanese wrestlers. In such a drastically changing environment, to counter the inflow of foreign wrestlers, domestic Japanese wrestlers have accumulated human capital by increasing their body mass.

The increase in body mass is expected to improve wrestlers' performance. On the other hand, it increases the probability of injury, thus lowering performance. Hence, it

is an empirical question whether the body mass is positively associated with a wrestler's performance. This paper thus used a data set for sumo wrestlers to investigate the effect of wrestlers' BMI on their winning rate and absence rate. The key findings are that 1) an increase in BMI did not result in a higher winning rate in either the early period (before the arrival of foreign wrestlers) or latter period (after their arrival) and 2) an increase in BMI raised the absence rate in the latter period but reduced the absence rate in the early period.

In my interpretation, before the emergence of foreign-born wrestlers, an increase in body mass reflected the strengthening of a wrestler's physique. This reduced the probability of injury although it did not increase the winning rate. After an inflow of foreign wrestlers, over-weight wrestlers became more inclined to suffer injury and they did not have improved winning rates. Considering these findings jointly leads me argue that an increase in body mass improved performance prior to globalization; however, an inflow of foreign wrestlers led domestic wrestlers to become over-weight, which hampered performance. The performance of wrestlers depends not only on body mass but also on technique and agility. In comparison with Westerners, Japanese people are generally short and light-weight, suggesting that Japanese wrestlers have a comparative advantage in terms of technique and agility. Hence, a strategy for

Japanese domestic wrestlers would be to improve technique and agility rather than increase body mass. Traditional training encourages Japanese sumo wrestlers to maintain an optimum body mass and maximize their performance by improving their agility and technique matched to their physique. Sumo society is known to have been governed by the traditional social norm and Japanese wrestlers are therefore thought to put high value on traditions including the way of training. However, contrary to tradition, the findings of this study made it evident that the emergence of foreign wrestlers blessed with a splendid physique misled outweighed domestic wrestlers to gain weight above their optimum level. There seems to be the possibility of multiple equilibriums in the labor market. As a consequence of the inflow of heterogeneous foreign wrestlers, the equilibrium of the traditional Sumo world transited to the equilibrium of the globalized sumo world.

From the findings in this paper, I make the argument that an increase in immigrants with human capital different from that of domestic labor leads the domestic labor to obtain human capital that does not match their characteristics, thereby reducing the performance of domestic labor. There is, however, another possibility, observed in professional football, that learning from players with advanced human capital such as excellent skill or physique improves the performance of players in less-developed

countries (Yamamura, 2009; Berlinschi et al., 2013). Hence, it is important to consider which type of human capital matches the characteristics of domestic labor when we analyze the learning effect of foreign labor in less-developed countries.

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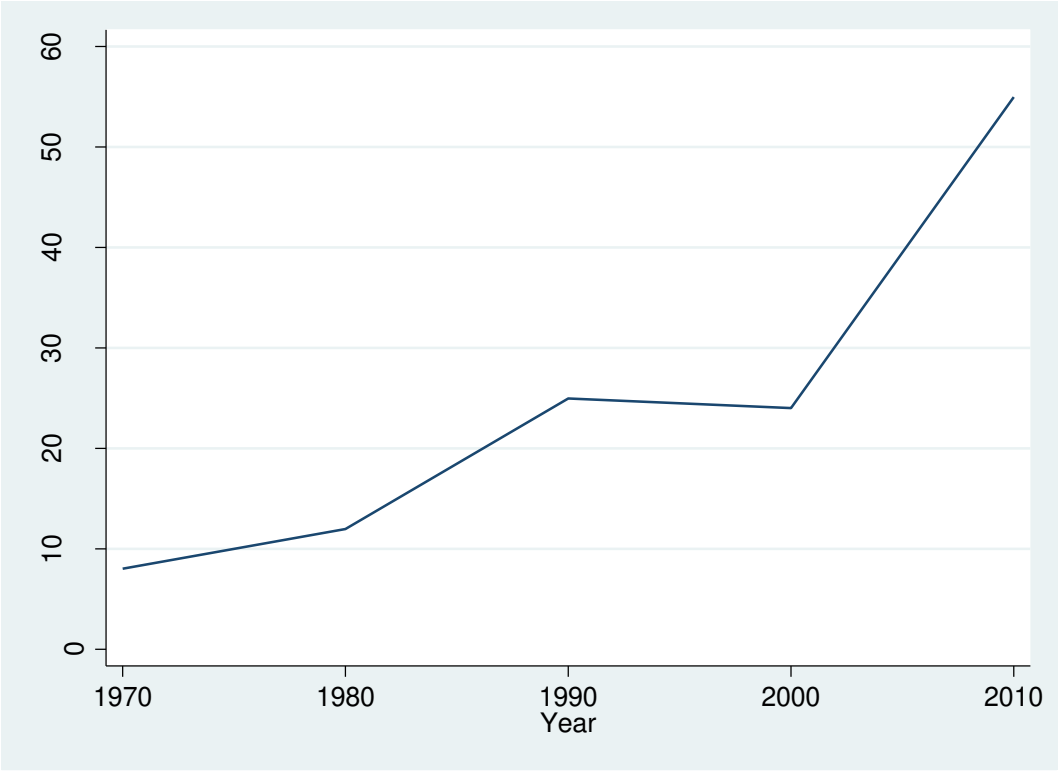
Figure 1. Number of foreign-born wrestlers



Source: SUMO reference (http://sumodb.sumogames.com/Default.aspx?l=e).

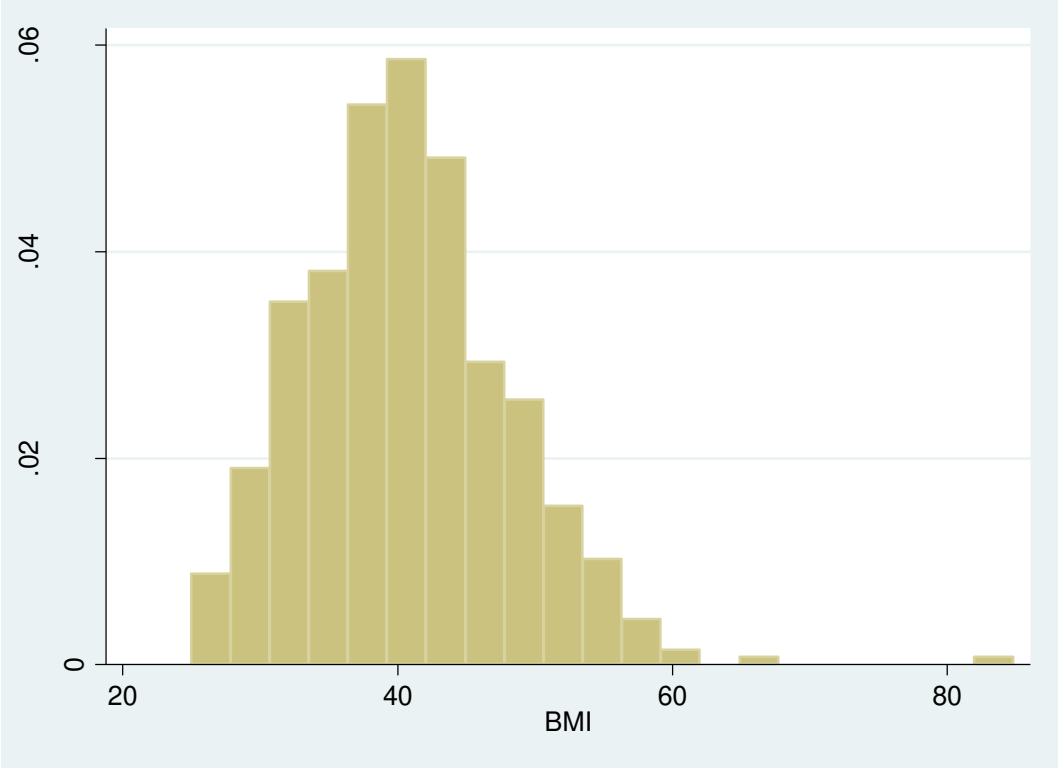


Figure 2. Distribution of BMI

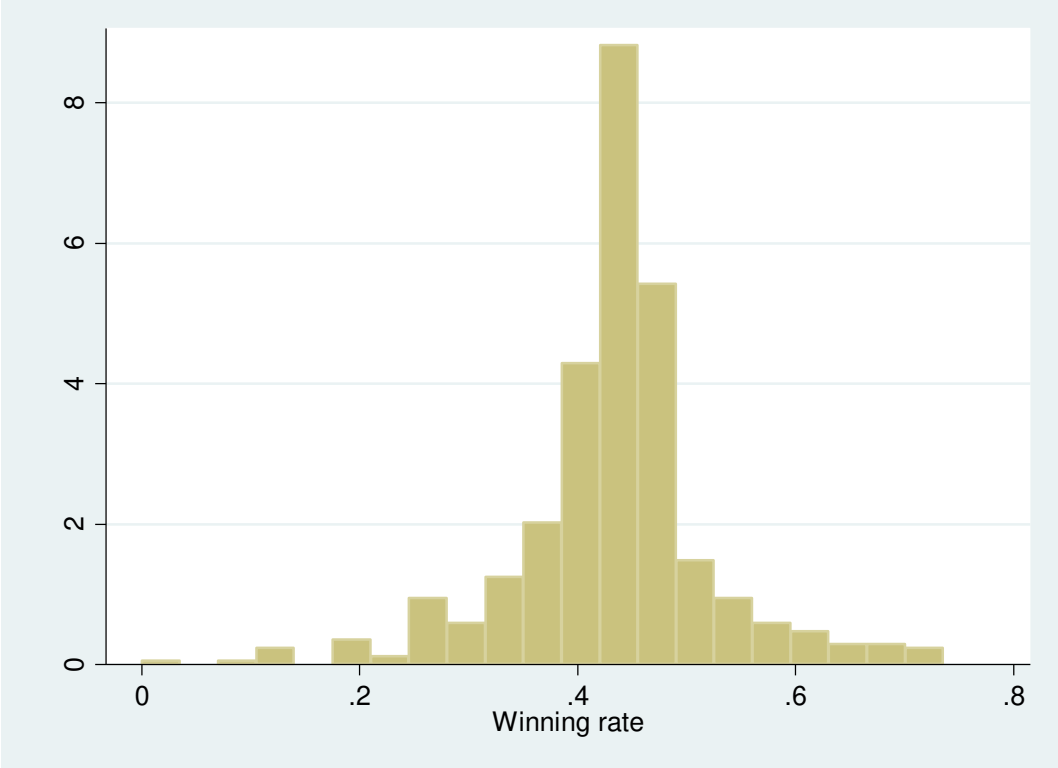


Figure 3. Distribution of winning rate

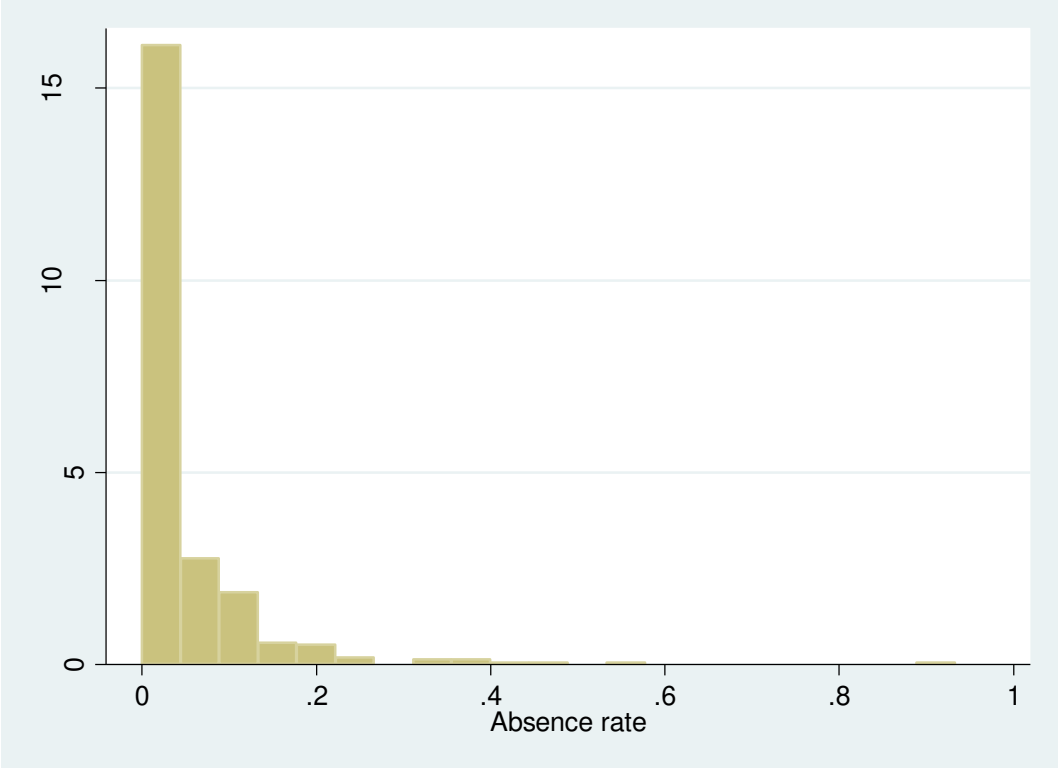


Figure 4. Distribution of absence rate

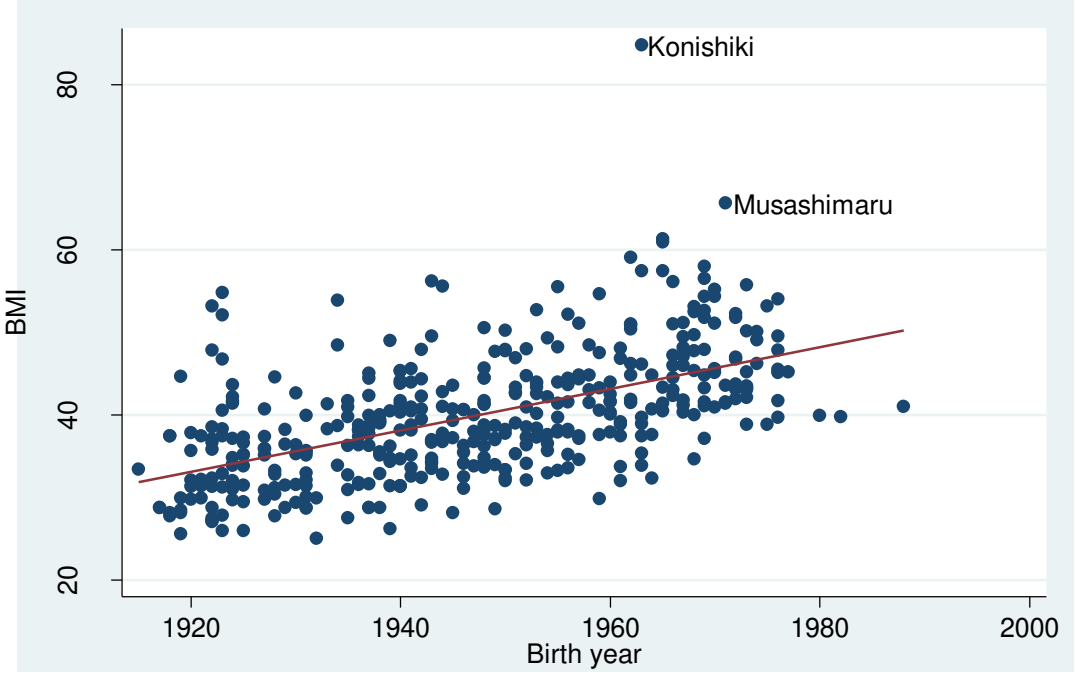


Figure 5. Association between year of birth and BMI.

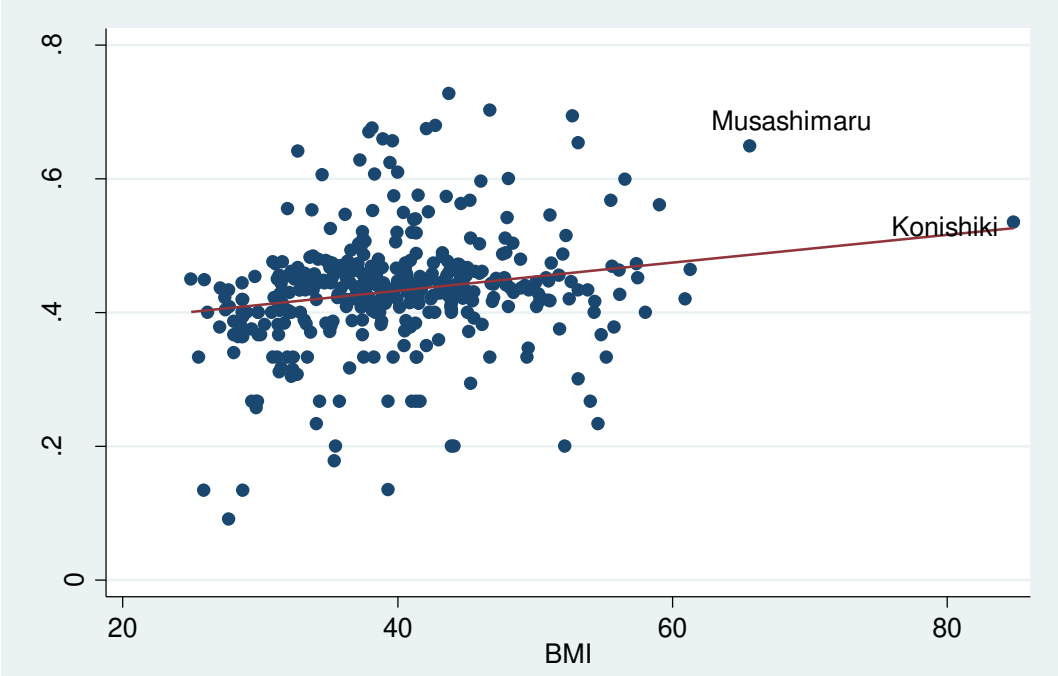


Figure 6. Association between BMI and winning rate.

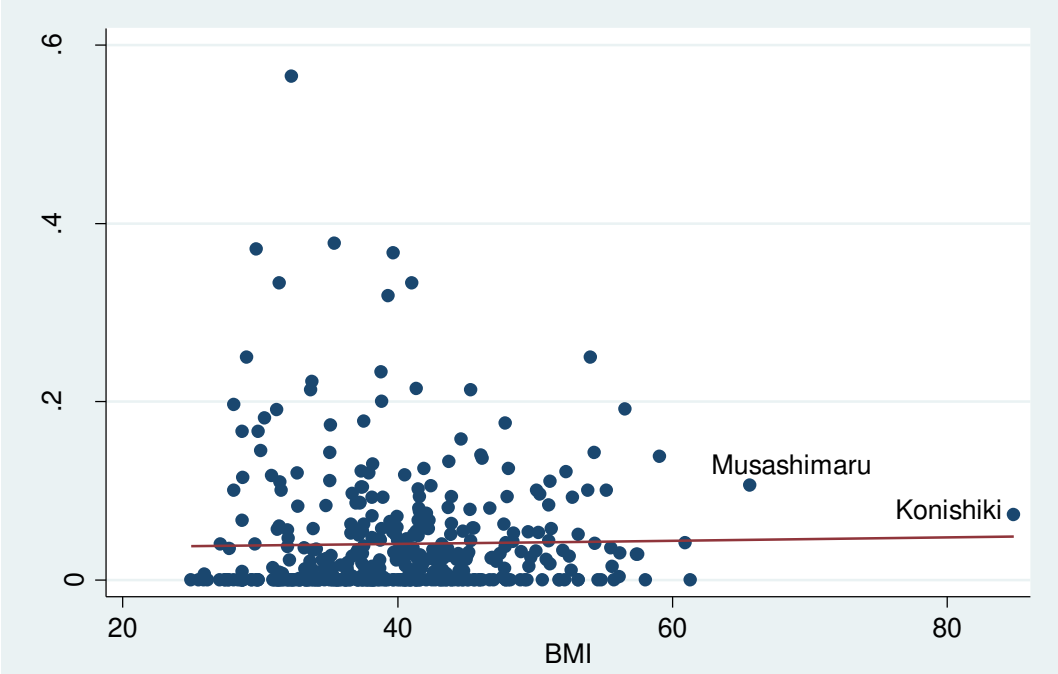


Figure 7. Association between BMI and absence rate.

Table 1
Comparison of mean values in different periods

Variable	Full sample	Early period (debut in 1945–1967)	Latter period (debut in 1968–2008)
Winning rate	0.43	0.43	0.43
Absence rate	0.43	0.43	0.42
BMI	40.6	36.1	43.2
Top division age	24.6	24.3	24.7
Foreigner dummy	0.06	0	0.09
Birth year	1951	1931	1964
Observations	411	183	228

Table 2

Comparison of mean values for domestic and foreign wrestlers in the latter-period sample

Variable	Domestic	Foreign	t-statistic
Winning rate	0.43	0.50	2.60**
Absence rate	0.36	0.53	0.88
BMI	42.5	51.9	4.32***
Observations	217	11	

** and *** indicate significance at 5% and 1% levels, respectively.

Table 3
Determinants of the winning rate (OLS model)

	(1) Full sample	(2) Early period (debut in1945–1967)	(3) Latter period (debut in 1968–2008)	(4) Latter period (debut in 1968–2008)
BMI	0.002***	0.004***	0.001	0.001
	(3.14)	(3.81)	(1.53)	(0.89)
Top division age	–0.011***	–0.007**	–0.013***	–0.013***
	(–7.72)	(–3.60)	(–6.89)	(–7.10)
Foreigner dummy	0.04**			0.05***
	(2.49)			(3.03)
Constant	0.64***	0.47***	0.71***	0.73***
	(15.2)	(7.19)	(12.1)	(12.7)
Observations	411	183	228	228
Adjusted R-squared	0.20	0.18	0.24	0.26

Note: Numbers in parentheses are t-statistics, which are calculated using robust standard errors. ** and *** indicate significance at 5% and 1% levels, respectively.

Table 4 (1)
Determinants of the winning rate (2SLS Model)

	(1) Full sample	(2) Early period (debut in 1945–1967)	(3) Latter period (debut in 1968–2008)	(4) Latter period (debut in 1968–2008)
BMI	0.0004	–0.00	0.003**	0.002
	(0.50)	(–0.60)	(2.18)	(1.51)
Top division age	–0.011***	–0.011***	–0.012***	–0.012***
	(–8.00)	(–3.73)	(–6.43)	(–6.68)
Foreigner dummy	0.05***			0.03
	(2.82)			(1.45)
Constant	0.70***	0.79***	0.59***	0.63***
	(12.4)	(4.25)	(6.77)	(6.63)
Over-identification test	0.72	0.87	1.21	0.98
	P-value = 0.69	P-value = 0.64	P-value = 0.54	P-value = 0.61
Observations	411	183	228	228
Centered R-squared	0.04	0.01	0.20	0.23

Note: Numbers in parentheses are t-statistics, which are calculated using robust standard errors. ** and *** indicate significance at 5% and 1% levels, respectively. Hansen J statistics are used in the over-identification test.

Table 4 (2)
Determinants of BMI (first stage of 2SLS model)

	(1) Full sample	(2) Early period (debut in 1945–1967)	(3) Latter period (debut in 1968–2008)	(4) Latter period (debut in 1968–2008)
Birth year	0.22***	0.17**	0.31***	0.22***
	(12.0)	(2.49)	(6.94)	(6.15)
Kanto dummy	2.51***	5.00***	–0.41	0.13
	(2.62)	(3.01)	(–0.39)	(0.14)
Kansai dummy	–0.18	0.31	–1.06	–0.62
	(-0.23)	(0.23)	(–1.10)	(–0.64)
Top division age	–0.27***	–0.27	-0.40**	–0.38**
	(-2.61)	(–1.54)	(–2.44)	(–2.51)
Foreigner dummy	7.11			6.16
	(1.62)			(1.37)
Constant	–401***	–290*	–563***	-494***
	(–10.6)	(–2.13)	(–6.41)	(–5.57)
F-statistics	43.5	9.86	13.3	9.91
Observations	411	183	228	228

Note: Numbers in parentheses are t-statistics, which are calculated using robust standard errors. ** and *** indicate significance at 5% and 1% levels, respectively. Hansen J statistics are used in the over-identification test.

Table 5

Determinants of absence rate (Tobit model)

	(1) Full sample	(2) Early period (debut in 1945–1967)	(3) Latter period (debut in 1968–2008)	(4) Latter period (debut in 1968–2008)
BMI	0.0007	–0.0004	0.002***	0.002***
	(1.08)	(–0.31)	(2.91)	(2.76)
Top division age	–0.008***	–0.008**	–0.008***	–0.008***
	(–3.81)	(–2.24)	(–3.40)	(–3.40)
Foreigner dummy	0.01			0.003
	(0.45)			(0.11)
Constant	0.18***	0.23**	0.11	0.11
	(2.81)	(2.00)	(1.48)	(1.48)
Censored observations	167	70	97	97
Observations	411	183	228	228
Log pseudo-likelihood	107.1	44.5	67.2	67.2

Note: Numbers in parentheses are t-statistics, which are calculated using robust standard errors. ** and *** indicate significance at 5% and 1% levels, respectively.

Table 6
Determinants of absence rate (IV Tobit model)

	(1) Full sample	(2) Early period (debut in 1945–1967)	(3) Latter period (debut in 1968–2008)	(4) Latter period (debut in 1968–2008)
BMI	–0.003	–0.017*	0.008***	0.009***
	(–0.21)	(–1.86)	(3.27)	(3.13)
Top division age	–0.009***	–0.018**	–0.006**	–0.006**
	(–3.84)	(–2.40)	(–2.56)	(–2.45)
Foreigner dummy	0.02			–0.05
	(0.76)			(–1.27)
Constant	0.24**	1.08**	–0.18	–0.23
	(2.50)	(2.16)	(–1.38)	(–1.53)
Over-identification test	4.39 P-value = 0.11	4.16 P-value = 0.12	2.57 P-value = 0.27	2.19 P-value = 0.33
Observations	411	183	228	228
Log pseudo-likelihood	–1222	–526	–680	–676

Note: Numbers in parentheses are t-statistics, which are calculated using robust standard errors. *, ** and *** indicate significance at 10%, 5%, and 1% percent levels, respectively. Amemiya-Lee-Newey minimum chi-square statistics are used in the over-identification test.