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Identifying the most Resilient Bangladesh Cricket Team during Run Chase in One-Day Internationals

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Abstract

The Bangladesh cricket team has made a remarkable improvement in the last 10 years. The purpose of this study is to assess the performance of Bangladesh cricket team during run chase in one-day international (ODI) cricket, and then to identify the most resilient team during the period of January, 2003 to June, 2018. The entire period of study is divided into four segments viz. 2003-06, 2007-10, 2011-14 and 2015-18. The aggregate probability of the team to win ODI matches, while chasing at different difficulty levels, is quantified for each of the time periods. Accordingly, the period in which the Bangladesh team is the most resilient is identified. The study suggests that the current team (2015-18) has higher chance of winning matches at almost all difficulty levels than the teams of other periods.

Keywords: Pressure Index, Team Performance, Cricket Analytics, Data Mining in Sports.

1. Introduction

One-day international (ODI) is a limited overs format of cricket and has been introduced in the 1960's to achieve definite outcome within a day/night as an alternative to the classical Test format of five-days. In ODI, each team bats for 50 overs and the team which scores the maximum number of runs is declared as the winner. The first official one-day international (ODI) match was played between Australia and England at the Melbourne Cricket Ground on 5th January, 1971. According to recent statistics published in www.espncricinfo.com, till 30th June,

2018, a total of 8026 number of ODI matches have been played at the international level by different countries.[1]

The recent rise of the Bangladesh cricket team, especially in case of ODI cricket, has been spectacular. In 1972, the Bangladesh Cricket Board was founded by the then Bangladesh government after the liberation of Bangladesh from Pakistan in 1971.The club-level Dhaka Metropolis Knockout Tournament was the first tournament organised in Bangladesh which was played in February and March, 1973. [2] In 1977, the Bangladesh Cricket Board sent an invitation to the Marylebone Cricket Club (MCC) for touring Bangladesh. The MCC tour helped the Bangladesh team to gain the status of 'Associate Member' of the International Cricket Council (ICC). In 1979, ICC organised a tournament for the non-Test playing countries for selection in the World Cup played in 1979. Bangladesh won two matches and lost two matches in this tournament. On February 1984, Bangladesh won the 'South-East Asian Conference Tournament' and that paved the path for their selection in the Asia Cup, 1986. Eventually, Bangladesh played their first ODI cricket match against Pakistan on 31st March, 1986. After playing for almost a decade, Bangladesh got its first ODI victory against Kenya on 12-13th April, 1997 and won the ICC Trophy, 1997. As a result, Bangladesh qualified for the 1999 World Cup and made a dramatic win against Pakistan, which was one of the most surprising results of that World Cup. On 26th June, 2000, Bangladesh acquired the status of full ICC Membership.

In ODI, the ICC ranking of Bangladesh has improved steadily over the years. The ICC ranking of the team was 11 in 2003. Bangladesh retained this rank for a few years and made minor improvement to 10 in 2006 and 9 in 2007. The rank remained the same till 2014. But since 2015, ODI ranking of Bangladesh has improved significantly, rising to 6 in 2017 and hovering at 7 in June, 2018. According to Rajesh (2016), Bangladesh has even recorded a win-loss ratio of 2.00, which is higher than England, South Africa, New Zealand and Australia in the year 2016. Bandyopadhyay (2013) opines that, Bangladesh may not have achieved outstanding records in other sports, but in cricket, especially in case of one-day internationals, improvement of Bangladesh has been commendable.

Although there are several works focused on performance measurement of different teams of other nations, the study of team performance of Bangladesh cricket is relatively few. In the present study, an attempt is made to analyse the performance of Bangladesh team during run chase in ODI cricket, and to identify

[1] http://stats.espncricinfo.com/wi/content/records/283878.html
[2] https://en.wikipedia.org/wiki/History_of_cricket_in_Bangladesh

the most resilient ODI team of Bangladesh, which is defined as a team that has higher probability of winning matches in all different match situations. Section 2 of the paper presents a brief account of literature on the team performance studies. Section 3 provides the objectives of the current study. Section 4 mentions the methodology that is used to quantify the probability of victory of an ODI team at different difficulty levels. Section 5 presents the result of the study and identifies the most resilient ODI team of Bangladesh during run chase. Some concluding remarks and direction of future research are provided in section 6.

2. Review of literature

As cricket is a team game, it is imperative to emphasize the study of team performances. One of the earliest studies in this direction is due to Clarke (1988). In his study, Clarke attempts to predict the optimal scoring rates of an ODI team for successfully chasing a target with the help of dynamic programming. In their study, Preston and Thomas (2000) investigate the optimum batting strategies for teams batting first as well as chasing teams, using data from limited overs cricket matches of English County teams. Allsopp (2005) develops a method for estimating the projected score of the team chasing a prefixed target during the second innings of ODI cricket match under home ground advantage. Barr *et al.* (2008) develop a world cricket team by studying the performance of players who has participated in the 2007 World Cup and provide some strategic suggestions so that other teams can compete well enough with the Australian team. Using an ordered response model to the data of test cricket matches of the years 1994 to 1999, Brooks, Faff and Sokulsky (2002) have shown that simple batting and bowling measures can predict test match performance of teams to a large extent. Allsopp and Clarke (2004) analyse the batting and bowling performances of teams playing both innings of ODI matches and the first innings of test matches with the help of multiple regression technique. For predicting match outcomes, the authors have used different explanatory variables viz., strength of a team in terms of batting and bowling in the first innings, team's first innings lead, batting line-up and playing a match in a home or away ground. The study concludes that in test matches, teams batting in the second innings are better placed than the other team batting first and there is no evidence to suggest that teams have an added advantage by winning the toss in case of test cricket matches. Douglas and Tam (2010) examine the team performances using several key variables in terms of batting, bowling and fielding for all winning and losing teams played in the Twenty20 World Cup 2009. They suggest that for victory in a Twenty20 match,

teams should dismiss wickets fast, bowl dot balls, and should emphasize on 50+ partnerships along with hitting boundaries while batting. Daud and Muhammad (2011) introduce an index called Team Index (T-Index) to rank cricket teams through runs and wickets. The teams are ranked by the principle that a team winning a difficult match (i.e. against a stronger opponent) shall be awarded more points than winning against a weaker team utilising the number of runs, wickets and also outcome of the match (i.e. win or loss). Dey *et al*. (2015) analyse team performance with the help of multi-criteria decision algorithms under fuzzy environment using data from limited overs cricket. To study the batting performance of Indian cricketers during 1985 to 2005 in one-day cricket, Damodaran (2006) applies stochastic dominance rules, which are normally used in investment management, by viewing players as securities and the team as a portfolio.

In case of other sports, several team performance studies have enriched our search. Sampaio and Janeira (2003) have studied the 1997-1998 and the 1998-1999 Portuguese Professional Basketball Leagues with the help of cluster and discriminant analyses to identify the game statistics that maximize mean differences between winning and losing teams according to previously defined factors (type, location and cluster groups). In a study of 288 matches played in the group stage of UEFA Champions league during the period 2007-10, Lago-Penas *et al.* (2011) analyse team performances of football in terms of win, draw and loss rather than final ranking. They conclude that the best discriminating indicators are the shots on goal, number of crosses, duration of ball possession, venue and quality of opposition. In rugby, Jones *et al.* (2004) have performed a case study of twenty matches from the domestic session of a professional rugby union and have observed statistically significant differences in winning probability as a function of percentage of line-outs won on opposition's throw, and the percentage of tries scored out of the total tries attempted.

The literature cited above reveal that though a number of studies on team performances are available based on the number of matches won by teams, very few studies have attempted to measure it based on the difficulty level of the match. A good team should be efficient in winning not only a greater number of matches, but also matches in which the situation is not in their favour. In other words, a team which is able to handle all sorts of pressure levels can be termed as a resilient team. Hence, in the present study, we determine the probability of win by different cricket teams of Bangladesh facing different levels of difficulty. The study involves four periods viz. 2003-2006, 2007-2010, 2011-2014 and 2015-

2018 and identifies the ODI team of Bangladesh that has the highest probability to win matches in all match situations.

3. Objectives

The paper achieves the following objectives:

(i) To develop a model based on pressure index that can quantify the aggregate performance of a team during run chase from several matches.

(ii) To study the team performance of Bangladesh during run chase in ODIs for the periods 2003-06, 2007-10, 2011-14 and 2015-18, and to find out which team is the most resilient one.

4. Data and Methods

4.1. Source of Data

The data for the present study are based on ball-by-ball information of all the ODI cricket matches in which Bangladesh has batted second during the period of 1st January, 2003 to 30th June, 2018, and are collected from the website www.espncricinfo.com. A total of 112 ODI matches are covered for this purpose. Tied, abandoned and rain-truncated matches have not been considered for the analysis.

4.2. Methods

The sub-section 4.2.1 discusses the concept of Pressure Index. The next sub-section 4.2.2 deals with the application of pressure index for determining the probability of victory of a team and in the last sub-section 4.2.3, the mathematical formulations of the previous subsections are utilised to find out the most resilient Bangladesh ODI team for the study period.

4.2.1 The Pressure Index

In a one-day cricket match, two teams of 11 players bat sequentially for an innings of 50 overs with 6 balls in each over. The team that bats first aims at scoring as many runs as possible to set a target high enough for the chasing team. So, the chasing team in their turn has to achieve this target before exhausting its resources i.e., 300 legal balls bowled by the opposition team or 10 wickets. Thus, the chasing team faces two types of challenges: the first one is to score runs at a comparable pace and the second one is not to lose too many wickets (resources)

before achieving the winning target. To quantify the difficulty level of the run chase, the Pressure Index defined in Bhattacharjee and Lemmer (2016) is used in the present study. The Pressure Index at any given instant during the run chase in a match is defined as,

$$PI = \left(\frac{CRRR}{IRRR}\right) \text{x } \frac{1}{2}\left[\exp\left(RU/100\right) + \exp(\Sigma w_i/11)\right] \tag{1}$$

where *IRRR* is the initial required run rate. If *T* is the target runs to be scored by the team batting second in *B* balls, then

$$IRRR = \frac{6 \times T}{B} \tag{2}$$

The current required run rate (*CRRR*) is the run rate at any point of the innings when R' runs are already scored in B' balls. Accordingly,

$$CRRR = \frac{6 \times \left(T - R'\right)}{B - B'} \tag{3}$$

Here, the ratio *CRRR/IRRR* gives an idea of whether the chasing team is lagging behind or leading by runs in achieving the target score set by the opposition team.

In the course of chasing runs, teams lose their wickets and as the loss of top ordered batsmen affect more adversely than the lower ordered batsmen, the wicket weights w_i are considered in this paper as defined in Lemmer (2005) and are provided in the Appendix 1. Also, $\sum_{i \in L} w_i$ is the sum of all the wicket weights lost by any team. Hence, $\exp(\sum_{i \in L} w_i/11)$ reflects the deteriorating batting strength of the chasing team.

Again, while batting, teams have two types of resources at their disposal viz, number of overs they are still to receive and the number of wickets they have at hand. The Duckworth-Lewis Full Table gives the percentage of these combined resources that remain for any number of overs left and wickets lost. Subtracting these values from 100, the percentage of resources utilised (*RU*) by the team are obtained. $\exp(RU/100)$ is a measure of loss of resources by the chasing team. As both the quantities $\exp(\sum_{i \in L} w_i/11)$ and $\exp(RU/100)$ reflect the loss in resources, the average of these two terms is used in (1).

If the pressure values are plotted against balls bowled and the successive points are joined, the curve obtained is known as the pressure curve. Figure 1 represents two pressure curves- one leading to a win to the team batting second (the solid line) and the other a loss to a team batting second (the dotted line).

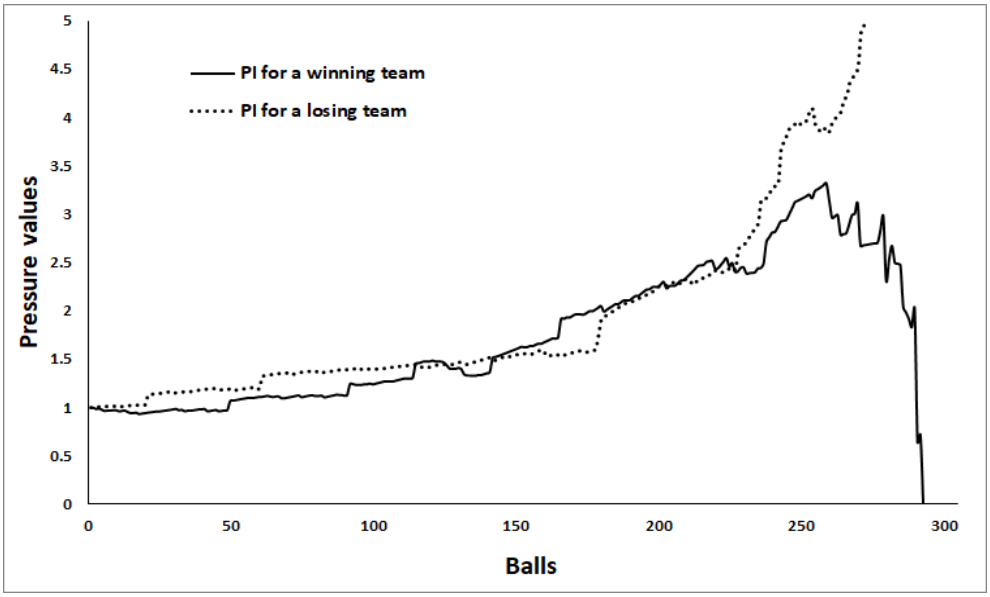

Figure 1: Pressure Curves for two matches –one leading to victory and one leading to loss for a team batting second

4.2.2 Determination of the empirical and observed probability of victory from Pressure Index values

Let the pressure curves of the run chase of a cricket team be considered in the graph. λ_i and λ_j be the two possible values of the pressure indices with $\lambda_i < \lambda_j$. The closed interval [λ_i, λ_j] be termed as the pressure zone (i, j). Let X_k represents a binary random variable taking the values,

$X_k = 1$, if the k^{th} match is won by the team

= 0, otherwise

Let, n be the number of visits and ξ be the number of visits that eventually led to victory, by all the pressure curves, in the given time period, to the pressure zone

(i, j). Thus, the relative frequency $\frac{\xi}{n}$ acts as an estimate of the probability of winning of the team given the pressure curve reaches the pressure zone (i, j) i.e.,

$$P[X_k = 1|\lambda_i < PI < \lambda_j] = \frac{\xi}{n} \tag{4}$$

As per the definition of the pressure index, PI $\in [0, \infty [$. But on observing the pressure curve of a large number of matches, some common trends are visible:

(i) If the pressure curve during any run chase reaches values less than *0.5*, then the match is ultimately won by the team batting second i.e., $P[X_k = 1|0 < PI < 0.5] = 1$

(ii) If the pressure curve during any run chase reaches values more than 3.5, then the match is ultimately lost by the team batting second i.e., $P[X_k = 1|PI > 3.5] = 0$

(iii) For the different sub intervals of PI values between [*0.5*, *3.5*] viz. $[0.5, \lambda_{i_1}], [\lambda_{i_1}, \lambda_{i_2}], ..., [\lambda_{i_m}, 3.5]$, the values of $P[X_k = 1|\lambda_i < PI < \lambda_j]$ generally starts with 1, gradually keeps on decreasing and eventually reaches 0.

So, when the values of $P[X_k = 1|\lambda_i < PI < \lambda_j]$ are plotted against the mid value of the pressure zone $[\lambda_i, \lambda_j]$, the graph is expected to produce the mirror image of an elongated '*S*'. However, the observed curve is found to produce a zigzag path, around a hypothetical curve, the mirror image of an elongated '*S*' with constant values at the tails viz. 1 and 0. Thus, a gradual decline is seen between 1 and 0, like that of decay curve (negative growth). Non-linear regression models shall be used to explore the relationship of the said probability function with the pressure index. An appropriate non-linear model that can be fitted to such a zigzag line generated by observed values of ($\frac{\lambda_i + \lambda_j}{2}$, $P[X_k = 1|\lambda_i < PI < \lambda_j]$) is the Farazdaghi and Harris (1968) yield–density equation. The Farazdaghi and Harris model (yield-density curve) is given by the equation

$$w = \frac{1}{a + bX^c} \tag{5}$$

with a, b and c as parameters of the model estimated from the data. The Farazdaghi and Harris model shows either asymptotic or parabolic yield–density

behaviour, depending on the value of c. If $c > 1$, then the curve shows a parabolic pattern.

Replacing $P[X_k = 1|\lambda_i < PI < \lambda_j]$ and $(\lambda_i+\lambda_j)/2$ in place of w and X in (5), we get the Farazdaghi-Harris curve as,

$$P[X_k = 1 | \lambda_i < PI < \lambda_j] = \frac{1}{a + b\left(\frac{\lambda_i + \lambda_j}{2}\right)^c} \tag{6}$$

where a, b and c are constants to be determined from data. A popular method for estimating the parameters of the non-linear regression function is the method of least squares. According to this method, the estimates of a, b and c are obtained by minimizing the quantity $S = \sum_{k=1}^{n} e_k^2$, where e_k represents the difference between the empirical probability (relative frequency) of victory of a team when the pressure values visit the interval $[\lambda_i, \lambda_j]$ and the corresponding estimate obtained by fitting the Farazdaghi-Harris model.

The estimation of parameters of the non-linear regression model, which cannot be converted to linearizable models through transformation, is not as straight forward as in case of linear/linearizable models. The Farazdaghi and Harris model discussed above is one such model. The estimation of the parameters of such non-linear models usually require the use of iterative methods on digital computers, as explicit formula for estimating the parameters of the models are not generally available. Most commonly available statistical software packages provide routines for calculating the estimates of parameters of non-linear models (Graybill and Iyer, 1994). We use Curve Expert Professional 2.6.5 to determine the parameters of the Farazdaghi and Harris model.

4.2.3 Fitting Farazdaghi-Harris curves to determine the most resilient team

The Farazdaghi-Harris curve as in (6) is fitted to the data for the chased matches of Bangladesh ODI teams for the four periods 2003-2006, 2007-2010, 2011-2014 and 2015-2018 and is shown in Appendix 2. The fitted Farazdaghi-Harris curve is called the resilience curve, since the curve gives the idea about the probability of victory of the team at different pressure levels.

In figure 2 (based on some hypothetical data), resilience curves of two different teams (Team 1 and Team 2, say) are plotted, i.e. the probabilities of victory of the

two teams are plotted against different pressure levels. The resilience curve of Team 1 is a smooth line and that of Team 2 is a dotted line. From the figure, one can see that the dotted line (Team 2) dominates the solid line (Team 1) for almost all pressure values. This indicates that the probability of winning of Team 2 is higher than the probability of winning of the Team 1, at almost any given level of pressure. But, at the initial stage, for low values of pressure, the Team 1 dominates Team 2, though very marginally. This indicates that in some cases, Team 2 has lost some matches which they could have won easily.

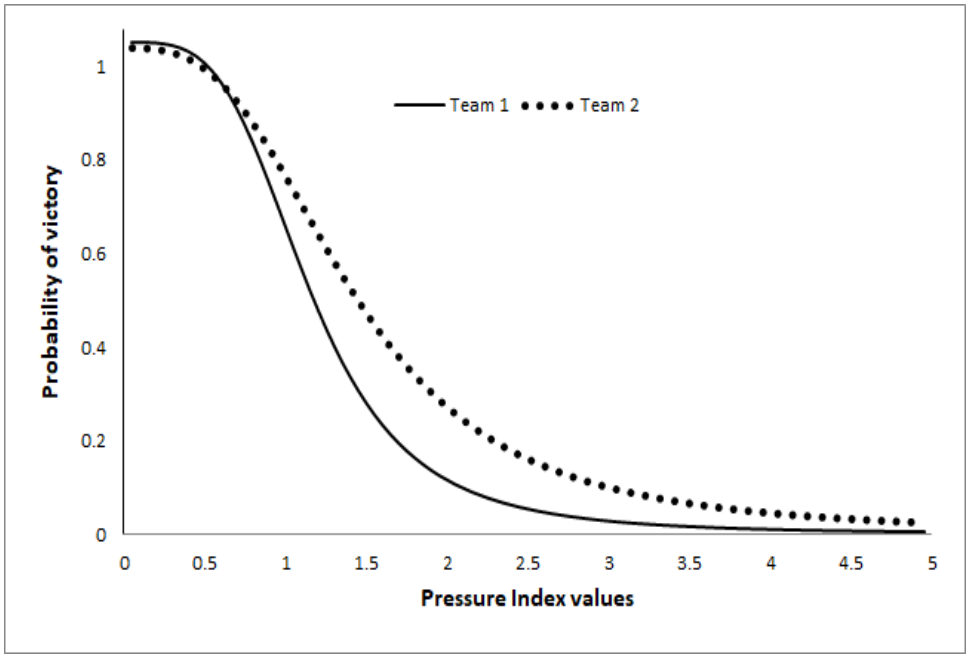

Figure 2: Farazdaghi-Harris (Resilience) Curves for two teams

Other than these few matches, the Team 2 has performed well and hence dominates Team 1 convincingly. For Team 1, it can be stated that- as the difficulty level increases, the team succumbs to the pressure and loses several matches. In other words, the Team 2 is more resilient than Team 1 during run chase.

5. Result and Discussion

During the period January, 2003 to June, 2018, Bangladesh has played 239 ODI matches which have resulted to either win or loss. The table 1 shows the total

number of matches played, won and lost by Bangladesh which are classified by innings and the time periods 2003-06, 2007-10, 2011-14 and 2015-18.

Table 1: Performance of Bangladesh team in ODI matches from January, 2003 to June, 2018

Time Periods		No. of matches	Won	Lost
2003-06	Batting Second	32	9	23
	Batting First	42	12	30
2007-10	Batting Second	34	15	19
	Batting First	39	13	26
2011-14	Batting Second	28	12	16
	Batting First	23	9	14
2015-18	Batting Second	19	10	9
	Batting First	22	12	10

*Note: Interrupted and tied matches are not considered
Source: www.espncricinfo.com

The Farazdaghi-Harris model (resilience curves) as in (6) are fitted for the different time periods viz. 2003-06, 2007-10, 2011-14 and 2015-18, and are shown in Appendix 2. A summary table is presented below:

Table 2: The fitted Farazdaghi-Harris Model (Resilience curve)

Time Interval	Values of Coefficients			R^2	R^2_{adj}	Std. Error
	a	b	c			
2003-06	0.9513	0.5700	3.7677	0.9446	0.9409	0.0905
2007-10	0.9692	0.3503	3.6801	0.9806	0.9793	0.0547
2011-14	0.9475	0.5049	3.2360	0.9541	0.9511	0.0810
2015-18	0.9525	0.4239	3.1941	0.9136	0.9080	0.1175

The values of R^2, R^2_{adj} and standard errors reveal that the fitting of the data to the model has been good.

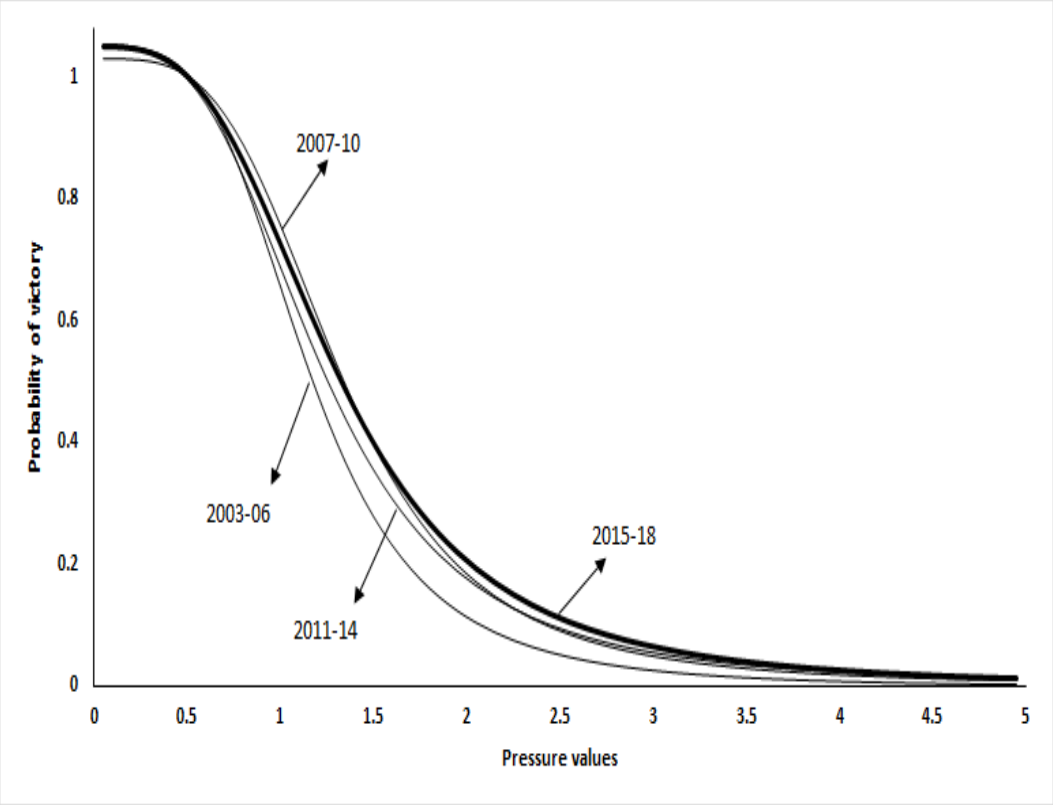

Figure 3: Farazdaghi-Harris (Resilience) Curves of Bangladesh ODI teams for all the time periods

The above figure shows all the four resilience curves for the time periods 2003-06, 2007-10, 2011-14 and 2015-18. It is observed that the performance of Bangladesh has significantly improved over the years. The curve of 2007-10 is above 2003-06 and the curve of 2015-18 is above all the other curves. However, the team of 2007-10 has won a large number of matches when the pressure level is low and hence the resilience curve representing 2007-10 is at the top of the curve of 2011-14. But the probability of victory at different pressure levels is the highest during the time period 2015-18 as compared to the other time periods. The percentage of victory during run chase also has improved with time and is the best in the latest period. This empirical work is also in keeping with the results- proving that the team of 2015-18 has higher probability of winning difficult match situations as compared to other teams, but only marginally in different pressure zones. In fact,

in the pressure zone between [0.6, 1.2], the team of 2007-10 seems to be marginally better.

The present study can significantly help the team management of Bangladesh cricket team to analyse the overall performance in ODI run-chase. The quantification of pressure level experienced by the Bangladesh team in all the time-periods under consideration may prove beneficial to coaches and managers in better decision-making. When such curves are drawn for two different teams say, Bangladesh and its opponent team, then interesting insights shall be available to both the team managements.

6. Direction of Future Research

Converting pressure curve (developed by Bhattacharjee and Lemmer, 2016) from several run chases into one resilience curve that quantifies the probability of a cricket team to win matches under different match situation, is the main methodological development of the paper. Some of the potential applications of resilience curves include:

a) With the help of resilience curve, the probability of victory of an ODI team at different difficulty levels for four different time periods is quantified. The same process can be used to compare the chance of victory of several cricket teams within a fixed time period. This is helpful to understand which team crumbles under pressure and which team has the ability to win matches even when the going gets tough.
b) From a study of resilience curves, one can also identify the teams which are inconsistent in their performances. Such teams win tough matches but lose some matches that they are expected to win very easily.
c) Also, the resilience curves of several teams drawn in the same graph can be used to explore if a team is dependent on one or two batsmen for victory or if there are several match winners in the team.
d) Further, with the development of pressure index for the first innings in limited overs cricket match, the possibility of converting several pressure curves of a team into a single resilience curve as done during run chase can be explored. This helps in quantifying the probability of winning while setting the target at different difficulty levels.
e) The methodology used in this study can also be extended to the other format of limited overs cricket, for example Twenty20.

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Appendix 1

Table 1: Wicket weights of different batting positions as in Lemmer (2005)

Batting Position (i)	1	2	3	4	5	6	7	8	9	10	11
Wicket weight w_i	1.30	1.35	1.40	1.45	1.38	1.18	0.98	0.79	0.59	0.39	0.19

Appendix 2: Resilience curves of Bangladesh for different time periods