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A quantitative approach to influential factors in One Day International cricket: Analysis based on Bangladesh

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Abstract. The Bangladesh Cricket Team has performed well in the recent past with steady traits of improvement. Apart from the players' performance, some external factors are associated with the outcome of a cricket match. This paper investigates prematch toss, batting sequence, match time, opposition team's origin and time (in years) as independent factors influencing the performance of the Bangladesh team. Outcomes of 314 One Day International (ODI) matches were fitted with a typical logistic regression model and modified Poisson model to explore the association of these factors with match results. Both models showed consistency, although the logistic model outcomes were extreme with wider confidence intervals for odds ratios, compared to the risk ratios of the modified Poisson regression model. Bangladesh, a country where cricket reflects nationalism, has shown significant improvement over time. They tend to perform better in day matches, play superior cricket against non-Asian teams and take full home advantage.

Keywords: Sports, ODI Cricket, logistic model, modified poisson model, Bangladesh

1. Introduction

Cricket is a spectator driven sport with high economic impact, attracting both local and international crowds (Gratton et al., 2000). However, it is not as widespread as football (soccer) and so has not received as much research attention (Duffeld and Drinkwater, 2008). Cricket is the reflection of nationalism in Bangladesh, which has become not only a national obsession but also a profitable market (Bairner, 2015). Bandyopadhyay (2013) went as far as to state cricket has become its only secular religion to underline the importance of cricket in Bangladesh. This paper concentrates on the external factors which are expected to influence the outcome of a cricket match, particularly One Day International (ODI) cricket. Accepting the performance variation among cricket players, the less discussed variables are considered here to check the significance of their impacts on the outcome of a cricket match. The performance of Bangladesh, an emerging nation in the cricket world, is analyzed from 1986 to 2016. This study applies the recently developed modified Poisson model to fit the data, along with the traditional logistic regression model to ascertain the applicability of the new model in sports analysis.

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2. Background

Cricket, first played in England, has not been the most popular of all sports and was mostly played in the Commonwealth countries due to Britain's colonization in the course of 19th century (Stoddart, 1998). With only 10 test-playing regular countries, cricket has the significantly less economic effect than the other international games (Cricketworld Media

Ltd, 2017). For instance, FIFA (Fédération Internationale de Football Association), an organization constituted with 221 associations all over the globe, had 3.2 billion viewers in the 2014 football world cup whereas 2015 cricket world cup attracted 1.5 billion viewers (FIFA, 2017; Rapid TV News, 2017). Gratton et al. (2000) pointed out that in the United Kingdom (UK), however, cricket appealed to the highest number of local and international spectators and generated the maximum (4.6 million USD) additional income for the host city in comparison with 5 other major sports events in the United Kingdom (UK).

There are a number of factors in a cricket match that are left to chance. These might have an impact on the game and subsequently to its result. The toss in a game of cricket matters more than it does in football or tennis. The weather condition and pitch condition compels the captain to prefer either to bat or bowl first. For example, overcast conditions may help the fast bowlers to swing the ball, which may not happen in the second innings. Day night one-day matches may experience dew later in the afternoon, which will restrain spin bowlers from properly gripping the ball. Such conditions are not important for games like football, where the dew or rain will affect both teams simultaneously. Among the different formats of cricket (Test, ODI, and T-20), ODI cricket is the most popular one (Sankaranarayanan et al., 2014); however, in recent years T-20 has grown into a more prominent version of cricket (Orchard et al., 2017). These factors tend to influence the outcome of ODI cricket matches more than other formats of the game. Analysis of the English county cricket during the 1996-97 season has shown the existence of home advantage; however, this advantage does not supersede the effect of players performance or team quality (Morley and Thomas, 2005). A statistical analysis of 427 ODI matches showed that the effect of coin toss does not significantly influence the outcome of a match (De Silva and Swartz, 1998). A study of 649 ODIs suggested batting first after winning the toss increases the chance of winning compared to bowling first (Dawson et al., 2009). Some studies ignored the matches of Bangladesh in their analysis due to their consistently mediocre performances and a low number of played matches (Ringrose, 2006). Dasgupta (2007) has given a detailed story of cricket trumping football in Bangladesh and rise of a cricket crazy nation. The rise of tigers could be flag shipped by the world cup 2007 and since then they have become a serious cricketing contender, especially on the home turf (Shams, 2011).

A number of studies have been conducted to understand the kinetics of bowling, both seam and spin, as well as injury rate among cricketers (Dennis et al., 2003, 2005; Chin et al., 2009; Hulin et al., 2013). However, a knowledge gap exists in understanding the effect of factors ‘not associated’ with players’ inbuilt performance on the outcome of a cricket match involving the Bangladesh cricket team. Cricket has been generating great revenue for Bangladesh, which is unexpected from a poor country (Mandle, 2012). Particularly in the new International Cricket Council (ICC) revenue model, they are claiming more money and Bangladeshi companies are sponsoring overseas series (ESPN SPORTS MEDIA LTD, 2017c). Additionally, this is the first study that evaluates the difference in match outcomes due to the originality of the opposition team (Asian or not). ‘Time’ (in years) is taken as an independent covariate to determine the direction of Bangladesh cricket team’s progress. Moreover, this study applied recently developed modified Poisson model alongside logistic regression model to fit the data and compare their applications in sports data.

3. Data overview

The paper focuses on studying the ODI cricket matches played by the Bangladesh team in the period from 31st March, 1986 to 12th October, 2016. All matches during this time period have been considered, except tied and suspended ones, totaling the sample size to 314. The data were extracted from ESPN Cricinfo on ODI matches played by Bangladesh (ESPN SPORTS MEDIA LTD, 2017b), which contains the information of the match outcome (win/loss), home or away ground, toss (win/loss), game plan (batting first/fielding first), match time (day/day & night), opposition team (Asian/non-Asian), and time measured in years. The outcome variable of the study is match result, which is binary in nature. All other covariates are also binary except for time (year), which is continuous.

4. Methodology

Bivariate analysis was conducted between the factors of cricket matches and result of those matches. Chi-square (χ^2) tests provided the p-values determining the strength of bivariate dependence. To acquire the direction and magnitude of the relationship among them, both the logistic regression model and the modified Poisson model were fitted with the outcome variable defined in terms of the win/loss. The logistic regression model developed by D.R. Cox (Cox, 1972) is used to study the association between a set of exposure variables and a binary response variable in terms of win/loss adjusting for covariates. The classical logistic regression model uses the logit link to produce odds ratio (OR) estimates as a measure of association. The odds ratio adequately approximates the risk or likelihood when the outcome is rare in all categories of explanatory variables; however, it overestimates when the outcome becomes more common (Greenland, 1987). Although the conversion of odds ratios to risk ratios (RR) is possible, they are not applicable in a straightforward manner when they involve covariates adjustments (Joffe and Greenland, 1995).

Poisson regression can also be used for analysis of binary outcomes to provide correct estimates of the risk. However, the conventional Poisson model tends to provide conservative results for binary outcomes (Thompson et al., 1998). A modified Poisson regression, proposed by Zou (2004), is a combination of typical Poisson model which is applied as a better alternative of logistic regression for estimating correct risks in terms of relative risks after correcting potential limitation of conventional Poisson (Yelland et al., 2011). It is frequently applied in epidemiological and public health research (Brown et al., 2005; Christakis et al., 2011). This model applies the information sandwich estimator to obtain variance estimates that are robust to the error misspecification. Moreover, the modified Poisson regression adjusts the heterogeneity of the typical Poisson regression model. This paper applied this model for sports data along with typical logistic method.

Model adequacy can be checked through R^2, which describes the proportional reduction in variation by comparing the conditional variation of the response to the marginal variation (Agresti, 2007). The Mcfadden's R^2 is a version of pseudo-R^2 statistic among the various R^2 (Matsusaka and Palda, 1999). Another statistic to explore the quality of a fitted model for a given dataset is the Akaike Information Criteria (AIC), a relative measure which can numerically express the amount of information in a model incorporating the number of covariates with maximized log-likelihood (Yamaoka et al., 1978). In addition, the Bayesian Information Criteria (BIC) is also applied which is related to the AIC, where sample size is taken into consideration. In order to calculate the model likelihoods, Bayesian methods often require computationally intensive techniques which assist in selecting the models (Gilks, 2005). The cross-validation (CV), another tool applied here, is a statistical method of evaluating models fitness by dividing data into two segments: one for training a model and the other for validating the model (Refaeilzadeh et al., 2009). In k-fold cross-validation, sometimes called rotation estimation, the data is partitioned into k equally (or nearly equally) sized independent segments or folds (Bengio and Grandvalet, 2004). This paper applied these four methods for model fitness and ensured the results were consistent. Statistical software *R* (*version* 3.2.3) was used for all statistical analysis.

5. Results

The improvement of Bangladesh in cricket is evident in this graph, where the bubble shows that the proportion of wins and the time line shows the fitted line of yearly winning proportions by Bangladesh. This reveals that Bangladesh has improved notably over the last 15 to 20 years. Bangladesh has already won back to back 6 series in the 2016-17 season at home turf giving further evidence of their emergence and effect of home ground supremacy (ESPN SPORTS MEDIA LTD, 2017a). An interesting break is observed in 1997 (Fig. 1), when Bangladesh won their first ICC trophy outperforming all the other associate nations and went on to play in the world cup. However, their true emergence is observed after 2004 as the Bangladesh cricket team started to perform against the full members.

The bivariate analysis shows that home ground advantage and origin of the opposition teams have a significant association with the match outcome (Table 1). However, the outcome of toss, game plan and match time do not display any significant impact upon the result of a cricket match according to the χ^2 tests.

Bivariate association between two variables does not imply a relationship between them after adjusting other variables. Therefore, multi-variable statistical models were fitted with the data. Both logistic regression and modified Poisson regression were applied (Table 2) and goodness of fit was examined by pseudo-R^2, AIC, BIC and CV.

The fitted models displayed similar results in terms of directions and significance; however, the OR in logistic model and RR in modified Poisson model was not same (Table 2). Particularly, RR gave very

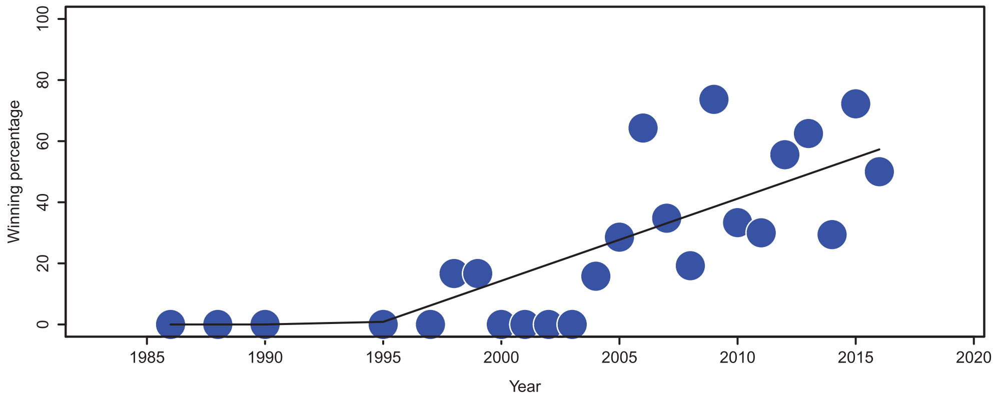

Fig. 1. Bangladesh cricket team's performance in last 20 years.

Table 1

Bivariate analysis of match results with the external factors

Variable	Scale	Result: Lost	Result: Won	P-value
Toss	Lost	113 (53.1%)	55 (54.5%)	0.911
	Won	100 (46.1%)	46 (45.5%)	
Game plan	Batting first	113 (53.1%)	47 (46.5%)	0.338
	Fielding first	100 (46.9%)	54 (53.5%)	
Match time	Day	116 (54.5%)	63 (62.4%)	0.229
	Day-night	97 (45.5%)	38 (37.6%)	
Home or away	Away	126 (59.2%)	44 (43.6%)	**
	Home	87 (40.8%)	57 (56.4%)	
Opposition team	Asian	92 (43.2%)	16 (15.8%)	***
	non-Asian	121 (56.8%)	85 (84.2%)	

***P-value< 0.01, **P-value< 0.05, *P-value< 0.10.

Table 2

Logistic regression and modified Poisson regression models fitted with outcomes of 314 ODI matches.

Variable	Logistic Regression			Modified Poisson Regression		
	OR	CI (95%)	P-value	RR	CI (95%)	P-value
Toss (ref: Lost)	1.00			1.00		
Won	0.90	0.52-1.57	0.719	0.98	0.92-1.05	0.637
Game plan (ref: Batting first)	1.00			1.00		
Fielding first	1.42	0.83-2.45	0.203	1.04	0.97-1.11	0.308
Match time (ref: Day)	1.00			1.00		
Day-night	0.44	0.22-0.86	**	0.89	0.82-0.97	***
Home or away (ref: Away)	1.00			1.00		
Home	1.72	0.94-3.15	*	1.09	1.05-1.13	***
Opposition team (ref: Asian)	1.00			1.00		
non-Asian	3.83	1.89-7.78	***	1.17	1.12-1.21	***
Year (continuous)	1.22	1.14-1.31	***	1.02	1.02-1.03	***
Pseudo-R^2		0.195			0.218	
AIC		331			742	
BIC		358			768	
CV		0.177, 0.176			0.183, 0.182	

***P-value< 0.01, **P-value< 0.05, *P-value< 0.10.

concise estimates and confidence intervals (CI), where OR gave large estimates and wider confidence intervals. It is important to note that the estimated odds ratio tends to overestimate the likelihood or chance compared to risk ratio. The logistic regression and the modified Poisson regression models showed match time, home or away, opposition team, and time as significant covariates. The direction of relationship in both models was parallel. The models were compared by applying Mcfadden's R^2, AIC, BIC, and CV score. The modified Poisson model seemed better fitted according to the pseudo-R^2 and the information criterion preferred logistic model. Near similar performance was observed in cross-validation.

Results from modified Poisson model shows Bangladesh has 11% lower chance of winning a day-night match than day matches (RR: 0.89, 95% CI: 0.82-0.97) (Table 2). Similar, however extreme, results were extracted from the odds ratio of logistic regression where the chance of winning a match at day-night is 56% lower than day matches. Bangladesh has 1.09 times more chance of winning at home compared to overseas (in modified Poisson regression), where the odds ratio is 1.72 (in the logistic model). For the opposition team, the estimated likelihood of winning is 1.17 (95% CI: 1.12-1.21) times higher against the non-Asian countries than the Asian countries according to modified Poisson regression. Odds ratio from the logistic regression model shows that the likelihood of winning is 3.83 (95% CI: 1.89-7.78) times higher against non-Asian countries compared to the Asian countries. Both models showed a positive relationship between time and outcome of matches played by Bangladesh; both were significant as well. There was no significant difference in match outcome by toss or game plan in either model.

6. Discussion

Literature states that the modified Poisson regression model is a better alternative for logistic regression. However, according to model comparison parameters applied in this data set, none of the two models stood out as the better fitted model. Hence, the influential factors on the performance of the Bangladesh cricket team are explained by both models rendering existing literature.

Bangladesh showed a higher percentage of wins in day matches (62.4%) compared to day-night (37.6%) during the last 20 years (Table 1). Both models showed the significant chance of winning a match for Bangladesh if it is played during the day. A number of underlying factors could be behind such phenomenon. Due to geographical conditions, Bangladesh is not a producer of strong fast bowlers (like Pakistan or Australia) and they tend to depend on a huge supply of spinners as it requires lesser physic (Orchard et al., 2009; Independent Publications Limited, 2017). Weather conditions and atmosphere (humidity & heat) influence the seam bowling (James et al., 2012). Similarly, dew factors come in at night, specially in the subcontinent, making the finger-spinners lose their grip on the ball to maintain the desired line and length. Thus Bangladesh, a heavily dependent team on spin bowlers, tends to do well in day matches when it is easier for spinners to perform better in a dew-free conditions.

Home advantage is a common phenomenon in every sports (Carron et al., 2005). A similar case has been found for Bangladesh, where they have lost more matches overseas (59.2%) and won more at home (56.4%). They have won more than half of the matches at home even though they were the lowest ranked test-playing country in last decade. De Silva and Swartz (1998) have shown that playing cricket at home increases the chance victory by log odds 0.5, which supports the odds and risk ratios from both of our models.

The Asian style of cricket is not homogeneous with the rest of the world. Heavy dependence on spin bowling, wristy batting style and catching style (reverse cup or orthodox cup) - all segments of the game naturally varies between Asia and rest of the world. Bangladesh's best win percentage is against Zimbabwe (58.2%), with whom they have played the highest number of ODI matches (67). The best win ratio against an Asian team is India (only 16.1%), which shows Bangladesh's under-performance against neighbors. Their elevated performance came against the non-Asian countries as more than 80% of their win (84.2%) are against non-Asians (Table 1). Bangladesh has 17% (modified Poisson model) more chance of overcoming the challenge from non-Asian teams than Asian counterparts.

Bangladesh gradually started to play more matches after 2000 and the number of victories increased as well. In recent times, it has shown remarkable performance as each year brought more victories than the previous years. The consistency of the Bangladesh cricket team's success was noticeable after the 2007 world cup and the performance graph only went up from there (Bandyopadhyay, 2013). The relation between Bangladesh's performance and time (in years) was affirmative in both models confirming their expected progress in world cricket.

This study is limited by lack of data on several factors like the Duckworth-Lewis (D/L) method results, world cup matches and revenue generated from cricket in Bangladesh. The matches that were determined by the D/L methods could refine the model and provide a more concise outcome. World cups could be considered as a threshold to evaluate the improvement of the Bangladesh team every 4 years. Moreover, a dummy variable can be added in the model to check Bangladesh performance from one world cup to the next. Another potential future research work could assess whether the economic growth of Bangladesh contributed to the recent success in cricket. Bangladesh has maintained a stabilized GDP growth rate around 6 percent over the last decade, and it is expected to result in higher investment in cricket due to its growing local popularity (Islam and Pattak, 2017).

7. Conclusion

The aim of the paper was to evaluate the superficial factors, apart from players' performance, in a cricket match. The data was based on Bangladesh, a new emerging cricketing nation previously ignored in various studies. The modified Poisson approach was applied alongside typical logistic regression to fit the variables with 314 ODI match results. The results conclude that Bangladesh tends to perform better at day matches rather than at day-night. Bangladesh, as expected, is superior at home and they are likely to win against a non-Asian team compared to other Asian counties in ODIs. It also allowed an evaluation of the effect of time on Bangladesh's performance over the years and confirm their significant improvement in past few years. The modified Poisson model and the logistic regression model both provided consistent results. However, the logistic model outcomes were more extreme with wider confidence intervals for odds ratios than the risk ratios of the modified Poisson regression model.

The study is limited by the absence of country or player ratings in the models. A better investigation can be conducted by fitting players' capabilities as well as the external variables. That will show how these factors hamper or enhance teams' performance in cricket matches.

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