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A MEASURE OF THE CURRENT BOWLING PERFORMANCE IN CRICKET

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ABSTRACT

The combined bowling rate (CBR) defined in Lemmer (2002) for use in limited overs matches and the dynamic bowling rate (DBR) defined in Lemmer (2005) for unlimited overs matches are both measures of career bowling performances. There is, however, a need for measures that can be used to assess the current bowling performances of bowlers in conjunction with their career performances. In order to meet this need, the CBR and DBR measures will be modified to reflect current performances better. Secondly, due to the importance of selecting bowlers who have high probabilities of rendering good performances, the consistency of the bowler (which also reflects the present form of the bowler) should also form part of the measure. The CBP measure developed in this paper has been used to rank a selection of South African bowlers according to their one-day careers and also their test careers.

Key words: Combined bowling rate; Consistency of bowlers; Cricket; Dynamic bowling rate; One-day internationals (ODIs), Rating of bowlers, Test cricket.

INTRODUCTION

Researchers working on the development of performance measures in cricket seem to concentrate almost entirely on batting in one-day matches. This is apparently due to the stimulus given by the Duckworth-Lewis method proposed in Duckworth & Lewis (1998) and further explained in Duckworth & Lewis (2002) for use in ODIs. A very interesting paper, which covers both batting and bowling in ODIs, is that of Beaudoin & Swartz (2003). They defined a statistic, the runs per match for a cricketer, as RM=100*(total number of runs)/(total resources used) where the totals are taken over all of the cricketer's appearances in ODIs. The measure is calculated by using the Duckworth-Lewis method. Conceptually, it is a simple yet very sensible measure. Unfortunately, as pointed out by the authors, its use is severely restricted by the enormous effort that is required to extract the necessary ODI data for analyses.

In this present paper the focus will be on measures of bowling performance in ODIs and tests alike. A comprehensive measure of bowling performance has been defined in Lemmer (2002) as:

$$CBR=3R/(W + O + W*R/(6*O))$$

where O is the number of overs bowled, R the number of runs conceded and W the number of wickets taken. This measure is normally calculated for a bowler's one-day career, but it can also be calculated for a specific innings, match or series of limited overs matches. In the case of unlimited overs matches, the dynamic bowling rate, DBR, which will be discussed later in this paper, is used.

The purpose of this study is to define a suitable measure of a bowler's current bowling performance. Following the approach used in Lemmer (2004a), CBR is modified in such a way that recent bowling performances carry higher weights than performances further back in the bowler's career. It is also necessary to define bowling consistency and show why this is important and necessary to be included as part of the current bowling performance measure.

BOWLING CONSISTENCY

The value of the CBR for the i-th innings will be indicated by CBR_i whereas the career CBR up to the i-th innings will be indicated by $CCBR_i$ for i = 1,2,…,n, where n indicates the number of ODI innings in which the bowler has bowled. There is no simple relationship between $CCBR_n$ and the individual CBR_i. Note that $CCBR_j$ is not equal to $ACBR_j$, the average of all the CBR_i up to the j-th innings. By plotting the $CCBR_j$ and the $ACBR_j$, it can be seen from Figure 1 that the figures have very similar patterns but $ACBR_j$ is larger than $CCBR_j$ for j>1 and more sensitive to exceptionally large (i.e. bad) CBR_i values.

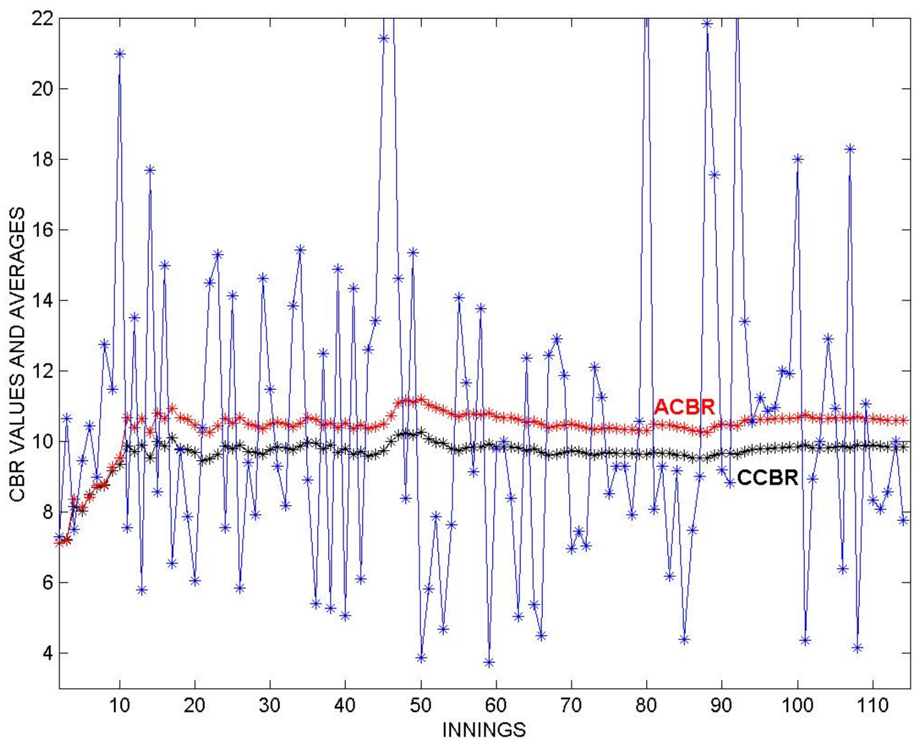

FIGURE 1. **CBR VALUES AND CURVES OF CCBR AND ACBR IN ODIs: M. NTINI**

From a statistical point of view a bowler's consistency can formally be defined as the coefficient of variation of the CBR values, i.e. the standard deviation of all the CBR values divided by their mean. After the j-th innings, this would be $B_{1j} = S_{1j}/ACBR_j$ where:

$$S_{1j}^2 = \sum_{i=1}^{j} (CBR_i - ACBR_j)^2/(j-1).$$

The use of ACBR is, however, not satisfactory because CCBR is the actual career performance measure. Note further that the CBR values are observed sequentially as in a time series, and at stage i it is logical to compare CBR_i with the career value $CCBR_i$. A better measure would thus be $B_{2j} = S_{2j}/CCBR_j$ where:

$$S_{2j}^2 = \sum_{i=1}^{j} (CBR_i - CCBR_i)^2/(j-1).$$

This measure is, however, still not satisfactory for the present study because a very small CBR value (i.e. a very good bowling performance) contributes to saying that the bowler is inconsistent. On the other hand, a bowler whose CBR values all lie close to the CCBR values will be called consistent, but such consistency only means more or less average performances.

This study prefers a non-symmetrical definition of consistency by saying that a bowler is consistent if he often obtains CBR values much smaller (better) than his CCBR value. This will happen if his CBR values are mostly below CCBR with some far below CCBR. The aim is to accentuate values far below CCBR but to allocate little or no weight to values above CCBR. This can be accomplished by defining $B_{3j}=S_{3j}/CCBR_j$ where:

$$S_{3j}^2 = \sum_{i=1}^{j} (CBR_i - CCBR_i)^2 \, Ind\{CBR_i < CCBR_i\}/(j-1)$$

The indicator function is defined as follows: Ind{A} = 1 if the event A is true and Ind{A} = 0 if A is not true. In order to judge whether this measure works satisfactorily, consider a case study consisting of the bowling figures after 36 innings. A twofold graph is drawn in Figure 2 with CCBR and the individual CBR_i in the top figure and B_3 in the bottom figure.

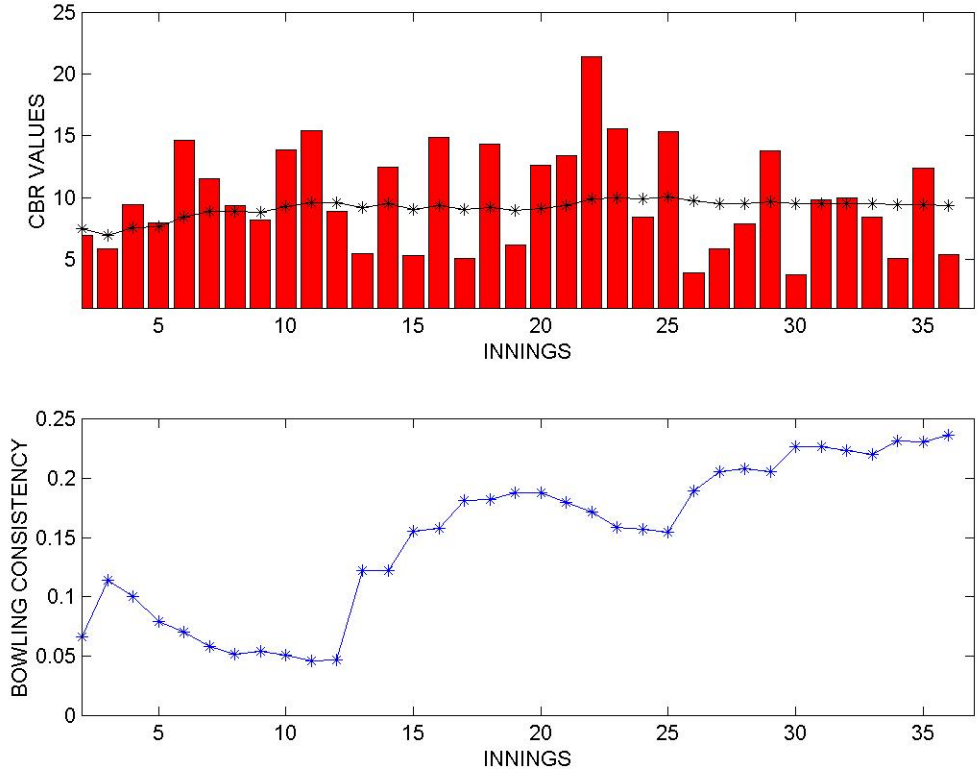

FIGURE 2. **TOP: CASE STUDY ODI VALUES: CBR AND CCBR**
BOTTOM: CASE STUDY ODI BOWLING CONSISTENCY

Since bad performances are not penalized, the curve does not respond to such cases. Careful examination reveals that in six cases the consistency curve of B_3 moves in the wrong direction. In the 14th match the performance was bad, but the curve shows a slight increase from the previous match. In match 33, a good performance is accompanied by a decrease in the curve. It is often difficult to judge whether the curve increases or decreases, i.e. whether it moves in the right direction. To quantify this, define the deviation $d(j)=CBR_j-CCBR_j$ and the increment of the consistency curve by $inc(j) = B_{3j} – B_{3,j-1}$. The signs of d(j) and inc(j) should differ. Define the product pr(j) = d(j).inc(j) and m_1 = proportion of cases where the signs differ, i.e. where the product is negative. The value of m_1 should be close to 1. In the case of Figure 2, m_1=0.824. Some of the increments are very small, so it is better to take the sizes of the deviations and increments into consideration too. Define npr as (-1) times the sum of the negative products and ppr as the sum of the positive products. Then let m_2 = npr/(ppr + npr). In the case of Figure 2, m_2 =0.985.

The measure B_3 can be improved by taking the positive deviations d(j) into account too. Let $BC_j=S_j/CCBR_j$ where:

$$S_j^2 = [\sum_{i=1}^{j} (CBR_i - CCBR_i)^2 \, Ind\{CBR_i < CCBR_i\}$$
$$- \sum_{i=1}^{j} (CBR_i - CCBR_i)^d \, Ind\{CBR_i > CCBR_i\}]/(j-1)$$

with $S_j = 0$ if […] <0, and where d = 1. If a bowler performs very well in an innings, the value of BC_j will increase markedly, but if he performs very badly, the value of BC_j will decrease only moderately due to the choice of d = 1. Measures B_1, B_2, B_3, BC and various other versions have been considered. The choice of a value for d to be used in BC was based on extensive studies in which various values of d have been considered. The value of d determines how severely bad performances are penalized. If d = 2 (as for good scores), such scores could overshadow good ones because even for the best bowler, the distribution of CBR is skewed to the right. The value of d should thus be scaled down from 2 in relation to the length of the left tail relative to the right tail of the distribution. Thirteen experienced ODI bowlers have been selected from a data set mentioned below, all their CBR_i values have been calculated and a distribution has been fitted to these 1430 values. As expected, a gamma distribution yielded a very good fit. When examining the distances of certain percentiles from the overall CBR value for the whole set, the indications were that the value of d should be in the range from 1 to 1.2. By plotting the consistency curves of many bowlers, it was found that with d = 1.2 the drop in the consistency curve for bad performances appeared too severe compared to d = 1. Taking into account that even the best bowler can occasionally have bad match figures due to the bad fielding of his team and not because of his bad bowling, it was decided to use the value d=1. Details of this extensive process have been discussed in a conference lecture (Lemmer, 2004b).

For the case study, the BC measure worked well and yielded $m_1 = 0.971$ and $m_2 = 0.999$. The consistency curve is given in Figure 3.

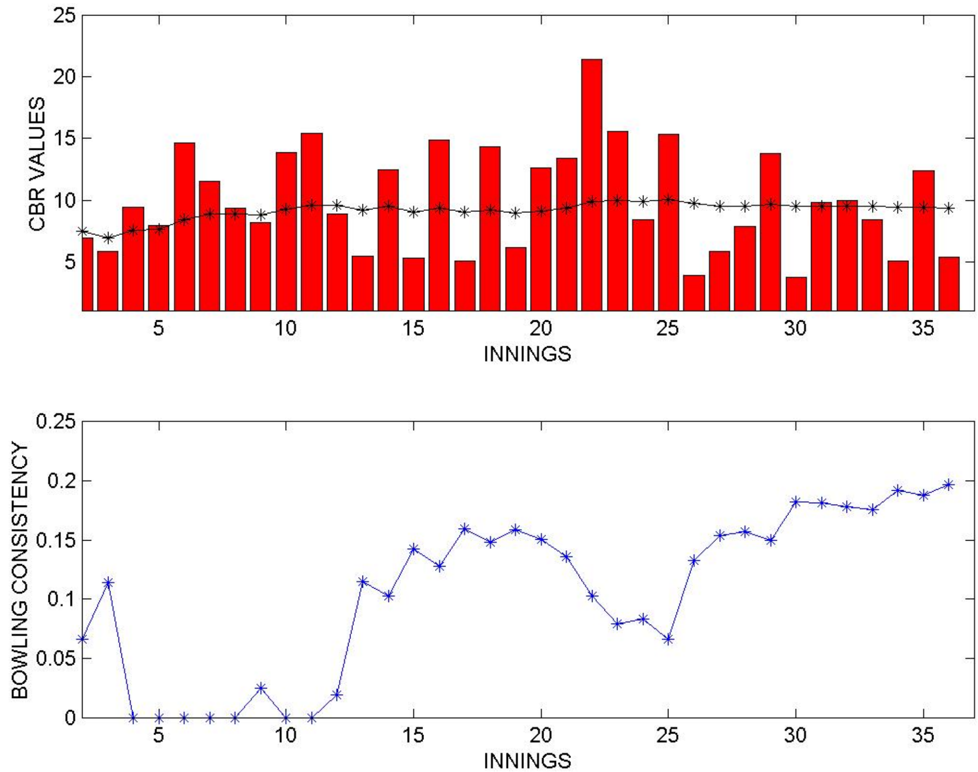

FIGURE 3. **TOP: CASE STUDY ODI VALUES: CBR AND CCBR**
BOTTOM: CASE STUDY ODI BOWLING CONSISTENCY

The curve is sensitive to very bad (high) CBR values and to very good (small) values. Initially, the curve may fluctuate a great deal, but it stabilizes as the number of innings played increases.

From the definition of bowling consistency, it is clear that consistency is a desirable characteristic. In order to learn more about bowling consistency, it is necessary to apply it to real data. Consider a data set consisting of the bowling figures of all the current bowlers of all ODI teams who have bowled at least one hundred overs each, taken on 02/02/2005 from Cricinfo (2005a). If the career consistency BC of each bowler is calculated, it is found that BC has an almost normal distribution with average 0.17333 and standard deviation 0.057138.

Consistency is an important requirement for a good bowler because it can be expected that a consistent bowler will normally bowl well with only occasional bad performances. In order to provide a further perspective on bowling consistency, it can be related to the probability of a good bowling performance. A bowler will be judged to have bowled very well if his CBR_i value in a match is smaller than $0.7CCBR_i$, i.e if his CBR_i value is at least 30% better than his current $CCBR_i$ value. For the data set, the relationship between the consistency measure BC and the probability of a very good performance has been found as PROB = 0.042 + 0.813BC. A very consistent bowler with BC = 0.30 has a 29% probability of a very good performance, whereas an inconsistent bowler with BC = 0.10 has only a 12% probability of a very good performance.

CBR is a formal measure based on all the bowling figures of the bowler, irrespective of the time span of his career. In the construction of a measure of current performance, it is important to attach more weight to recent performances compared to performances far back in time. One possibility is to calculate CBR for the last ten, twenty or thirty matches, indicated by CBR10, CBR20 and CBR30. Each of these, however, takes no account of any previous performances. A better approach is to use all the career figures, but to allocate high weights to recent figures and progressively lower weights to figures further back. The method proposed here is to use weights according to those of an exponentially weighted average (cf. Lemmer, 2004a). The weights are, however, not applied to the individual CBR_i, but to each of the consecutive match values of O, R and W separately. If the last (most recent) set of scores of O, R and W has a weight ω, the weight of the second-last set is $\beta\omega$, the weight of the third last set is $\beta^2\omega$, etc., where $\beta=1-\alpha$ with α being a suitable value. The weighted sums of O, R and W are then used as in the CBR formula to calculate the value of the exponentially weighted CBR measure, WCBR. In Lemmer (2004a) the value used for α was 0.04. In this study, the values 0.04, 0.06, 0.08 and 0.10 were considered. By calculating the correlation between each of CBR10, CBR20 and CBR30 on the one hand and WCBR with each of the α values, it was found that CBR20 and WCBR with $\alpha=0.06$ had the highest correlation (r=0.96). The choice of α was further facilitated by plotting $CCBR_i$ and $WCBR_i$ jointly on the same graph for each of the α values considered. This has been done for a large number of bowlers and the choice of α was confirmed. Note that CBR20 (which is based on only twenty CBR values) is much more sensitive to exceptionally good or bad performances than WCBR, which makes it unsuitable as a career performance measure. For illustration purposes, the graphs of English bowler Ashley Giles are given in Figure 4 for $\alpha=0.06$. The more stable curve ending at the top in the top figure is CCBR.

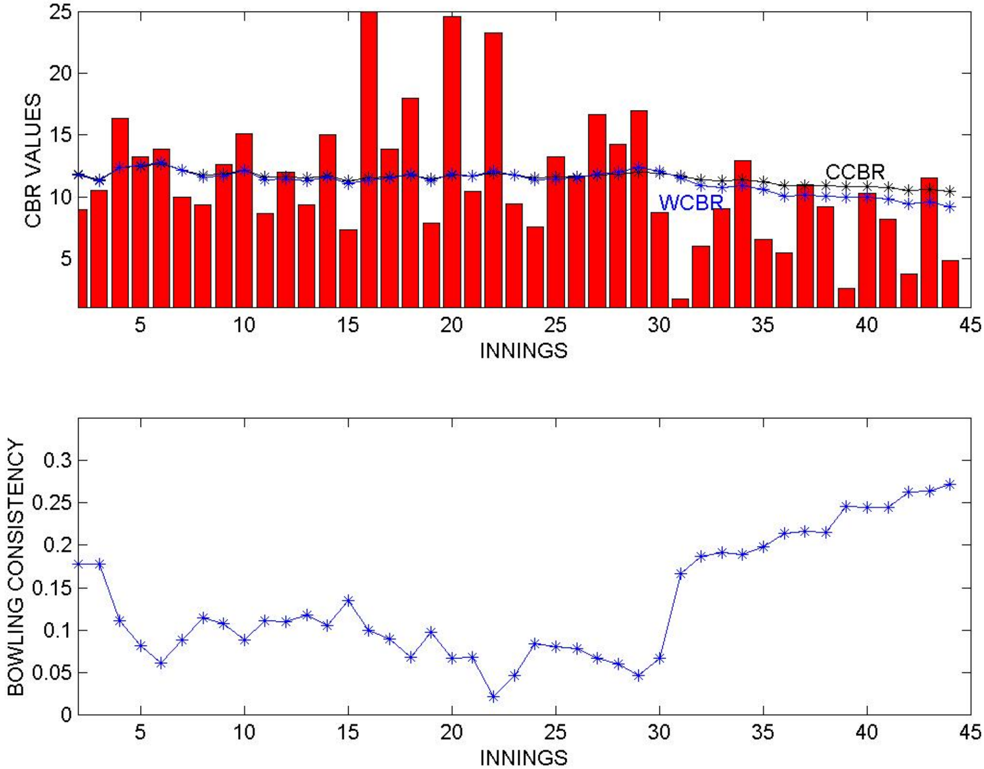

FIGURE 4. **TOP: GILES' CAREER ODI VALUES: CBR, CCBR AND WCBR**
BOTTOM: GILES' CAREER ODI BOWLING CONSISTENCY

Up to his 30th match, Giles had a mixture of good and bad performances, resulting in low consistency, as can be seen on the bottom graph. From the 30th innings, he became much more consistent as shown on the graph and reflected by the increasing gap between the CCBR and WCBR curves. It is clear that the final value of WCBR quantifies the bowler's current performance better than the final value of CCBR. It was thus decided to use WCBR instead of CCBR as a basis for the new measure. This is similar to the use of EWA in the construction of BP for batting – cf. Lemmer (2004a). Note that the high percentage of good (lower than CCBR) CBR values in the latter part of Giles' career reflects his high consistency, despite the appearance of inconsistency in a normal statistical sense.

CURRENT BOWLING PERFORMANCE MEASURE

To have a measure that has a large (rather than small) value in the case of good performance, it is better to use the inverse of WCBR, namely 1/WCBR. In order to take consistency into account too, 1/WCBR must be scaled up or down by using A = BC/average(BC) = BC/0.17333 in a suitable way. For the data set it is found that the average of A is 1.0000 and the standard deviation of A is 0.32965. In the construction of the batting performance measure BP in Lemmer (2004a) the consistency scale factor C had an average of 1.0000 and a standard deviation of 0.0677. In order to obtain a similar scale factor here, consider B = A^c with c such that the standard deviation of B is as close as possible to 0.0677. Using the same trick as in Lemmer (2004a), let c = 0.0677/0.32965 = 0.2054. Then the average of B is 0.9934 and its standard deviation is 0.0674. These statistics are very similar to the scaling factors C and RP in Table 3 in Lemmer (2004a), and are shown in Table 1.

TABLE 1. **STATISTICS OF ODI DATA SET**

	BC	A	B	C	RP
Average	0.1733	1.0000	0.9934	1.0000	0.9969
Standard deviation	0.0571	0.3297	0.0674	0.0677	0.0681

The measure of current bowling performance is defined as CBP = 100*B/WCBR where the factor 100 is conveniently used to avoid working with too many decimals. This can be used to rank bowlers in order to select the best ones. For comparison purposes it is useful to classify bowlers into ten classes according to their current bowling performances (see Table 1 in Lemmer, 2004a). The classification table is given in Table 2, which also includes the classes for the current bowling performance measure in the case of test matches (discussed below). A bowler with CBP >11.19 falls in class one, the best class.

TABLE 2. **A CLASSIFICATION SCHEME OF TEN CLASSES FOR CBP VALUES FOR TESTS AND ONE-DAY INTERNATIONALS**

Class number	Interval for tests	Interval for ODIs
1	7.26^+ - ∞	11.19^+ - ∞
2	6.86^+ - 7.26	10.06^+ - 11.19
3	6.50^+ - 6.86	9.62^+ - 10.06
4	6.15^+ - 6.50	9.21^+ - 9.62
5	5.94^+ - 6.15	8.81^+ - 9.21
6	5.74^+ - 5.94	8.33^+ - 8.81
7	5.51^+ - 5.74	7.97^+ - 8.33
8	5.20^+ - 5.51	7.61^+ - 7.97
9	4.77^+ - 5.20	6.91^+ - 7.61
10	0.00 - 4.77	0.00 - 6.91

The use of the current bowling performance measure (CBP) is now illustrated. In Table 3 the South African bowlers who had, at the end of the 2004/2005 season, bowled at least 100 overs and played at least 20 ODIs have been ranked according to the CBP.

TABLE 3. **RANKING OF SA ODI BOWLERS ACCORDING TO CBP**

Rank	Name	Average	CBR	WCBR	BC	PROB	CBP	Class
1	A. Hall	28.92	10.53	10.35	0.264	0.214	10.53	2
2	S. Pollock	24.15	9.04	10.19	0.211	0.238	10.22	2
3	M. Ntini	22.86	9.83	9.87	0.162	0.175	9.99	3
4	N. Boje	35.41	11.10	11.13	0.139	0.154	8.59	6
5	L. Klusener	29.95	11.04	11.73	0.177	0.165	8.56	6
6	J. Kemp	32.56	11.15	11.58	0.161	0.217	8.51	6
7	A. Nel	30.49	11.21	11.47	0.103	0.091	7.84	8
8	J. Kallis	31.90	11.31	12.79	0.156	0.198	7.65	8
9	R. Peterson	69.56	12.84	12.82	0.146	0.150	7.53	9

Much useful information can be obtained from this table. According to the traditionally used average, Ntini should be in the first place. The better, more comprehensive, combined bowling rate (CBR) would place Pollock first. Note that both CBR and WCBR should be as small as possible. A comparison between the values of CBR and WCBR is very informative because the latter places more weight on recent performances. In Hall's case WCBR = 10.35 is smaller (better) than CBR = 10.53, indicating that he was improving his bowling performances. Except for Peterson, all the other bowlers were going the opposite way round – Ntini and Boje only slightly, but Pollock and Kallis quite drastically. Looking at bowling consistency (BC), Hall stands out as much more consistent than all the others, with Pollock in second place. The probability of a good bowling performance, which is, according to previous discussion, related to BC, is highest in the case of Pollock, Kemp and Hall. All these considerations are jointly accommodated in the CBP measure, which places Hall in the top position as the best South African ODI bowler at the end of the 2004/2005 season. In comparison with all the current ODI bowlers (according to the classification scheme in Table 2), Hall and Pollock were in class 2, Ntini in class 3 and the rest below average.

TEST MATCHES

The measure proposed in Lemmer (2005) for bowling performance in the case of unlimited overs matches is the dynamic bowling rate:

$$DBR = 7R/(4W + O + 2W*R/(6*O)).$$

The steps that are required for the construction of a measure of current bowling performance are the same as for the CBP above and can thus be presented much more concisely. Data is recorded per innings and not per match.

The value of DBR for the i-th innings is indicated by DBR_i and the career DBR value up to the i-th innings by $CDBR_i$, $i = 1,2,\ldots,n$. The bowling consistency coefficient after j innings is defined as $BC_j = S_j/CDBR_j$ where:

$$S_j^2 = [\sum_{i=1}^{j} (DBR_i - CDBR_i)^2 \, Ind\{DBR_i < CDBR_i\} - \sum_{i=1}^{j} (DBR_i - CDBR_i)^d \, Ind\{DBR_i > CDBR_i\}]/(j-1)$$

with $S_j = 0$ if […] <0, and d = 1. The choice of the most appropriate value of d has again been confirmed by examining the consistency curves of test bowlers.

For further developments, a data set consisting of the bowling figures of all the current test bowlers who have bowled at least one hundred overs each, was taken from Cricinfo (2005b) on 02/02/2005. The career consistencies of all of these 87 bowlers have been calculated and it was found that the distribution of BC is approximately normal with average 0.19809 and standard deviation 0.08642.

It is well known that in the case of test matches bowlers are less restricted than in ODIs and can therefore perform better, as can be seen from the ordinary bowling measures (the average, the economy rate and the strike rate). The requirement for a very good bowling performance will thus be slightly stricter than in the case of ODIs, namely if the bowler's DBR_i value is at least 33% better than his $CDBR_i$ value, i.e. if $DBR_i<0.67CDBR_i$ he has bowled very well. For the data set it was found that the probability of a very good performance is given by PROB = 0.06 + 0.757BC. For an inconsistent bowler with BC = 0.10 the probability of a very good performance is 8.2% and for a very consistent bowler with BC = 0.35 the probability of a very good performance is 27.1%. This confirms the importance of bowling consistency and motivates its utilization in the construction of a measure of bowling performance.

To obtain a measure reflecting current performances, one can start by calculating DBR for the last ten, twenty or thirty innings and indicate these by DBR10, DBR20 and DBR30. Much better, however, is an exponentially weighted measure WDBR constructed similarly to WCBR. Again the α values 0.04, 0.06, 0.08 and 0.10 were considered and it was found that the highest correlation (r = 0.96) existed between DBR20 and WDBR with α = 0.06. The measure of the current bowling performance is now constructed by using 1/WDBR and scaling it up or down by using an appropriate power of A = BC/0.19809. For the data set the average of A is 1.0000 and its standard deviation is 0.43627. Using the same downscaling technique as in the case of the batting performance measure of test batsmen in Lemmer (2004a), calculate c = 0.0718/0.43627 = 0.1646. Let $B = A^c = A^{0.1646}$, then the average of B is 0.9890 and its standard deviation is 0.0732. These statistics are summarized in Table 4. By comparing them with the statistics of BP from Table 6 of Lemmer (2004a) it is clear that the scaling is very satisfactory.

TABLE 4. **STATISTICS OF TEST DATA SET**

	BC	**A**	**B**	**C**	**RP**
Average	0.1981	1.0000	0.9890	1.0000	0.9937
Standard deviation	0.0864	0.4363	0.0732	0.0718	0.0729

For tests and other unlimited overs matches, the measure of current bowling performance is defined as CBP=100*B/WDBR. By calculating the CBP for each bowler in the data set and estimating the deciles of the distribution of the CBP, the classification scheme is as given in Table 2.

A ranking of the current SA bowlers who had, at the end of the 2004/2005 season, bowled at least 100 overs and played at least 15 test matches is given in Table 5.

TABLE 5. **RANKING OF SA TEST BOWLERS ACCORDING TO CBP**

Rank	Name	Average	DBR	WDBR	BC	PROB	CBP	CLASS
1	A. Nel	25.45	14.02	13.13	0.189	0.071	7.56	1
2	S. Pollock	22.09	11.92	13.20	0.189	0.184	7.51	1
3	L. Klusener	37.91	14.66	14.59	0.263	0.274	7.18	2
4	M. Ntini	29.22	15.27	14.91	0.176	0.155	6.58	3
5	A. Hall	37.19	16.41	17.23	0.288	0.259	6.17	4
6	J. Kallis	31.60	14.49	15.87	0.162	0.180	6.10	5
7	N. Boje	37.49	15.47	17.16	0.138	0.138	5.49	8
8	M. Hayward	29.80	16.07	16.90	0.096	0.103	5.26	8
9	G. Smith	87.29	20.34	20.83	0.137	0.115	4.52	10

According to the career dynamic bowling rate (DBR), Pollock should have been in the top position, but the large increase from DBR = 11.92 to WDBR = 13.20 clearly indicates that towards the end he was out of form. This gave Nel the opportunity to shift into the first place. That this was justified can be seen by observing that he showed great improvement towards the end with WDBR = 13.13, much smaller than DBR = 14.02. Ntini also showed marked improvement and Klusener to some extent, but all the others fell back. Hall and Klusener were very consistent with relatively high probabilities of good bowling performances. Measured against the total group of current test bowlers used to draw up the classification Table 2, Nel and Pollock were in class 1, Klusener in 2, Ntini in 3, Hall in 4 and Kallis in 5.

CONCLUSION

Bowling consistency was defined and a suitable measure (BC) developed to quantify it. A bowler's consistency is important in its own right because it gives an indication of the present form of a bowler and the likelihood that the bowler will perform well.

A bowler's present form can also be judged by comparing WCBR and CBR in the case of one-day matches and WDBR and DBR in unlimited overs matches.

The current bowling performance measure (CBP) defined in this study is a joint measure that takes into account all the important measures of bowling performance. It is completely objective and thus not subject to personal prejudices. Its calculation is by means of an easily programmable algorithm using only the bowler's career values of O, R and W per innings played.

Measures like the CBP and others discussed here and in previous publications indicate that selectors often do not succeed in selecting the best players. The challenge is to convince cricket statisticians, coaches and selectors to use these measures in order to select the best players, measure their performances on a regular basis and train them to reach and maintain their optimal performance levels.

The following comments by one of the referees are very valid: "Research in virtually all disciplines has become increasingly dependent on the application of statistical techniques. If civilization is to progress, our knowledge must be increased at all levels and statistics is an essential link in this process because it entails the development and application of techniques for interpreting cricket data".

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