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Estimating the performance of basketball players when fouls drawn are unknown

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Abstract
Historical comparison of performance is relevant for the field of basketball analytics, in order to obtain a wider picture of the productivity in disparate basketball seasons and ages. However, when achieving comparisons of historical performance of basketball players, the problem of lack of data of fouls drawn in previous seasons arise. This research has proposed a method of estimating the global performance of players when fouls drawn are unknown, in order to achieve a better comparison of the productivity of basketball players across different seasons.

Keywords: Basketball, NBA, player total contribution, statistics, fouls drawn, player productivity

Introduction
Fouls drawn are an important variable for determining indexes measuring global performance of basketball players. Drawing a fouls means in some cases the opportunity to go to the free throw line, and in every case the threat of expulsion (by accumulating fouls) for the player who make the foul. Therefore, fouls drawn contribute to the evaluation of performance of basketball players, although the weight of such variable is different depending on the system of evaluation considered. For example, the Spanish ACB League system of evaluation weights fouls drawn with 1 point (equivalent to 1 point scored), and the Player Total Contribution (PTC) index (Martínez, 2019a) [5], weights fouls drawn as 0.23 (with respect to 1 point scored). However, if we try to achieve comparison of historical performance of basketball players, we face the problem of lack of data of fouls drawn in previous seasons. For example, in the official NBA stats site, there is no reliable data of fouls drawn previous to the 2005/2006 season. For the ACB Spanish League stats site, there is no reliable data of fouls drawn previous to the 1990/91 season.
The aim of this research is to propose a method of estimating the global performance of players when fouls drawn are unknown, in order to achieve a better comparison of the productivity of basketball players across different seasons. In particular, we are going to focus of analysis in the estimation of the PTC (Martínez 2019a) [5]. Therefore, we provide a way to improve the historical comparison of player performance.

Methods
We will consider the index Player Total Contribution (PTC), which has been presented in Martínez (2019a; 2019b; 2019c) [5, 6, 7]. PTC is an index to evaluate the performance (production) of basketball players, which is based only on box-score data, and it has been validated using disparate procedures (Martínez, 2019a) [5].
PTC = 1 PTS + 0.91 BLK + 0.58 DRB + 0.92 ORB + 0.86 STL + 0.48 AST + 0.23 FD - 0.91 MFG – 0.57 MFT – 0.86 TOV – 0.23 PF
Where: PTS: points made; BLK: blocks made; DRB: defensive rebounds; ORB: offensive rebounds; STL: steals; AST: assists; FD: fouls drawn. MFG: missed field goals; MFT: missed free throws; TOV: turnovers; PF: personal fouls made.
We computed the per minute version of the PTC (PTC/MP) for the 2007 to the 2019 NBA regular season. In addition, we computed the same index but without considering fouls drawn (PTC/MP_wfd).

We employed a linear approximation to predict PTC/MP (1)

$$PTC/MP_i = \beta_0 + \beta_1 PTC/MP\_wfd_i + u_i \quad (1)$$

Where PTC/P_i is the Player Total Contribution per minute for each i player, β are the weights of the version without fouls drawn: PTC/MP_wfd_i (being β_0 the intercept), and u_i is a random error. It is a model assumption that $cov(x, u) = 0$.

In order to avoid non-reliable data of performance related to players who played a low number of games and minutes we employed a filter; a minimum threshold of 28 games and 500 minutes played. The total sample size after applying the filter was of 4405 observations.

Once obtained the estimates in the training sample (ePTC/MP), we tested them in a validation sample: the NBA 2005/06 regular season (where fouls drawn were also available).

Results

Results of the OLS estimation is showed in Table 1.

Table 3: Results of the OLS estimation

	Coefficient
PTC/MP_wfd	1.0512***
Constant	0.0002
R^2	0.9971***

**p<0.001

The Breusch-Pagan/Cook-Weisberg test for heteroscedasticity was significant $\chi^2 = 264.86; p < 0.001$, therefore robust standard errors were computed.

The linear fit was almost perfect, as Figure 1 shows:

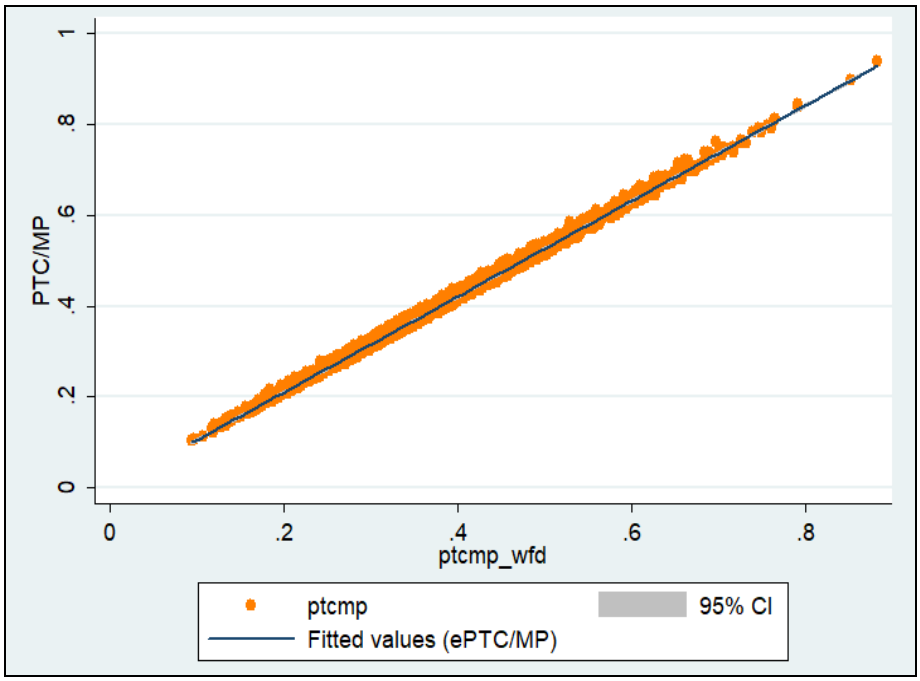

Fig 1: Estimated PTC/MP (ePTC/MP)

The validation sample

We applied the estimated coefficient (1.0512) to predict the PTC/MP for the 2005/06 NBA regular season. The variance of the residuals of both training and validation samples were quite similar when applying the filter (minimum games and minutes played) and without applying it. Results are shown in Table 2:

Table 2: Distribution of PTC/MP for the 2018/19 NBA regular season and probabilities

Seasons	**Residual variance with the filter**	**Residual variance without the filter**
2007-2019	0.0000369	0.0001057
2006	0.0000412	0.0001091

Discussion

Historical comparison of performance is relevant for the field of basketball analytics, in order to obtain a wider picture of the productivity in disparate basketball seasons and ages. Basketball analytics is a growing field of research since the works of, for example, Berri (2008; 2012) [2, 3], Berri, Schmidt & Brook (2006) [1], Hollinger (2005) [4] or Winston (2009) [8].

It is not clear, however, how this estimation could keep these high level of reliability for seasons in the 60s or the 70s, where the game was quite different. This is a limitation of this research that it seems difficult to overcome. However, and considering this shortcoming, the method presented in this study could serve to achieve a more robust and confident analysis of historical data.

Further research could do similar analyses for other basketball leagues, in order to check if the estimated coefficient provided in our study is stable.

Conclusion

This paper has presented a way to estimate the productivity of basketball players when fouls drawn are unknown, or when data available is not reliable. The equation for achieving the prediction is simple:

$$ePTC/MP_i = 1.0512 PTC/MP\_wfd_i$$

Therefore, analysts, media and fans have a tool to estimate the performance of basketball players for previous seasons in order to achieve historical comparisons.

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Conflicts of Interest: The author have no conflict of interest to declare.

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