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Pitcher's Name	Daniel Murray	**Purpose**	General Research Project: Mathematics (A10)

(A) Working Title	Measuring efficiency in the National Rugby League
(B) Basic Research Question	How well do teams in the National Rugby League play up to their potential?
(C) Key paper(s)	Anthony Bedford, James Baglin, 2008, Evaluating the performance of an ice hockey team using interactive phases of play, IMA Journal of Management Mathematics, no. 2, pg 159-166 Carlos Pestana Barros, Pedro Garcia-del-Barrio, 2008, Efficiency measurement of the English football Premier League with a random frontier model, Economic Modelling, no. 25, pp 994-1002 Afriat, S.N., 1972. Efficiency estimation of production frontiers. International Economic Review 13, 568-598 Richard A. Hofler, James E. Payne, 1997, Measuring efficiency in the National Basketball Association, Economics Letters, no. 55, pp 293- 299 García, J., Ibáñez, S.J., Gómez, M.A., Sampaio, J, 2014, Basketball Game-related statistics discriminating ACB league teams according to game location, game outcome and final score difference, International Journal of Performance Analysis in Sport, no. 2, pp 443-452
(D) Motivation / Puzzle	Sports fans frequently debate about which team is the best, usually by quoting won-lost records. Conversely, many coaches talk less about won-lost records and more about their teams "playing up to their potential" Puzzle: Can stochastic production frontier models measure efficiency within a Sports League?
THREE	**Three** core aspects of any empirical research project i.e. the "IDioTs" guide
(E) Idea	"Core" idea: The novel idea is efficiency will be measured by the application of the stochastic frontier methodology developed by Aigener et al. (1977, Journal of Economic Studies). The stochastic frontier model which will be employed in this study was developed, and continues to be largely used, in a production context. It is natural to address efficiency in that case and easy to understand what it means. In the case of a sport, however, terms like production, frontier and efficiency may not have clear meanings. For this discussion, 'production' means a team's wins. The 'frontier' and 'frontier production' refer to the maximum attainable (potential) wins that a team can achieve, given its players, coaching and other circumstances. Finally, 'efficiency' describes how closely to its potential a team approaches. Central hypothesis(es): Teams will become more efficient at reaching their potential when: • The ratios of tackles and missed tackles is hypothesised to have a positive impact on team wins when >0. These two variables measure the quality of a team's defensive ability. • The ratios associated with effective plays and ineffective plays is hypothesised to have a positive impact on team wins when >0.

	These two variables measure the quality of a team's ability to execute strategic decisions. • The ratios of Completions and Errors is hypothesised to assist increases in wins when >0. These two variables measure the ability of a team to effectively keep possession of the ball.
(F) Data	(1) Country/setting: Australia, National Rugby League Unit of analysis: Individual teams Sampling: Weekly Type: Game related (2) Expected sample size: 16 teams on 5 years (2009-2013) (3) Data Source: NRL.com. No hand-collecting required. Timeframe: No major time delays; Research assistance needed?: No; Funding/grant?: No; (4) Standard data - Nothing novel, high quality data from NRL.com (5) Will there be any problem with missing data/observations? Nothing major, just standard issues (6) Will your test variables exhibit adequate("meaningful" variation to give good power?: Yes. Large and "meaningful" variation will be inherent in the results of NRL games.
(G) Tools	Basic empirical framework: Stochastic frontier model Econometric software needed/appropriate for job? Python Knowledge of implementation of appropriate or best statistical/econometric tests?: Yes Compatibility of data with planned empirical framework?: Yes, already used and admitted in the existing literature
TWO	**Two** key questions
(H) What's New?	Idea is novel - The idea of "Measuring efficiency" to reach a competitive advantage in game results is novel. While the (positive) effect of measuring efficiency on the National Basketball Association, Major League Baseball and UK Premier League has been studied in prior research, the more specific effect of 'measuring efficiency' has never been applied to the National Rugby League. The main novelty therefore lies into a focus on measuring efficiency, accounting for -1- determining the NRL's ability to measure potential predictions -2- analysing a team's ability to improve and evaluate current inefficiencies.
(I) So What?	Considering the measurement of efficiency in a team's ability to maximise potential is of particular interest for NRL clubs and relevant associations on one side, and socially responsible investors on the other. Indeed, both need to understand the underlying mechanisms that prompt teams to increase winning potential. As each season is becoming more unpredictable, understanding how improvements in efficiency ratios can influence a team's victory capability will play a crucial role in the success of a club.
ONE	**One** bottom line
(J) Contribution?	Primary source of the contribution: The idea that teams focus more on increasing efficiency to reach their team's potential under competitive pressure is our main contribution. We test this idea by considering efficiency is dependent on a number of factors intuitive to success, while other studies focus on a number of variables unrelated to direct success.
	Is collaboration needed/desirable? -Idea: No -Data: No -Tools: No Target Journal: Journal of Mathematical Social Sciences, Journal of Mathematic

(K) Other Considerations	Modelling, Journal of Economic Theory, Journal of Economic Behaviour and Organisation? To be discussed. "Risk" assessment: - "No result" risk: Low- the source of contribution rather comes from the angle of approach, any results can be interesting, although it will be easier to 'sell' the paper if we get significant coefficients: -"competitor" risk (ie being beaten by a competitor): LOW - No current papers are being written at the moment in relation to measuring efficiency against and Australian sports league -risk of "obsolescence": LOW - efficiency issues are attracting a growing interest, and investors are becoming more and more competitive, the subject is likely to remain topical for a while.

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