1 Introduction

This dissertation represents a selection of empirical microeconometric essays applied to topics in health, sports and education which reflect my professional and personal interests. Although very distinct fields, the common theme running through the chapters is the application of econometric methods based on a theoretical framework aimed at addressing policy issues and hopefully leading to more informed decision making by policy makers. The questions addressed are: whether to approve for national reimbursement a policy shifting some of the burden of care of treating the elderly on many repeat prescriptions from family doctors to community pharmacists; identifying the impact of post-season play-offs on regular season game attendance and whether play-offs should be extended and finally a review of the economics of the use of funding formulae in education in England and Wales and the potential consequences for educational outcomes based on different allocations of funding among primary schools.

1.1 Outline of Thesis

In chapter two I build an economic evaluation model of a medical intervention which is designed to share the burden of the regular treatment of the elderly on many repeat prescriptions from family doctors to community pharmacists. The model is designed to meet the requirements of the National Institute of Health and Clinical Excellence (NICE) reference case model, the framework by which new technologies and medications are assessed for their suitability for reimbursement in England and Wales.

The chapter begins by outlining the reference case model: introducing the core summary concepts of the Incremental Cost-Effectiveness Ratio (ICER), Incremental Net Monetary Benefit (INMB) statistics and the Maximum Willingness To Pay (MWTP) for an effect, before outlining the role that the NICE has played in formalising these concepts into a reference case model. Particular attention is drawn to the treatment of parameter uncertainty by the reference case model – rather than
being used as reject or not-reject hypothesis test and thus the basis for decision making, it is used to identify the probability of an incorrect decision and represented by Cost-Effectiveness Acceptability Curves (CEACs). Furthermore by combining this probability with the cost of making an incorrect decision, it is used to inform the decision as to whether (and where) future research is required.

I then discuss the reasons why the use of econometrics (with exception of survival models) has been rather marginalised in health economic evaluations and then why there may be an increasing need for such models. I outline three main requirements that models should fulfil to fit reference case needs.

An economic evaluation model of pharmaceutical care plans for the elderly on 5 or more prescriptions is produced populated by parameters derived from a five part econometric analysis of data generated by an interrupted time series trial. The use of econometric models is motivated by the data generating process which may make the simple comparison of before and after misleading if costs and benefits are naturally expected to change over time. I find that the evidence on benefits is rather weak, but according to the NICE reference case framework, points towards a cost-effective intervention.

In chapter three I address the conventionally held wisdom that play-offs systems, by virtue of prolonging the extent to which participants within a competition still have an opportunity to achieve a desirable end-of-season outcome, increase attendance during that competition. The chapter is illustrated with an empirical estimation of the impact of the current English promotion play-off system in a single season of the second top tier of the professional football divisions relative to the old system of automatic promotion for the final-placed top three teams.

The theoretical model underpinning this chapter is one which is based on a simple model of production of demand for individual games. The intuition being that different designs of play-offs have different implications for the creation and distribution of demand drivers across individual games and thus may influence attendance. The chapter thus spends some time reviewing the demand for attendance literature but identifies that there were no existing sufficient measures which may
meaningfully enter a demand function. Taking a cue from how another sports economics topic has (largely) been resolved i.e. the Uncertainty of Outcome hypothesis, which suffered from the same issue and found its solution via betting odds, I develop measures of match significance which are based on the probability of a team achieving the end-of-season outcome. These match significance measures are directly affected by competition design and may also enter as right hand side variables in a regression model.

In identifying match significance, an important stylised fact comes to light: although play-off designs do create more games where there is still some significance in the match outcome, it does so by distributing a fixed stock of significance across more games. Furthermore, it tends to distribute significance down the league and thus more likely to redistribute significance from bigger teams to smaller teams i.e. from teams with a greater ability to turn demand drivers into attendance to teams with limited ability. It is thus an empirical question whether the creation of significant games outweighs the effect of redistributing significance to matches involving smaller teams.

The econometric estimation accounts for the skewed and heteroscedastic nature of the data by using Random Effects in a GLM framework. The multiplicative nature of the log link creates an interaction between demand variables and the team-specific random effects thus creating a mechanism to allow for a bigger impact of play-off affected demand variables on bigger teams. The endogenous allocation of demand variables and the potential problem it may create via a correlation with team random effects is also catered for by including team-averaged variables in the specification. Multicollinearity, specifically a strong correlation between significance variables, remains an issue that remains unresolved though a sensitivity analysis reveals the likely extent of the impact. A final data issue remains in the calculation of match significance. Although the measures have prima facia validity, it is likely that this is an area in which further refinement is required.

I find that the play-off system has increased attendance at regular season games, however the effect is small (less than 1%) and not uniform across teams. This leads to the question as to whether the increase in attendance is worth the relative threat to the integrity of the competition.
In chapter four the empirical content is provided by the estimation of an education production function using three years worth of data on the spending and educational outcomes from all primary schools located in a single English Local Education Authority (LEA). The research was motivated by a request from the LEA to advise them on whether the latest version of national formula funding was causing them to lose out on national to LEA level funding and secondly to provide any guidance on how to allocate funding across schools.

The chapter therefore begins with a clarification of the rationale and nomenclature for formula funding with specific reference to education and the evolution of funding formula ‘generations’. I then explicitly tie together the underlying theory of the education production function, the production possibility frontier and definitions of the formula generation to show that the current third generation formula is essentially choosing a specific but arbitrary point on the production possibility frontier. This leads to the suggestion that a fourth generation funding formula should consider just exactly where on the production function frontier that policy makers should be aiming for. This requires knowledge not only of the education production function, but also of the education social welfare function. I argue that this element of the decision making process has been largely ignored and in no small part led to the ‘2003 funding crisis’.

I then present a literature review of both education production functions and education social welfare functions. In terms of volume of research, the difference between these two important elements required for optimal decision making is stark with the production function literature dwarfing the social welfare literature. This discrepancy (which admittedly I add to with this dissertation) is possibly due to the generally consistent but contentious findings that the relationship between funding and educational outcomes is somewhat inelastic – a situation which has led to a fifty year (and counting) argument between a number of economists with Hanushek on side arguing that the results are valid and indicative of the fact that we are operating on the flat part of the education production function and a whole host of economists on the other arguing, that the findings are beset by methodological issues (notably
endogeneity of funding) and a belief that the results are not as insignificant or inelastic as painted by Hanushek.

I then present an econometric model which attempts to estimate the impact of funding on the probabilities of pupils achieving set levels in mathematics and English at key stages one and two. A two-part model is estimated to account for the bi-model nature of the outcome data with a logistic model estimating the probability that a pupil registers at least a minimum score and a second ordered-logistic model to assess the conditional impact of funding of successful pupils across higher levels. In order to incorporate heterogeneous school production functions, a random coefficient model is estimated with an adaptation to allow for endogenous funding.

I find that increased funding does indeed lead to improved outcomes. However in line with the other two chapters, the practical effect is very modest, even after correcting for the endogenous allocation of funding.

1.2 Publications, Funding and Acknowledgements

The research contained in chapter two was conducted with a number of colleagues from the University of York, University of London, Swansea University, RAND Corporation, The University of Hull, East Riding and Hull local Pharmaceutical Committee, University of Leeds, University of Kent and the University of Huddersfield as part of a larger evaluation of the RESPECT project funded by the Medical Research Council (grant reference G0001150). This chapter focuses on the economic evaluation component of the overall project which was the responsibility of three economists: Professor Mark Sculpher, Dr Zoe Philips and myself, all of the University of York. Mark Sculpher was responsible for the overall delivery of the evaluation and Zoe Philips was responsible for the initial collection of trial results and accompanying model parameters (i.e. costs of primary care use). The econometric modelling and application of results in the NICE framework are my own work and the focus of this chapter, though I benefited from the advice and guidance of all fellow authors in the RESPECT team. An oral presentation of this research was presented as a top-ranked abstract plenary presentation at SMDM in Boston 2006 and a version of
Chapter three contains work that originates from my personal interests and was unfunded. A version of this chapter was published as a chapter in the book Statistical Thinking in Sports (Bojke, 2007) and has been presented at the first European workshop in sports economics at the Rijksuniversiteit Groningen in 2005, at the 30th Annual Meeting of the Society for Medical Decision Making in Philadelphia in 2008 (they had a special sports section prior to the conference meal) and more recently as an invited speaker for the department of economics at the University of Newcastle upon Tyne in 2010.

The work contained in chapter four was originally a project commissioned to help inform the funding allocation decisions of the Swindon Local Education Authority, who provided access to data on their primary and secondary schools over a 3 year period (although much is also available in the public domain.). The original research was conducted with National Foundation of Educational Research (NFER) colleagues Dick Downing and Mary Atkinson and this chapter may be regarded as an extension of that original work. My thanks go to my ex-colleagues and Swindon LEA for their help, support and permission to allow this work to contribute to my thesis.