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## Microeconomic essays in health, sports and education economics

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## 5 Thesis Conclusions

### 5.1 Summary and Policy Implications

The general theme running through the course of this dissertation is the estimation of production functions (of health related quality of life and costs; of attendance and of educational attainment) using econometric methods. Although the statistical methods are given context by being based on an underlying theory, the ultimate objective of each of the chapters is not to test a hypothesis, but rather lead to more informed policy or decision making processes. It is meant to be scientific with a small 's' as Ziliak and McCloskey (2004) would describe it. In practice this has led to: probably a greater emphasis on the actual distribution of  $Y$  as a function of a policy amenable variable,  $X$  rather than just the conditional distribution; a lack of emphasis on hypothesis testing; and the adoption of GLM models as opposed to transformations of the dependent variable.

These differences are probably most obvious in the health economics chapter which attempts to use econometric models in an established framework of decision making – the NICE reference case model. The econometric models suggest that: there is no statistical nor real practical effect on survival of the intervention; there is an increasing trend in expected costs over time for patients and that the impact of the intervention is to increase these costs in the first instance, but over time this incremental cost declines to zero. The impact on a patient's health related quality of life is hindered by a lack of observation points and results are generally statistically non-significant, though indicate a positive impact of the intervention. From a narrow statistical point of view there is a greater certainty that costs will be increased than there is that the health related quality of life will be increased. Nevertheless, when the reference case framework is adopted and expectations are shown as an ICER the NICE interpretation of the analysis is that the evidence points to a cost-effective medication. The lack of precision of the estimates is identified when Probabilistic Sensitivity Analysis is conducted which shows the considerable uncertainty that surrounds the probability that the intervention is cost-effective. An Expected Value of Perfect Information calculation which, driven by the uncertainty, the ratios of two

small numbers and large population affected identifies a very high value for future research. Thus the current limited evidence suggests the intervention is cost-effective but there is a very strong case for revisiting this decision once further evidence is available.

One further point worth making is that the econometric models indicate that perhaps the choice of trial population and the possibility that it may not accurately reflect the population that could be affected in a national roll-out may have created a misleading ICER. The models show that although the benefits appear to be fairly uniform across the population, the incremental cost of the intervention was lowest at the lower bound of the trial population. If it can be argued that PC would affect patients under 75 and/or elderly patients on fewer than 5 repeat prescriptions then there are grounds for arguing that the ICER will be expected to be lower in real-life than it was in the trial.

The overall conclusion is that although the established framework of synthesising the evidence suggests the intervention is cost-effective, the reality is that the intervention appears to have a very marginal impact on both costs and benefits and that there is still a great deal of uncertainty surrounding the estimate of the benefit.

In chapter three I identify the economic issues surrounding the design of sporting competitions, specifically the impact of post-season play-off designs. The main question I address is whether the perceived wisdom that play-offs create increased attendance within regular season games is supported by evidence. In doing so I argue that there is no satisfactory existing theoretical framework on which to build the econometric model. Thus, unlike in chapter two, there is a greater degree of defining the economic framework in which to address the issue of altering the size or structure of play-off systems. In doing so I propose a concept of match significance that is similar in many respects to the current measures of match uncertainty. The benefit of the new measure is that it reduces the potential for undesirable properties and anomalies and establishes a clear link by which play-off systems may influence attendance. I tentatively suggest a practical measurement of this concept which appears to produce sensible results but has a number of limitations which may be addressed in future research.

The impact of the competition design on the distribution of significance is then illustrated by building a counterfactual top three automatic promotion system and assuming that individual match results would have occurred as was under the actual system. This comparison is illuminating as it shows the play-off system has created a significant number of matches where there is at least some end-of-season significance in the result of the match. It does so however by spreading a fixed stock of significance across more games. Furthermore it tends to distribute significance further down the league to smaller teams with perhaps lower ability to convert demand variables such as match significance in to attendance. The question of whether play-offs do increase attendance is thus an empirical question rather than one in which the theory may offer a firm conclusion.

The econometric estimation of the model is hindered by a potentially quite severe multicollinearity problem, however results are robust enough to offer support to the notion that play-off systems do indeed increase attendance at regular season games. However, the increase is rather modest, approximately a 1% increase in attendance over the season. The impact is not universal across all teams with in this case a few teams losing quite a few supporters and several teams picking up individually smaller (but collectively bigger) gains in supporters over the season. As such, there is also a hitherto unknown effect on the equity of the distribution of supporters across teams which may represent an unknown benefit. The results also tentatively suggest that extending the play-offs to incorporating more teams would increase attendance, but the chapter concludes by asking whether the costs of the play-offs, the promotion of an inferior team with an increased probability of first-season relegation, are sufficiently recognised and taken into consideration.

In chapter four I look at the economics of formula funding of education in England. The empirical content is provided by an ordered logistic regression model of key stage attainment as a function of school pupil population characteristics and endogenously allocated funding in primary schools in a single local education authority over three years. The chapter starts however with an outline of how formula funding has been evolved over recent history and explicitly links each 'generation' to the standard underlying education production function model. In doing so I illustrate the limitations of the current 3<sup>rd</sup> generation funding formula and suggest what a 4<sup>th</sup>

generation formula should incorporate, explicit incorporation of the societal welfare function. I also argue that these (predictable) limitations directly contributed to the 2003 funding crisis and thus illustrate the importance that policy-makers should give to the consideration of the implications derived from the underlying theory.

The chapter then reviews the literature on social welfare functions in education and the estimation of education production functions. There is very little on the former but a rather heated argument on the results produced by the education production function which has lasted forty plus years has led to an incredible wealth of empirical studies on the education production function. The evidence is clearly mixed with the majority of papers suggesting a small impact of funding but a non-negligible number of studies finding no or even a negative effect. Three arguments have been put forward to explain these outcomes. The first argues that the evidence is not as mixed as suggested, this argument focuses on the fact that most papers demonstrate a statistically significant impact of funding on education. To my mind this is precisely the type of empirical economics that this dissertation is striving to avoid – a narrow focus on the statistical properties of an estimate with really very little consideration given to the underlying policy questions of interest. The second focuses on the econometric issues that occur when dealing with endogenously allocated funding and the predictable bias that may arise if such issues are ignored. The endogenous allocation of funding is an issue that I explicitly model in the empirical content in this chapter and although it makes a fairly substantial impact on the magnitude of the regression equation parameters, converting the parameters into education outcomes reveals the effect is still rather small in practical terms. Thus my conclusion is in broadly in line with the third argument; that western economies are operating on the flat part of the education production function and that future policy should perhaps focus on means of shifting the education production function rather than pursue movements along it.

Furthermore, although I estimate an inelastic relationship between increased funding and improved educational outcomes there appears to be a stronger impact on those pupils who achieve at least the minimum outcome than those who fail to meet the minimum national standard. This suggests that increasing funding further may not

only be a relatively expensive policy but also lead to greater inequalities in educational outcomes.

## **5.2 Outline of Future Research**

A number of future research directions have already been clearly indicated in this conclusions section: further evidence on the impact on the HRQoL of Pharmaceutical Care, a better means of measuring significance of individual matches and estimation of the social welfare function in education. Of these it is the measure of match significance in which I would like to make one further contribution. Perhaps not surprisingly I believe the answer lies in betting odds, however the odds of season outcomes per team rather than the odds within individual results. If it is possible to track, say the probabilities of teams being promoted over the course of a season (and such betting markets do exist) then it will be possible to model the impact of games on such odds and hence a more direct measure of significance.

In terms of the econometric modelling a number of changes and improvements spring to mind. Firstly I extensively use random effects across all models. However when dealing with explicit and permanent units of interest such as football teams or schools within an LEA, then in future research I would more inclined to use fixed effects on the basis that the units are not a random draw from a population of interest, they are the population of interest. And the parameters associated to such units are not a nuisance parameter to be purged from the analysis, rather they are a fundamental item of interest and should be treated as such.

I would also like to implement an improvement in the means of simultaneously estimating model parameters. This is most apparent in the economic evaluation models where the estimation of costs and benefits is conducted separately. Panel data software is now sufficiently advanced that multivariate estimation is possible and it is something that I seek to incorporate in future work.

In accordance with the decision-making theme of this dissertation, arguably a Bayesian framework would be more appropriate. To some extent I think the

treatment of uncertainty in the NICE framework, using the variance-covariance matrix to construct a measure of the probability that an intervention is cost-effective, is effectively a (prior-less) Bayesian interpretation of the reported statistics. I would however like to more formally explore the use of the Bayesian approach in future research.