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Preface

Nonparametric and semiparametric modeling and estimation procedures are now widely applied in econometrics. Their popularity generally comes from the reduction of the probability of misspecification compared with their parametric counterpart. My research is composed of two parts: a theoretical part on semiparametric efficient estimation of partially linear model and an applied part in energy economics under different dynamic settings. The chapters are related in terms of their applications as well as the way in which models are constructed and estimated. In the second chapter, estimation of the partially linear model is studied under different stochastic restrictions of the residual term. We work out the efficient score functions and efficiency bounds under four stochastic assumptions — partially uncorrelated, independence, conditional symmetry, and conditional zero mean. A feasible efficient estimation method for the linear part of the model is also developed based on the efficient score function associated with each parametric submodel. A battery of specification test that allows for choosing between the alternative assumptions is provided. A

Monte Carlo simulation is also conducted to contrast and compare the finite sample properties of the efficient estimator with those of Robinson's estimator.

The third chapter presents a dynamic optimization model for a stylized oilfield resembling the largest developed light oil field in Saudi Arabia, Ghawar. We use data from different sources to estimate the oil production cost function and the revenue function that constitute part of our dynamic programming model. We pay particular attention to the dynamic aspect of oil production by employing a petroleum engineering software to simulate the interaction between production control variables and reservoir state variables. A nonparametric smoothing technique — tensor spline — is also employed to approximate the value function. Optimal solutions are studied under different scenarios to account for the possible changes in the exogenous variables and the uncertainty about the forecasts. The model is based on the profit maximization hypothesis. While Saudi oil policy is likely to reflect many political and strategic motives, our analysis is nevertheless instructive in that it enables one to quantify cost of pursuing these non-economic objectives.

The fourth chapter examines the effect of oil price volatility on the level of innovation displayed by the U.S. economy. A measure of innovation is calculated by decomposing an output-based Malmquist productivity index, which is a nonparametric index. We also construct a nonparametric measure for oil price volatility. Technical change and oil price volatility are then placed in a VAR framework with oil price and a variable indicative of monetary policy. The system is estimated and analyzed for significant relationships. We find that oil price volatility displays a significant negative effect on innovation. A key point of this analysis lies in the fact that we impose no functional forms for production technologies and the methods we employ keep technical assumptions to a minimum.

The fifth chapter contrasts these two alternatives in terms of cost effectiveness and social welfare in a nonparametric game theoretic framework, taking into account that electricity markets are not perfectly competitive. The search for economically efficient policy instruments designed to promote the diffusion of renewable energy technologies in liberalized markets has led to the introduction of quota-based tradable "green" certificate (TGC) schemes for renewable power. However, there is a debate about the pros and cons of TGC, a quantity control policy, compared to guaranteed feed-in tariffs (FIT), a price control policy. We find out that a mix of the two may prove to be more efficient, a possibility deserving further investigation.

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Introduction

1.1 Parametric and Nonparametric Modeling and Estimation

In this section, I would like to address, in general, the motivation for parametric and nonparametric (and semiparametric) modeling and estimation and issues regarding the applications. The specific motivation and background for each individual research project is left to the introduction of each of the respective chapters.

The basic incentive for nonparametric models comes from the price that we might have to pay for using pure parametric models, i.e., the possible misspecification that could lead to highly biased results in estimation and prediction in terms of both finite sample and asymptotic properties. The nonparametric method, hence, provides an alternative estimation procedure in the absence of strong *a priori* restriction.

In addition, a nonparametric estimation approach may also have the following potential advantages, as summarized by Härdle (1990).

- a versatile method of exploring a general relationship between variables;
- predictions of observations to be made without reference to a fixed parametric model;
- a tool for finding spurious observations by studying the influence of isolated points;
- a flexible method of substituting for missing values or interpolating between adjacent data points.

The motivations behind using nonparametric method in this paper, apart from reducing the possibility of specification errors, lie mainly in the first two advantages listed above. For example, the Malmquist index, constructed in chapter 4 using a linear programming method, is a nonparametric productivity index, which requires no specification of a production function in constructing the productivity and innovation indices. In chapter 3, we use tensor spline to explore the relationship between the optimal value and the state variables involved in Saudi's optimal production model, which also requires no specification of functional form for the value function. These nonparametric techniques not only lead to reduction of the approximation bias from possible misspecifications, but also furnish us with more adaptive tools to study the relationships between economic variables.

While we enjoy the advantages of nonparametric methods, the main cost associated with them, compared with a correctly specified parametric model, is the loss of efficiency, i.e., reduction in the precision of estimations and predictions. The idea to achieve balance between the bias caused by possible misspecification in the parametric technique and the poor precision generated from the nonparametric method gives rise to our interest in semiparametric modeling and estimation, which can be viewed as a hybrid of the pure parametric and nonparametric methods. The advantage of the semiparametric approach is that we can specify the part of the model that we have confidence in and focus on the estimation of "parameter of interest" and leave the part uninterested or unknown — the so called "nuisance parameter" — to be unspecified. As a combination of parametric and nonparametric approaches, semiparametric method does share the advantage and disadvantage of the two in a more balanced way, which is the reason for the popularity of semiparametric modeling.

In chapter 2, we study an important semiparametric model known as the partially linear model (PLM). The PLM is a typical example of semiparametric model, which has one part of the regressors formatted in linear form and the other part in unknown functional form. Its popularity can be attributed to its flexible functional form. We construct a consistent estimator that follows a *Normal* distribution and attains the efficiency bound in the limit. Monte Carlo simulation results also show that the estimator in general performs better in finite sample than Robinson's estimator, the most widely cited estimator of the PLM in the previous literature. Although the PLM is the only semiparametric model we study in this book, it does not mean that our method is only limited to the PLM. As a matter of fact, it is possible that the general idea of deriving the semiparametric efficient estimator from efficient score can be extended to other cases.

An interesting question is how we can possibly use the PLM and the derived efficient estimation method in applications. Two famous examples are Engle, et al. (1986) and Hausman and Newey (1995). Engle et al. employ the PLM to model the relationship between electricity demand and weather. Hausman and Newey estimate the demand for gasoline in the PLM format, and then use the estimated