Teaching and Educational Commentary

Textbook Review of: Equilibrium Displacement Models: Theory, Applications, and Policy Analysis.
By Gary W. Brester, Joseph A. Atwood, and Michael A. Boland

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Abstract

Equilibrium Displacement Models: Theory, Applications, and Policy Analysis by Gary W. Brester, Joseph A. Atwood, and Michael A. Boland provides a resource that serves practitioners and students alike. The discussion of EDMs is scholarly, rigorous, and clear throughout the book and it will be a useful resource for all scholars who are interested in analyzing policy impacts. The book is engaging and effective from a pedagogical point of view and provides clarity of explanation and breadth of policy examples. The review is conducted by a group of applied economists with specialization in EDMs, reflecting many different uses and perspectives.

1 Introduction

Equilibrium Displacement Models: Theory, Applications, and Policy Analysis by Gary W. Brester, Joseph A. Atwood, and Michael A. Boland provides a resource that can be used by practitioners and students to answer policy impact questions. The broad base of the textbook and its appeal to different users prompted us to use a multi-author approach to review the book. The review includes an extensive list of models from the book available online in a Microsoft Excel workbook. In what follows, we provide the reviews of different chapters of the book by applied economists with specialization in equilibrium displacement models (EDMs).

2 Book Review

Chapter 1 provides an overview of EDMs in terms of their widespread use and motivates why the book was written and for whom. The use of EDMs is well known by those who work in policy analysis, and the authors motivate why EDMs, computable general equilibrium models, and simulations might be appropriate in specific situations. Both pros and cons of this partial equilibrium framework are discussed. In addition, general applications to both vertically and horizontally related markets are presented. The chapter concludes with a discussion of using EDMs to estimate changes in producer and consumer surplus caused by exogenous shocks to a market based on a cursory literature review of EDM applications.

Chapter 2, the literature review chapter, is cursory in the sense that many papers using EDMs have been published. The chapter organizes the literature review into various categories, although many studies encompass more than one model. For example, some studies may focus on input markets while also evaluating market interventions. The authors have presented studies that are categorized into such areas as international trade, research and development, advertising, market power, and precision of EDM estimates. What is helpful in this chapter is a discussion on how EDMs evolved over time, which shows why their use was never codified before into one source, such as this textbook.

Chapter 3 explains why EDMs are attractive for studying problems in applied economics. Perhaps more than other partial equilibrium models, EDMs are prized for their simplicity and ease of construction. A key strength of these models is their ability to elucidate market responses without requiring full knowledge of underlying functional representations. This feature makes them particularly versatile. EDMs are well-suited to evaluate the effects of market perturbations within a multifactor framework. For instance, they could be used to measure the impact of fertilizer price shocks on the ethanol industry or evaluate the effects of labor laws on strawberry growers. This chapter gets to the core of what an EDM does—evaluating the effects of economic shocks. While practitioners have many different tools to choose from to tackle this task, the attractiveness of an EDM is its simplicity—it takes our complex, often nonlinear reality and returns linear approximations. The authors dedicate Chapter 3 to demonstrating this through the use of several simple mathematical examples, both with linear and nonlinear equations. These examples provide the reader with the book's first glimpse of an actual EDM (albeit purposefully via a simplistic example); the authors are not demonstrating how to use an EDM in an applied sense, but rather, illustrating both the simplicity of EDMs set against other methods and that the resulting approximations are comparable to those generated by other more complicated and more complex tools. The reader is also provided with some guidance in when (or perhaps when not) to use EDMs. At the conclusion of Chapter 3, one question is still not clear. EDMs are efficient tools for approximation when analyzing relatively small perturbations of parameters but can begin to lose accuracy as the size of perturbations increases. How big of a perturbation is "too big" for a versatile EDM?

Chapter 4 addresses the conversion of the basic primal problem into its dual structure, which is needed due to the uncertainty of the functional form of the production function in an EDM. Chapter 4 and the rest of the text offers a much needed and very useful resource for practitioners. In reading Chapter 4, there were two main areas in need of more emphasis, which can be seen as an opportunity for future expansions of this new resource. First, many EDM applications in the literature involve multiple horizontally connected industries that each contain multiple vertically connected sectors. For instance, consider beef (cow-calf, feedlot, wholesale/packer, and end user), pork (farrow, finish, wholesale/packer, and end user), and broiler/chicken (live animal and end user) applications in the *American Journal of Agricultural Economics* and other key outlets. It remains to be seen exactly how the authors' homogenous of degree zero (HOD0)-consistent approach would apply there. The need for more parameters in an EDM (e.g., cost shares at each level) must be appreciated. Second, some practitioners use EDMs for forward-looking, projection-generating purposes, and it would be nice if a forecasting example could have been included to assist in these applications.

Chapter 5 illustrates how to use EDMs to estimate the impacts of market intervening policies. These policies create differences between consumer and producer prices or quantities demanded and supplied. These differences are incorporated into the model as equilibrium equations. The policy examples are grouped into cases where policies specify the magnitude of the differences (referred to as "exogenous wedges") and cases where policies do not specify the magnitude of the shock ("endogenous wedges"). Additional restriction equations are necessary in the case of endogenous wedges for the model to identify specific values of the shock. Examples are illustrated throughout the chapter, using the one-output, two-input model developed in Chapter 4. The content is figuratively the meat of the book for readers who are interested in applying the EDMs for policy analysis. The policy examples are comprehensive for most food and agricultural applications, particularly pertaining to the United States, and are presented in ways that allow for readers to match their policies of interest to the examples in the chapter, with an ability to adapt them if necessary. This compilation is a valuable contribution. The chapter is organized like a how-to manual. A result of this organization is that the exposition of examples becomes repetitive, but this feature will be helpful to readers who want to jump to and learn about the examples that are applicable to them. This type of reader, however, may need to spend some time finding the most applicable example in the current format of the text. The chapter might have been more helpful

if it had an overview of the policies and how the authors categorized them, along with a list of numbered sub-sections that correspond to the examples with a reference to the page numbers.

The organization of Chapter 5 is less suited to readers seeking a general understanding of applying EDMs for policy analysis. These readers may find the repeated material in the series of examples distracting, while wondering how many examples they need to study to have an adequate understanding of the concepts. If the chapter were to be reorganized for these readers, the mechanism of exogenous and endogenous wedges could be elaborated on and generalized with one specific example for each. Other examples could be deferred to a separate section as practice problems with answers.

Chapter 6 investigates several approaches to incorporating market power into EDMs. Essentially, market power can be considered a tax on a market in which "tax revenue" is obtained by those with market power. Examples include results from monopoly pricing and the use of price ceilings to offset monopoly power. An evaluation of a monopolistically competitive market is also provided. Although relatively few papers have incorporated market power into an EDM, the chapter demonstrates how it can be done in a straightforward manner.

Chapter 7 demonstrates the use of EDMs for examining several policy interventions in markets with multiple inputs or outputs. The functional form of the EDMs are clearly defined and presented in a way that will allow easy adaptation for practitioners. For all presented policy scenarios, the authors clearly define all parametrized variables and their associated values, with references, such that the reader could replicate their results in a general spreadsheet package with ease. The chapter begins by presenting an EDM with two connected markets. The authors present a scenario of international beef trade where there exists an import demand function, export supply function, tied through a total domestic availability function. With import and export shares generated from historical averages and elasticities pulled from the literature, the EDM estimates a wide range of typical international trade policies. With slight modifications to the base model, the presented EDM shows how several impact assessments can be performed, including a tariff placed on imported beef, a change in an existing tariff, export subsidies, or import quantity restrictions.

Chapter 7 also details how an EDM can be used to model a market with three inputs and a single output. After augmenting the basic EDM to include equations for the three-input case, various policy scenarios are considered that demonstrate the flexibility and intuitive appeal of EDMs. The EDM can estimate the impact on equilibrium market prices and quantities associated with an exogenous change in output demand, a restriction of input use, or a change in input cost. The chapter demonstrates these policy interventions for a production function that has both flexible input use and one that has fixed input proportions.

Finally, Chapter 7 presents the idea of specifying one of the inputs in the industry production function as financial capital or owner's equity. In most cases for which government interventions affect a market, there will be implications for the owners of the firms that supply the market and the returns on their investments. By modeling one of the inputs as financial capital, using estimates from the literature for short-run own-price elasticity of the supply of financial capital, and adjusting the substitutability with other inputs in the production process, the EDM can estimate the impact on returns to capital in a market when policy shocks are introduced. Minimum returns to owner's equity are required for an industry to remain competitive. By explicitly modeling these returns, while conducting policy analysis, economists may be able to discuss potential long-run impacts on capital flows in and out of an industry. This may be of particular relevance for an infant industry that relies on outside investment or venture capital such as agricultural technology and innovation.

Chapter 8 addresses issues related to using EDMs to calculate changes in economic surplus and deadweight losses. As noted by Just, Hueth, and Schmitz (2004), care must be taken when using partial equilibrium models to estimate these changes to avoid double counting. Also, changes in surplus are not estimable for some markets included in an EDM if exogenous shocks that emanate from outside the modeling structure are being considered. For example, a shock to the demand for a product may be

caused by a change in the demand for a substitute. However, if the substitute product (and all other substitutes) are not included in the model, it is not possible to calculate a change in consumer surplus because only the demand for one consumer product is being considered. That is, one does not know what the net change in consumer surplus will be in response to a shock in a market not included in the model. The chapter is highly detailed and presents two different ways of calculating changes in consumer and producer surplus caused by market interventions. Authors who wish to measure welfare effects should pay close attention to this chapter.

Chapter 9 notes that EDMs express results in percentage change, and as such a key fact of all EDMs is that they require estimates of structural elasticities (e.g., own price, cross price, output, input, etc.). Because EDMs are effectively linear (first order) approximations in differential space, the elasticities are treated as constants, but we know that in general, elasticities are not constant and can change (for example) in response to induced changes in price or quantity. This leads to a related question: How sensitive are the results for an EDM to the elasticities used to calibrate the model? A standard approach in the literature is to present a table with a range of elasticity values from say 50 percent to 150 percent of baseline values to assess how the results are affected. This approach is useful in identifying which parameters are important drivers of the results and which are not. However, it does not tell us how parameter uncertainty affects inferences. For that, confidence intervals for the simulated price and quantity effects are needed. This need was addressed in separate papers by Davis and Espinoza (1998) in the United States and Zhao et al. (2000) in Australia. These papers showed how confidence intervals for results from EDM can be constructed by replacing the point estimates of elasticities in the model with their probability distributions. The confidence intervals provide a basis for inferring whether simulated price and quantity effects are significant, that is, different from zero in a statistical sense.

In motivating Chapter 9 on sensitivity analysis in EDMs, Brester, Atwood, and Boland emphasize the purpose of adopting a probability distribution approach for sensitivity analysis is "…if a researcher wishes to estimate confidence intervals or perform hypothesis tests, then they must consider joint realizations of an EDM's underlying parameters (Davis and Espinoza 2000)" (Brester, Atwood, and Boland, p. 233). While it is certainly the case that a natural implication of doing, what has succinctly been termed a Stochastic EDM (SEDM) elsewhere (Dharmasena, Davis, and Capps 2014), is the ability to construct confidence intervals and conduct hypothesis tests, that was not the initial motivation. The initial motivation stemmed from a concern about non-signable comparative statics. It is well known that analytically in most systems of equations coming out of economics the comparative statics are not signable. Stated alternatively, in most cases, the exact direction of the effects of exogenous shocks is not known unequivocally. Thus, the actual direction (sign) of the effect of the exogenous shock will depend on the interactions of the relative magnitudes of (i) elasticities and (ii) exogenous shocks. An SEDM is a type of empirical comparative static exercise that would provide information on the most probable sign, magnitude, and significance, which are at the heart of empirical estimation.

Chapter 9 addresses an issue not evaluated in Davis and Espinoza's (1998) study, namely the effect of correlated elasticities on simulation results. Specifically, a copula approach to generating the covariances/correlations among elasticities is taken, and simulations are performed with and without the indicated correlations to determine how results from a simple EDM are affected. In the book, application results were not affected to any extent. Although a nice application of copulas, it should be realized that this is just one approach to getting covariances and is based on non-sample information (assumptions), whereas alternatively if one is pulling elasticities from an econometric analysis, there may be covariances based on data and estimation (i.e., sample information). Chapter 9 and the accompanying appendix is good in terms of walking one through how to do stochastic simulation of an EDM and the use of spreadsheets, which are downloadable. If the reader is not familiar with the conceptual steps (theory) of copulas, they may need to consult the original Iman and Conover (1982)

article or related literature. In sum, Chapter 9 provides a clear and concise introduction and example of the usefulness of adding SEDMs to the applied economist's toolbox.

Chapter 10 provides a summary of the book. This would have been a good place to remind readers that the models and results presented in the book have been developed within Excel, and the spreadsheets are available online from the University of Minnesota Library's website. In addition, a print-on-demand link is available from that website. Two things might improve the book in a later edition but do not detract from this first edition. First, consider expanding the definition of EDM as discussed by Piggott (1992). This would expose the reader to a larger literature on the topic that has proved useful for policy analysis. Two examples by Martin and Anderson (2012) and Kinnucan and Myrland (2005) demonstrate this. The book gives the impression EDM is confined to Muth's model but in reality, Muth-type models are a subset of a larger class of models referred to by trade economists as "hat-calculus models." Second, the book focuses on policy applications of EDMs. However, they have another useful function, namely providing a theoretical basis for specifying econometric models and interpreting their results.

3 Conclusion

Brester, Atwood, and Boland are to be thanked for bringing together in one place a presentation of one of the main tools in the applied economist's toolbox, the EDM. Prior to this book, the researcher and student interested in learning about EDMs would have to scour the literature searching for descriptions of the tool and various applications. The book is full of much useful information related to the underlying theory, implementation, and interpretation of EDMs.

The discussion of EDMs is scholarly, rigorous, and clear throughout the book. The preface and emails add a personal touch that draws the reader in and adds to the book's effectiveness from a pedagogical point of view. The book is a must-read for anyone interested in using the method in their research or teaching. To be sure, there is no way to fully meet the needs of all readers, and any shortcomings of the book are outweighed by its clarity of explanation and breadth of policy examples. It will be a useful resource for all scholars including upper-level undergraduate and beginning graduate students who are interested in analyzing policy impacts with an EDM. The authors should be commended for a text that is easy to follow, which, in turn, will notably increase the impact of this resource for years to come.

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