

Envelopes for Economists: Housing Hedonics and Other Applications

An e-Book Edited by John Yinger

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Introduction

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This e-book brings together my research and teaching notes on hedonic equations for housing, which are defined as equations to measure the impact of local public services and neighborhood amenities on housing prices. A key conceptual tool in the study of housing hedonics is a mathematical envelope. This tool arises in other concepts, as well, some of which are explored in this e-book's first part.

Several of the chapters in this e-book are co-authored, and I am very grateful for the many contributions my co-authors have made. These co-authors include Il Hwan Chung, William D. Duncombe, Yue Hu, Phuong Nguyen-Hoang, and Pengju Zhang.

This e-book is divided into five parts: Introduction to Envelopes, Introduction to Housing Hedonics, Formal Derivation of Bid Functions and Their Hedonic Envelope, Housing Prices and Access to Jobs, and The Impact on Housing Prices of Governmental Re-Organization and Reform.

Part 1, "Introduction to Envelopes," contains three chapters. Chapter 1, "Introduction to Envelope Mathematics and Its Applications in Economics," defines a mathematical envelope and explains some of the ways it is used in economics. This chapter is built around a model devised by Johann Heinrich von Thünen in 1826 concerning the spatial allocation of agricultural activities around a central market.¹ This model introduced the concepts of bid functions and sorting and implicitly modeled the land-price envelope. All these concepts and the relationships among them are defined in this chapter. Alonso (1964) and others translated these concepts to the housing market, where they became the founding concepts of urban economics. These concepts also are the basis for housing hedonics, which is the main focus of this book.

Chapter 2, "World-Record Envelopes," is mainly for fun, but it also makes a serious point, namely, that the concept of an envelope can provide insights about many kinds of behavior.² This chapter shows that a curve linking world record speeds of athletes in different racing events to event distances is an envelope of the underlying performance curves of elite athletes. This chapter estimates the world-record envelope for men and women in running, freestyle swimming, and speed skating and explores variation in this envelope over time.

Chapter 3, “The Long-Run Average Cost Curve,” discusses the envelope that all economists learn about, namely the long-run average cost curve. This chapter explains why this curve is an envelope and discusses the history of its derivation, including a famous mistake made by Jacob Viner, and shows how the form of the envelope varies with different assumptions about the form of the production function or of the short-term cost functions. This chapter also explores the relationship between a mathematical envelope and the envelope theorem.

Part 2, “Introduction to Housing Hedonics,” explains the concepts of bidding and sorting in the housing market and reviews the use of these concepts in the housing literature. Chapter 4, “Bidding and Sorting,” provides an intuitive overview of these concepts. A more formal version of this material can be found in Ross and Yinger (1999). Chapter 5, which is co-authored with Phuong Nguyen-Hoang, is titled “Hedonic Vices: Fixing Inferences about Willingness to Pay in Recent House-Value Studies.” This chapter explores the methodology of recent empirical studies of housing hedonic and shows that many of these studies violate one or more of the lessons in the associated conceptual literature. Chapter 6, which is also co-authored with Phuong Nguyen-Hoang, is called “The Capitalization of School Quality into House Values: A Review.” Many studies estimate the impact of school quality on house values. This chapter provides a conceptual framework for comparing these studies.

The next part of the book, Part 3, is titled “Formal Derivation of Bid Functions and Their Hedonic Envelope.” This part begins with Chapter 7, “Hedonic Markets and Sorting Equilibria: Bid-Function Envelope for Public Services and Neighborhood Amenities.” This chapter is the foundation on which this e-book is built. It derives housing bid functions for heterogeneous households across neighborhoods with different amenity levels and then solves for the associated envelope, which is the housing hedonic equation. This envelope is then estimated using data for the Cleveland area in 2000 and the implications for household sorting are explored. This approach is not, of course, the only way to obtain a housing hedonic, but it is a new approach based on fairly general assumptions and a clear link to a straightforward estimating method. Although applications outside housing are not considered in this chapter, the method in this chapter could be applied in some other markets. Many scholars have investigated a wage hedonic in the labor market, for example. See Kniesner and Leeth (2010). This type of hedonic expresses the market wage at each value of a workplace amenity, such as safety. The equations in this chapter, perhaps with some adjustments, could be applied to this case.

An application of this method to a widely studied neighborhood trait, namely the racial and ethnic composition of the population, appears in Chapter 8, “Hedonic Estimates of Neighborhood Ethnic Preferences.” This chapter shows that the method in Chapter 7 can estimate the impact of racial and ethnic preferences on housing prices. It shows, in the case of Cleveland in 2000, that some households prefer a largely black neighborhood, whereas other households prefer a largely white neighborhood.

The final chapter in this part, Chapter 9, “Hedonic Equilibria in Housing Markets: The Case of One-to-One Matching,” provides a technical supplement to Chapter 7. The method developed in Chapter 7 requires an assumption about the nature of the hedonic equilibrium, which depends on the distributions of both the amenity (say, school quality) and of the bid function slopes

for that amenity. This chapter shows that the assumptions about the form of the hedonic equilibrium in Chapter 7 are valid for a wide range of assumptions about the form of these two distributions.

Part 4, “Housing Hedonics for Access to Jobs,” turns to the central question in urban economics, namely, the impact of access to jobs on the price of housing. This is, of course, the core question in Alonso (194) and many other studies in urban economics. As Alonso recognized an analysis of this question must recognize that households are heterogeneous and sort across locations based on their bid-rent functions. Although this point is widely recognized by urban economists, no previous study has estimated the envelope of the bid-rent functions of heterogeneous households. The chapter in this part, “The Price of Access to Jobs: Bid-Function Envelopes for Commuting Costs,” fills this gap.

The final part of the book is called “The Impact on Housing Prices of Governmental Reorganization and Reform.” The chapters in this part investigate household preferences by estimating the impact on house values of large changes in state education aid or local governmental organization. Chapter 11, which is co-authored with Il Hwan Chung and William D. Duncombe, is titled “The Impact of State Aid Reform on Property Values: A Case Study of Maryland’s Bridge to Excellence in Public Schools Act.” The legislation examined in this chapter dramatically increased and redistributed state aid to education, with significant impacts on property values.

The last two chapters explore the property-value impacts of school district consolidation. Chapter 12 is co-authored with William D. Duncombe and Pengju Zhang. It is titled “How Does School District Consolidation Affect Property Values: A Case Study of New York.” This study finds that consolidation tends to have a negative impact on house values in the short run but a positive impact in the long run. Apparently, it either takes time either for the advantages of consolidation to be apparent or for the people who prefer consolidated districts to move in. Chapter 13, which is co-authored with Yue Hu, conducts a similar evaluation using Census tract data. It shows that the impact of consolidation on house value is positive in low-income tracts but negative in high-income tracts.

References

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- Kniesner, Thomas J., and John D. Leeth. 2010. "Hedonic Wage Equilibrium: Theory, Evidence, and Policy." *Foundations and Trends in Microeconomics* 5 (4): 229–299.
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- von Thünen, Johann Heinrich. 1875. *Der isolirte Staat in Beziehung auf Landwirtschaft und Nationalökonomie*, 3rd ed. 4 vol., Berlin: Wiegandt, Hempel & Parey, 1875.

Endnotes

¹ See von Thünen (1875). This is the third (expanded) edition of a book that was first published in 1826.

² Like almost all economists, I learned about envelopes from the study of average cost curves (the subject of Chapter 3). So when my interest in running led me to play around with the world-record speed-distance curves for running in about 1980, I recognized that these curves form an envelope of the underlying individual performance curves. I collected data on world records and found a specification that provided a close approximation to the world-record envelope for running. It took me a while, but eventually I also found the form of the underlying family of individual performance curves. See Chapter 2. This experience made me aware that envelopes have many applications and many different forms. This awareness helped me when I derived a new form for a household's bid function for housing in neighborhoods with different amenities. To be specific, I realized that I could derive a specification for the envelope of a family of functions with this new form—that is, a specification for the housing hedonic. This approach is explained in Chapter 7 and applied in many other Chapters. A variant on this theme appears in Chapter 10, which derives and estimates the envelope of household bids for access to jobs, which is a core subject in the field of urban economics.