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Advertising, Learning, and Consumer Choice in Experience Good Markets: An Empirical Examination

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# Dynamic discrete choice structural models: A survey

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## ABSTRACT

This paper reviews methods for the estimation of dynamic discrete choice structural models and discusses related econometric issues. We consider single-agent models, competitive equilibrium models and dynamic games. The methods are illustrated with descriptions of empirical studies which have applied these techniques to problems in different areas of economics. Programming codes for some of the estimation methods are available in a companion web page.

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## 1. Introduction

This paper reviews recent developments in the literature on the estimation of discrete choice dynamic programming models of individual behavior. The goal of this paper is to provide an update of existing surveys of this literature, e.g. [Eckstein and Wolpin \(1989\)](#) and [Rust \(1994a\)](#).<sup>1</sup> In order to avoid repetition, we emphasize the methodological contributions during the last decade. Thus, some of the major themes of the survey are: the extension of methods which avoid repeated full solution of the structural model in estimation; the development and increased use of simulation and approximation methods; and the exploration of techniques that allow researchers to estimate dynamic equilibrium models, both strategic and competitive. This paper tries to make the reader familiar with these recent developments. With that purpose in mind, this survey is complemented with programs that implement some of the estimation methods we describe. These programs are available at the journal's web site.

In dynamic discrete choice structural models, agents are forward looking and maximize expected intertemporal payoffs. The parameters to be estimated are *structural* in the sense that they describe agents' preferences and beliefs about technological and institutional constraints. Under the principle of *revealed preference*, these parameters are estimated using microdata on individuals' choices and outcomes. Thus an attractive feature of this

literature is that structural parameters have a transparent interpretation within the theoretical model that frames the empirical investigation. Moreover, econometric models in this class are useful tools for the evaluation of new (counterfactual) policies.<sup>2</sup> Seminal papers include [Wolpin \(1984\)](#) on fertility and child mortality, [Miller \(1984\)](#) on job matching and occupational choice, [Pakes \(1986\)](#) on patent renewal, and [Rust \(1987\)](#) on machine replacement. A well-known impediment to the development of this literature has been the computational complexity of estimation. Solving the structural model or evaluating an estimation criterion such as the likelihood can *both* be nontrivial numerical tasks, and estimation in this context typically requires the use of algorithms in which a dynamic programming solution procedure is nested in the optimization of the estimation criterion. In spite of this, over the last twenty years there has been a significant number of interesting applications of these models to different areas in economics. In this paper, we will select a few of these applications as examples to illustrate estimation methods and econometric issues. Many of the problems encountered by applied researchers are the same as in other discrete choice microeconomic models, e.g., permanent unobserved heterogeneity, initial conditions, censored outcomes and sample selection, measurement error, endogeneity, identification, etc. Having to consider explicit solutions to the dynamic optimization problem that is postulated to describe individual behavior adds another layer of complexity. But such a close link

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<sup>1</sup> Other excellent surveys are [Rust \(1994b\)](#), [Pakes \(1994\)](#) and [Miller \(1997\)](#).

<sup>2</sup> See [Wolpin \(1996\)](#) for a review of some uses of these models for public policy analysis, and [Keane \(2010\)](#) and [Rust \(2010\)](#) in this issue for more discussion on the use of empirical structural dynamic models.



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# The Credibility Revolution in Empirical Economics: How Better Research Design is Taking the Con out of Econometrics

Joshua D. Angrist and Jörn-Steffen Pischke

Just over a quarter century ago, Edward Leamer (1983) reflected on the state of empirical work in economics. He urged empirical researchers to “take the con out of econometrics” and memorably observed (p. 37): “Hardly anyone takes data analysis seriously. Or perhaps more accurately, hardly anyone takes anyone else’s data analysis seriously.” Leamer was not alone; Hendry (1980), Sims (1980), and others writing at about the same time were similarly disparaging of empirical practice. Reading these commentaries as late-1980s Ph.D. students, we wondered about the prospects for a satisfying career doing applied work. Perhaps credible empirical work in economics is a pipe dream. Here we address the questions of whether the quality and the credibility of empirical work have increased since Leamer’s pessimistic assessment. Our views are necessarily colored by the areas of applied microeconomics in which we are active, but we look over the fence at other areas as well.

Leamer (1983) diagnosed his contemporaries’ empirical work as suffering from a distressing lack of robustness to changes in key assumptions—assumptions he called “whimsical” because one seemed as good as another. The remedy he proposed was sensitivity analysis, in which researchers show how their results vary with changes in specification or functional form. Leamer’s critique had a refreshing emperor’s-new-clothes earthiness that we savored on first reading and still enjoy today. But we’re happy to report that Leamer’s complaint that “hardly anyone takes anyone else’s data analysis seriously” no longer seems justified.

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# Practical Methods for Estimation of Dynamic Discrete Choice Models

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## Abstract

Many discrete decisions are made with an eye toward how they will affect future outcomes. Formulating and estimating the underlying models that generate these decisions is difficult. Conditional choice probability (CCP) estimators often provide simpler ways to estimate dynamic discrete choice problems. Recent work shows how to frame dynamic discrete choice problems in a way that is conducive to CCP estimation and demonstrates that CCP estimators can be adapted to handle rich patterns of unobserved state variables.

# Ability sorting and the returns to college major

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## Abstract

Large earnings and ability differences exist across majors. This paper seeks to estimate the monetary returns to particular majors as well as find the causes of the ability sorting across majors. In order to accomplish this, I estimate a dynamic model of college and major choice. Even after controlling for selection, large earnings premiums exist for certain majors. Differences in monetary returns explain little of the ability sorting across majors; virtually all ability sorting is because of preferences for particular majors in college and the workplace, with the former being larger than the latter.

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## 1. Introduction

Students who choose natural science majors earn substantially more than humanities majors. In fact, economists have reported that differences in returns to majors are much larger than differences in returns to college quality. James et al. (1989, p. 252) argue that "... while sending your child to Harvard appears to be a good investment, sending him to your local state university to major in Engineering, to take lots of math, and preferably to attain a high GPA, is an even better private investment." Although a number of researchers have documented the large differences in earnings across majors (see Daymont and Andrisani, 1984; Grogger and Eide, 1995; James et al., 1989; Loury, 1997; Loury and Garman, 1995), none of the papers model the choice of major itself and we do not know whether these are actual monetary premiums or whether the observed premiums are driven by the differing abilities of individuals choosing the different majors.

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Finite Mixture Distributions, Sequential Likelihood and the EM Algorithm

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## THE EFFECT OF MATERNAL EMPLOYMENT AND CHILD CARE ON CHILDREN'S COGNITIVE DEVELOPMENT\*

BY RAQUEL BERNAL<sup>1</sup>

*Universidad de los Andes, Colombia*

This article develops and estimates a dynamic model of employment and child care decisions of women after childbirth to evaluate the effects of these choices on children's cognitive ability. We use data from the National Longitudinal Survey of Youth to estimate it. Results indicate that the effects of maternal employment and child care on children's ability are negative and sizable. Having a mother that works full-time and uses child care during one year is associated with a reduction in ability test scores of approximately 1.8% (0.13 standard deviations). We assess the impact of policies related to parental leave and child care on children's outcomes.

### 1. INTRODUCTION

Extensive research has shown that children's early achievements are strong predictors of a variety of outcomes later in life. The high achievers are more likely to have higher educational attainment and higher earnings and are less likely to have out-of-wedlock births, be on welfare, or participate in crime. For this reason, the issue of what determines ability of individuals at early stages of life is critical for the design of public policy aimed at improving labor market outcomes.

The effect of parental time inputs and child care (as well as child care quality) on children's development has been widely analyzed, especially in the psychology and sociology literature. Economists have also realized the importance of this question. For many years we have been trying to understand the determinants of individuals' labor market performance, in particular, wages. In spite of the vast research in this area, there is still a large component of wages that we have not been able to explain. Other related studies<sup>2</sup> have concluded that once people

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<sup>2</sup> See Keane and Wolpin (1997, 2001), Cameron and Heckman (1998), and Cunha and Heckman (2006).

**THE ROLE OF RETIREE HEALTH INSURANCE IN THE  
EMPLOYMENT BEHAVIOR OF OLDER MEN\***

BY DAVID M. BLAU AND DONNA B. GILLESKIE<sup>1</sup>

*Ohio State University, U.S.A; University of North Carolina at Chapel Hill and  
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Using data from the Health and Retirement Survey, we estimate preference and expectations parameters of a structural model of the employment and medical care decisions of older men in order to evaluate the role of health insurance. The budget constraint incorporates detailed cost-sharing characteristics of private health insurance and Medicare as well as rules and requirements associated with Social Security and private pensions. Simulations imply that changes in health insurance, including access and restrictions to retiree health insurance and Medicare, have a modest impact on employment behavior among older males, with the greatest effect on men in bad health.

1. INTRODUCTION

A large majority of adults in the United States who have health insurance are covered by plans provided by employers until they become eligible for Medicare at age 65. Some employers extend health insurance coverage to retirees, whereas others terminate coverage when an individual leaves the firm. A risk-averse individual who believes there is some chance that he will incur large medical expenses is likely to place a high value on health insurance. If such an individual faces loss of his employer-provided health insurance by retiring, then he has an incentive to remain with his employer longer than he would if health insurance was not linked to his employment status.<sup>2</sup>

Recent proposals for reform of the U.S. health insurance system would fully or partly break the close link between health insurance coverage and employment for older individuals. For example, the Clinton Administration proposed a reform that would allow individuals to purchase Medicare beginning at age 62 years. The Health Insurance Portability and Accountability Act of 1996 forbids

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<sup>2</sup> Alternatively, individuals who would lose their health insurance upon retiring could purchase an individual health insurance policy. Such policies, however, are generally not a good substitute for employer-provided (group) health insurance because they have much higher premiums for a given level of coverage than employer-provided policies and they often exclude coverage for pre-existing conditions (Simantov et al., 2001).



# Health, economic resources and the work decisions of older men

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## ABSTRACT

We specify a dynamic programming model that addresses the interplay among health, financial resources, and the labor market behavior of men late in their working lives. We model health as a latent variable, for which self-reported disability status is an indicator, and allow self-reported disability to be endogenous to labor market behavior. We use panel data from the Health and Retirement Study. While we find large impacts of health on behavior, they are substantially smaller than in models that treat self-reports as exogenous. We also simulate the impacts of several potential reforms to the Social Security program.

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## 1. Introduction

Population aging and other challenges to public and private pension financing highlight the importance of understanding the determinants of retirement behavior. Much of the recent research on the labor force behavior of older workers has focused on the effects of financial incentives such as Social Security and private pensions, generally showing that these incentives have powerful behavioral effects (e.g., Blinder et al., 1980; Burkhauser and Quinn, 1983; Diamond and Hausman, 1984; Stock and Wise, 1990; Rust and Phelan, 1997; Gruber and Wise, 1999; Gordon and Wise, 2004; Gustman and Steinmeier, 1986, 2000, 2005). Additionally, a substantial amount of research has focused on the effects of the availability of both privately and publicly provided health insurance on retirement behavior (Rust and Phelan, 1997; Gustman and Steinmeier, 1994; Blau and Gilleskie, 2001a, 2006, 2008). At the same time, econometric studies of retirement behavior have provided strong evidence for the importance of health factors (e.g., Quinn, 1977; Gordon and Blinder, 1980;

Burkhauser and Quinn, 1983; Diamond and Hausman, 1984; Gustman and Steinmeier, 1986; Quinn et al., 1990; Rust and Phelan, 1997; Bound and Burkhauser, 1999; Blau and Gilleskie, 2001b). Indeed, in analyses using Census data we found that more than half of men and one-third of women who leave the labor force before reaching the Social Security early retirement age of 62 report that health limits their capacity to work (Bound et al., 1997).

However, as several reviews have noted, important questions remain regarding the magnitude of the effect of health on labor market behavior (Chirikos, 1993; Lumsdaine and Mitchell, 1999; Currie and Madrian, 1999). Moreover, except for early work by Quinn (1977) and research focusing specifically on the effects of changes in Social Security Disability Insurance (DI) on the work force attachment of older men (e.g., Parsons, 1980; Halpern and Hausman, 1986; Bound, 1989; Haveman et al., 1991; Bound and Waidmann, 1992, 2002; Kreider, 1999a; Kreider and Riphahn, 2000), no one has studied the effect of the availability of financial resources on the relationship between health and retirement. This is despite the likelihood that health and financial factors interact in affecting retirement decisions – that is, deteriorating health will tend to make continued work less attractive, but individuals will tend to retire only if they have sufficient financial resources.

More fundamentally, previous longitudinal retirement research has suffered from limited measures of health, relying heavily on global measures such as self-rated work limitations and self-rated

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Discrimination and Skill Differences in an Equilibrium Search Model

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## COHABITATION, MARRIAGE, AND DIVORCE IN A MODEL OF MATCH QUALITY\*

BY MICHAEL J. BRIEN, LEE A. LILLARD, AND STEVEN STERN<sup>1</sup>

*Deloitte Financial Advisory Services LLP, Washington, DC, U.S.A.;*  
*University of Michigan, U.S.A. (deceased); University of Virginia, U.S.A.*

The objective of this research is to further our understanding of how and why individuals enter and leave coresidential relationships. We develop and estimate an economic model of nonmarital cohabitation, marriage, and divorce that is consistent with current data on the formation and dissolution of relationships. Jovanovic's (*Journal of Political Economy* 87 (1979), 972–90) theoretical matching model is extended to help explain household formation and dissolution behavior. Implications of the model reveal what factors influence the decision to start a relationship, what form this relationship will take, and the relative stability of the various types of unions. The structural parameters of the model are estimated using longitudinal data from a sample of female high school seniors from the United States. New numerical methods are developed to reduce computational costs associated with estimation. The empirical results have interesting interpretations given the structural model. They show that a significant cause of cohabitation is the need to learn about potential partners and to hedge against future bad shocks. The estimated parameters are used to conduct several comparative dynamic experiments. For example, we show that policy experiments changing the cost of divorce have little effect on relationship choices.

### 1. INTRODUCTION

It has long been the goal of social scientists to better understand how and why individuals enter and leave relationships. A substantial body of research has shown these relationships greatly impact individuals as well as society at large. Complicating this line of research is the fluid and diverse nature of family structure. It has been estimated, for example, that over half of all first marriages will be disrupted (Cherlin, 1992). It has also been shown that a significant number of

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<sup>1</sup> We would like to thank B. Ravikumar, William Johnson, Francis Kramarz, Bob Rosenthal, and seminar participants at the 1997 Summer Research Workshop at the Institute for Research on Poverty, University of Michigan, University of Virginia, Virginia Tech, George Washington University, the University of North Carolina at Greensboro, Boston University, the 1998 Economic Demography Workshop at the meetings of Population Association of America, the 1998 SITE meetings, and the Southern Economic Association meetings. This research was partially supported by grants P-50-12639, R01-HD30856, and R01-HD31585 from the NICHD. Brien also would like to acknowledge research support from the Center for Children, Families, and the Law at the University of Virginia. The views expressed in this article are those of the authors and should not be attributed to the institutions with which they are affiliated. All mistakes are our own. Please address correspondence to: Steven Stern, Department of Economics, University of Virginia, P.O. Box 400182, Charlottesville, VA 22904-4182 U.S.A. E-mail: [sns5r@virginia.edu](mailto:sns5r@virginia.edu).



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Unemployment Insurance and the Business Cycle

Author(s): Laura Brown and Christopher Ferrall

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Dynamic Programming Model Estimates of Social Security Disability Insurance Application Timing

Author(s): Richard V. Burkhauser, J. S. Butler, Gulcin Gumus

Reviewed work(s):

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## A DYNAMIC MODEL OF CONTRACEPTIVE CHOICE OF SPANISH COUPLES

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### SUMMARY

We propose a simple dynamic stochastic model of sterilization and contraceptive use and we estimate its structural parameters using a sample of married couples from the 1995 Spanish Family and Fertility Survey. The estimated structural model improves on previous studies in terms of its ability to rationalize observed behaviour. Allowing for simple forms of permanent unobserved heterogeneity across couples in their ability to conceive has important implications for estimates of utility and cost parameters. Estimates of child valuation parameters imply that most Spanish couples would have two children, but significant deviations from this goal are brought about by imperfect and costly fertility control. We perform simulations to quantify the impact on fertility of the availability of sterilization and other technologies which improve fertility control. Copyright © 2006 John Wiley & Sons, Ltd.

### 1. INTRODUCTION

The analysis of fertility within the framework of modern economic theory goes back to Becker (1960, 1991). Since then, the literature known as the ‘New Family Economics’ has developed considerably. During the last 20 years researchers have developed new methods for the estimation of structural dynamic models of discrete choice.<sup>1</sup> These models are an attractive framework for the analysis of fertility decisions since they can explicitly accommodate several important features which were neglected in earlier static models, such as: (1) the dynamic dimension of fertility choices which are made in a life-cycle context; (2) the stochastic nature of human reproduction, whereby parents make contraceptive choices and respond to the (irreversible) realizations of the birth process. Furthermore, structural methods allow us to obtain estimates of parameters which can be interpreted directly in the context of the maintained behavioural model. The large computational burden of empirical work has constrained the number of applications in economic demography. Wolpin (1984), Montgomery (1988), Hotz and Miller (1993) and Ahn (1995) are a few exceptions. In this paper we propose a simple model of sterilization and contraceptive use over the life-cycle and we estimate its structural parameters using data from the 1995 Spanish Family and Fertility Survey. Our main goal is to investigate whether the main features of the data can be rationalized in a dynamic stochastic optimization framework. During the last two decades there was a large and rapid decline in fertility rates in Spain. In 1975 the Total Fertility Rate (TFR) was still 2.8 but by 1995 it was only 1.2, the lowest in the world.<sup>2</sup> In contrast, during the same period in the USA the TFR increased slightly from 1.8 to 2.1. Although many other OECD countries have

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<sup>1</sup> See Eckstein and Wolpin (1989) and Rust (1994) for surveys of this field.

<sup>2</sup> The Total Fertility Rate is the average number of children per woman in a synthetic cohort obtained from cross-sectional age-specific fertility rates. In a stationary environment 2.1 is the replacement level.

# Structural Modeling in Marketing: Review and Assessment

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The recent marketing literature reflects a growing interest in structural models, stemming from (1) the desire to test a variety of behavioral theories with market data, and (2) recent developments that facilitate estimation of and inference for these models. Whether one should always go through the effort of developing such tightly parameterized models with the associated computational burden of estimating them and whether it pays off to make strict behavioral assumptions in terms of better decisions remain open questions. To shed some light on these issues, we provide examples of structural approaches to consumer choice and demand as well as examples where the goal is to study the nature of competition in the marketplace. From that review comes our discussion of issues in the development and application of structural models, including their estimation, testing, and validation, their applicability in the practice of marketing, and their usefulness for normative as well as descriptive purposes.

**Key words:** structural models; heterogeneity; competition; endogeneity; dynamic demand models.

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## 1. Introduction

The recent marketing literature reflects a growing interest in structural models. By *structural models* we mean those that rely on economic and/or marketing theories of consumer or firm behavior to derive the econometric specification that can be taken to data. In particular, structural models are typically derived based on optimizing behavior of agents (e.g., utility maximizing by consumers, profit maximizing by firms, etc.). Furthermore, because one can assess the role of the behavioral assumptions in driving empirical findings, the appropriateness of these assumptions can be investigated. Consequently, the structural approach allows us to test the theories from which the models are derived, and obtain behavioral predictions that are invariant to the effects of policy changes. Hence, the increased interest in the development and application of structural models in marketing stems from (1) the desire to test a variety of behavioral theories with market data, and (2) recent developments that facilitate estimation of and inference for these models.

Although it is clear that there are situations where a structural approach may be preferred by marketing researchers, whether structural modeling will become the dominant paradigm in marketing, whether one should always go through the effort of developing such tightly parameterized models with the associated computational burden of estimating them, and whether it pays off to make strict behavioral assumptions in terms of better decisions remain open questions. Our objective in this paper is to shed some light on these issues. For this, we first provide examples of structural approaches to consumer choice and demand—both static and dynamic—as well as to the nature of competition in the marketplace. From that review comes our discussion of several important issues in the development and application of structural models, including their estimation, testing, and validation, their applicability in the practice of marketing, and their usefulness for normative as well as descriptive purposes. Interested readers are also referred to related reviews by Kadiyali et al. (2000), Dubé et al. (2002), Chintagunta et al. (2004).

**LABOR MOBILITY OF IMMIGRANTS: TRAINING, EXPERIENCE,  
LANGUAGE, AND OPPORTUNITIES\***

BY SARIT COHEN-GOLDNER AND ZVI ECKSTEIN<sup>1</sup>

*Bar-Ilan University; Bank of Israel, Tel Aviv University,  
and CEPR*

This article analyzes the labor mobility and human capital accumulation of male immigrants from the former Soviet Union to Israel. We estimate a dynamic choice model for employment and training in blue- and white-collar occupations, where the labor market randomly offered opportunities are affected by past choices. The estimated model accurately reproduces the patterns in the data. The estimated direct earning return to local training, local experience, and knowledge of Hebrew are very high, whereas imported skills have zero (conditional) return. The welfare gain from the impact of training on job offer probabilities is larger than its effect on wages.

1. INTRODUCTION

The transition pattern of highly skilled immigrants to a new labor market is characterized by high wage growth and a rapid decline in unemployment as immigrants first find blue-collar jobs and then gradually move into white-collar occupations. One of the factors in this process is the acquisition of local human capital in the form of a “new” language, experience, and skills gained from vocational training programs provided by the government.<sup>2</sup> In this article, we quantify the impact of the local accumulation of human capital and imported skills on labor mobility and wages (Weiss et al., 2003), with particular emphasis on the role of local training courses. In particular, we study the effect of training in white- and blue-collar occupations on wages, job offer probabilities, and individual utility. In addition, we estimate the predicted aggregate wage growth of immigrants and the individual welfare gain from the availability of training.<sup>3</sup>

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<sup>2</sup> Borjas (1994, 1999) and LaLonde and Topel (1994) provide comprehensive surveys on various topics in the economics of immigration.

<sup>3</sup> Heckman et al. (1999) provide a comprehensive survey of the methods and empirical findings regarding the gains from vocational training programs provided by the government. However, the econometric models they present are static.



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# Estimating the return to training and occupational experience: The case of female immigrants

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## ABSTRACT

We formulate a dynamic discrete choice model of training and employment to measure the personal and social benefits from government provided training for a sample of high-skilled female immigrants from the Former Soviet Union in Israel. We find that training has a significant impact on the mean offered wage in white-collar occupations, but not in blue-collar occupations. Training substantially increases the job-offer rates in both occupations. Counterfactual policy simulations show a substantial social gain from increasing the access to training programs, and the estimated model provides a good fit for within-sample, out-of-sample and aggregate trends using cross-sectional survey data.

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## 1. Introduction

Do government-provided training programs benefit the participants and/or society? Heckman et al. (1999) give the following answer: “As currently constituted, these programs are often ineffective on both counts”. The evidence for this conclusion is based almost entirely on low-skilled workers. We address this question in the context of highly-skilled female immigrants from the Former Soviet Union (FSU) in Israel who first learn a new language (Hebrew) and then choose whether to work or attend government provided training, where the availability of both options is uncertain. Conditional on participation in training, the immigrant decides whether to accept a white- or blue-collar job if one or both are offered. The job offer rate and the associated wage depend on occupation and participation in a training program. Within this framework, we measure the benefit to the female immigrant and the social return to government-sponsored vocational classroom training (CT) programs.

This paper contributes to the literature on the measurement of gains from training in three ways: (1) By distinguishing between direct human capital gain as measured by the effect of training

on wages and the direct impact of training on reducing labor market friction through its effect on job offer probability.<sup>1</sup> (2) By estimating the effect of training programs on both skilled and unskilled workers and (3) by facilitating a dynamic cost-benefit analysis in which the effect of training is not constant but rather evolves over time as participants move between employment and unemployment as well as between occupations.<sup>2</sup> In addition, we extend the literature on the integration of immigrants in the labor market. In particular, the distinction between the impact of training on job-offer rates and on wages enables us to better measure the economic sources of potential benefits from training programs. In other words, it allows us to determine whether these programs provide greater access to jobs or whether they increase potential human capital.

<sup>1</sup> Heckman et al. (1999) cite studies that have estimated the individual and social benefit from training using either its effect on the mean wage or on employment (unemployment) probability. Despite the difference in approaches numerous experimental and non-experimental studies in OECD countries have lead to the same conclusion: the return to training (measured by increase in wages) is approximately zero. However, training programs in Europe usually do have a significant effect on the employment rates.

<sup>2</sup> Heckman and Vytalil (2005) provide a comprehensive analysis of the estimation of treatment parameters for policy evaluation and the importance of structural econometric studies which have an important bearing on the cost-benefit analysis of alternative Active Labor Market Policies (ALMP). The papers by Blundell et al. (2004) and Lise et al. (2005) on ALMP discuss the importance of the impact of training on transitional dynamics in evaluating the policy benefit.

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E-mail address: [cohens1@mail.biu.ac.il](mailto:cohens1@mail.biu.ac.il) (S. Cohen-Goldner).

Uncertainty and Learning in Pharmaceutical Demand

Author(s): Gregory S. Crawford and Matthew Shum

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A Stochastic Dynamic Model of the Mental Health of Children

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# Land Use Change with Spatially Explicit Data: A Dynamic Approach

Alessandro De Pinto · Gerald C. Nelson

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**Abstract** Most of the economic literature that uses spatially-explicit data to estimate the determinants of land-use change is limited to static models and cross-sectional data sets. Recent attempts to move to a more dynamic analysis include using panel data sets and survival analysis. In this study, we use a dynamic model of land-use where the agent's choices are regarded as the solution to a dynamic programming problem. The irreversibility of some decisions, expectations about future prices, and forward-looking behavior of the land user can all be accounted for. The model specification that incorporates some of the complexities of the dynamic literature. First, prediction accuracy is superior to any of the existing models. Second, we demonstrate that transaction costs tend to overestimate the effects of change on land use.

**Keywords** Land use · Deforestation · Discrete choice dynamic optimization · Dynamic optimization

## 1 Introduction

Most of the economic literature that uses spatially-explicit data to investigate the determinants of land use choices and land use change is limited to static models and cross-sectional data sets (Chomitz and Gray 1995; Nelson and Hellerstein 1995; Deininger and Minten 2002; Chomitz and Thomas 2003). However, even the original publication by Chomitz and Gray (1995, pp. 493–494) acknowledged that important issues in land use change are inherently dynamic and that expectations of future prices and irreversibility of some land use choices should be considered. When cross-sectional data are used, all the dynamics and interactions responsible

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A Political Economy Model of Congressional Careers

Author(s): Daniel Diermeier, Michael Keane, Antonio Merlo

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Duration to First Job and the Return to Schooling: Estimates from a Search-Matching Model

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The Specification and Estimation of Dynamic Stochastic Discrete Choice Models: A Survey

Author(s): Zvi Eckstein and Kenneth I. Wolpin

Source: *The Journal of Human Resources*, Vol. 24, No. 4 (Autumn, 1989), pp. 562-598

Published by: [University of Wisconsin Press](#)

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## Brand and Quantity Choice Dynamics Under Price Uncertainty\*

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**Abstract.** We develop a model of household demand for frequently purchased consumer goods that are branded, storable and subject to stochastic price fluctuations. Our framework accounts for how inventories and expectations of future prices affect current period purchase decisions. We estimate our model using scanner data for the ketchup category. Our results indicate that price expectations and the nature of the price process have important effects on demand elasticities. Long-run cross price elasticities of demand are more than twice as great as short-run cross price elasticities. Temporary price cuts (or “deals”) primarily generate purchase acceleration and category expansion, rather than brand switching.

**Key words.** price expectations, pricing, scanner data, dynamic programming, simulation, discrete choice, stock piling, inventories

**JEL Classification:** C1, C61, D1, D8, M3

The goal of this paper is to develop and estimate a dynamic model of consumer choice behavior in markets for goods that are: (1) frequently purchased, (2) branded, (3) storable, and (4) subject to frequent price promotions, or “deals.” In such an environment, forward-looking behavior of consumers is important. Specifically, optimal purchase decisions will depend not only on current prices and inventories, but also on expectations of future prices. There is no single “price elasticity of demand.” Rather, the effect of price changes on consumer demand will depend upon how the price change affects expectations of future prices. This depends on the extent to which consumers perceive the price change to be permanent or transitory, and the

\*An earlier draft of this paper was presented under the title “Consumer Price and Promotion Expectations: Capturing Consumer Brand and Quantity Choice Dynamics under Price Uncertainty.”

†Corresponding author.

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Decision-Making under Uncertainty: Capturing Dynamic Brand Choice Processes in Turbulent Consumer Goods Markets

Author(s): Tülin Erdem and Michael P. Keane

Reviewed work(s):

Source: *Marketing Science*, Vol. 15, No. 1 (1996), pp. 1-20

Published by: [INFORMS](#)

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Sequential Labor Decisions Under Uncertainty: An Estimable Household Model of West-African Farmers

Author(s): Marcel Fafchamps

Reviewed work(s):

Source: *Econometrica*, Vol. 61, No. 5 (Sep., 1993), pp. 1173-1197

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Precautionary Saving, Credit Constraints, and Irreversible Investment: Theory and Evidence from Semiarid India

Author(s): Marcel Fafchamps and John Pender

Source: *Journal of Business & Economic Statistics*, Vol. 15, No. 2, Structural Estimation in Applied Microeconomics (Apr., 1997), pp. 180-194

Published by: [American Statistical Association](#)

Stable URL: <http://www.jstor.org/stable/1392304>

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Unemployment Insurance Eligibility and the School-to-Work Transition in Canada and the United States

Author(s): Christopher Ferrall

Reviewed work(s):

Source: *Journal of Business & Economic Statistics*, Vol. 15, No. 2, Structural Estimation in Applied Microeconomics (Apr., 1997), pp. 115-129

Published by: [American Statistical Association](#)

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A Sequential Game Model of Sports Championship Series: Theory and Estimation

Author(s): Christopher Ferrall and Anthony A. Smith, Jr.

Reviewed work(s):

Source: *The Review of Economics and Statistics*, Vol. 81, No. 4 (Nov., 1999), pp. 704-719

Published by: [The MIT Press](#)

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The International Effects of U.S. Farm Subsidies

Author(s): Eric O'N. Fisher and Harry de Gorter

Reviewed work(s):

Source: *American Journal of Agricultural Economics*, Vol. 74, No. 2 (May, 1992), pp. 258-267

Published by: [Oxford University Press](#) on behalf of the [Agricultural & Applied Economics Association](#)

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## NORC at the University of Chicago

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A Joint Dynamic Model of Fertility and Work of Married Women

Author(s): Marco Francesconi

Reviewed work(s):

Source: *Journal of Labor Economics*, Vol. 20, No. 2 (April 2002), pp. 336-380

Published by: [The University of Chicago Press](#) on behalf of the [Society of Labor Economists](#) and the [NORC at the University of Chicago](#)

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The Effects of Health, Wealth, and Wages on Labour Supply and Retirement Behaviour

Author(s): Eric French

Reviewed work(s):

Source: *The Review of Economic Studies*, Vol. 72, No. 2 (Apr., 2005), pp. 395-427

Published by: [Oxford University Press](#)

Stable URL: <http://www.jstor.org/stable/3700657>

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A Dynamic Stochastic Model of Medical Care Use and Work Absence

Author(s): Donna B. Gilleskie

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Published by: [The Econometric Society](#)

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Estimating the Impact of Consumer Expectations of Coupons on Purchase Behavior: A  
Dynamic Structural Model

Author(s): Füsün Gönül and Kannan Srinivasan

Source: *Marketing Science*, Vol. 15, No. 3 (1996), pp. 262-279

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Dynamic Labor Force Participation Decisions of Males in the Presence of Layoffs and Uncertain Job Offers

Author(s): Füsün Gönül

Reviewed work(s):

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# Estimating price expectations in the OTC medicine market: An application of dynamic stochastic discrete choice models to scanner panel data

Füsün F. Gönül\*

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## Abstract

This paper examines the differences in managerial implications of dynamic and reduced-form models when the models are applied to brand choice behavior in the over-the-counter (OTC) back and leg ache medicine market. The models we develop are useful to brand managers and researchers who are interested in dynamic factors that influence choice such as prior experience with brands, future price expectations, and an overall concern for the future. The key findings of our research are that the dynamic model is supported by the data over the single-period model; that past experience with a brand matters in current choice; that consumers' price expectations influence their current choices; and that expectations follow a distinct pattern. © 1999 Elsevier Science S.A. All rights reserved.

*JEL classification:* M31; C33

*Keywords:* Dynamic programming; Price expectations; Scanner panel data; Structural model

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## 1. Introduction

Recently, more pharmaceutical manufacturers invest in developing and offering over-the-counter (OTC) equivalents of their prescription (Rx) products<sup>1</sup>. In

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\*E-mail: fg0k@andrew.cmu.edu

<sup>1</sup> The typical OTC drug is lower in strength than its Rx counterpart, and may also vary in form, size, and flavor.



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Optimal Mailing of Catalogs: A New Methodology Using Estimable Structural Dynamic Programming Models

Author(s): Füsün Gönül and Meng Ze Shi

Reviewed work(s):

Source: *Management Science*, Vol. 44, No. 9 (Sep., 1998), pp. 1249-1262

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Marriage and Career: The Dynamic Decisions of Young Men

Author(s): Eric D. Gould

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Published by: [The University of Chicago Press](http://www.press.uchicago.edu)

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Cities, Workers, and Wages: A Structural Analysis of the Urban Wage Premium

Author(s): E. D. Gould

Reviewed work(s):

Source: *The Review of Economic Studies*, Vol. 74, No. 2 (Apr., 2007), pp. 477-506

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A Structural Dynamic Analysis of Retirement Behaviour in the Netherlands

Author(s): Arjan Heyma

Reviewed work(s):

Source: *Journal of Applied Econometrics*, Vol. 19, No. 6, The Econometrics of Social Insurance (2004), pp. 739-759

Published by: [John Wiley & Sons](#)

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Conditional Choice Probabilities and the Estimation of Dynamic Models

Author(s): V. Joseph Hotz and Robert A. Miller

Source: *The Review of Economic Studies*, Vol. 60, No. 3 (Jul., 1993), pp. 497-529

Published by: [Oxford University Press](#)

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A Simulation Estimator for Dynamic Models of Discrete Choice

Author(s): V. Joseph Hotz, Robert A. Miller, Seth Sanders, Jeffrey Smith

Source: *The Review of Economic Studies*, Vol. 61, No. 2 (Apr., 1994), pp. 265-289

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Institute of Social and Economic Research -- Osaka University**

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Intertemporal Labor Supply and Human Capital Accumulation

Author(s): Susumu Imai and Michael P. Keane

Reviewed work(s):

Source: *International Economic Review*, Vol. 45, No. 2 (May, 2004), pp. 601-641

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Employment, Deterrence, and Crime in a Dynamic Model

Author(s): Susumu Imai and Kala Krishna

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Source: *International Economic Review*, Vol. 45, No. 3 (Aug., 2004), pp. 845-872

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Estimation of a Dynamic Auction Game

Author(s): Mireia Jofre-Bonet and Martin Pesendorfer

Reviewed work(s):

Source: *Econometrica*, Vol. 71, No. 5 (Sep., 2003), pp. 1443-1489

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A Dynamic Programming Approach to Model the Retirement Behaviour of Blue-Collar Workers in Sweden

Author(s): Anders Karlstrom, Marten Palme, Ingemar Svensson

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## Structural vs. atheoretic approaches to econometrics

Michael P. Keane\*

University of Technology Sydney, Australia  
Arizona State University, United States

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Instrumental variables

### ABSTRACT

In this paper I attempt to lay out the sources of conflict between the so-called “structural” and “experimentalist” camps in econometrics. Critics of the structural approach often assert that it produces results that rely on too many assumptions to be credible, and that the experimentalist approach provides an alternative that relies on fewer assumptions. Here, I argue that this is a false dichotomy. All econometric work relies heavily on *a priori* assumptions. The main difference between structural and experimental (or “atheoretic”) approaches is not in the number of assumptions but the extent to which they are made explicit.

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### 1. Introduction

The goal of this volume is to draw attention to the many researchers, especially young researchers, doing high quality structural econometric work in several areas of applied microeconomics. It is motivated by a perception that structural work has fallen out of favor in recent years, and that, as a result, the work being done by such young researchers has received too little attention. In this paper, I would like to talk about why structural work has fallen out of favor, whether that ought to be the case, and, if not, what can be done about it. I will argue that there is much room for optimism, as recent structural work has increased our understanding of many key issues.

Since roughly the early 90s, a so-called “experimentalist” approach to econometrics has been in vogue. This approach is well described by Angrist and Krueger (1999), who write that “Research in a structuralist style relies heavily on economic theory to guide empirical work . . . An alternative to structural modeling, . . . the “experimentalist” approach, . . . puts front and center the problem of identifying causal effects from specific events or situations”. By “events or situations”, they are referring to “natural experiments” that generate exogenous variation in certain variables that would otherwise be endogenous in the behavioral relationship of interest.

The basic idea here is this. Suppose we are interested in the effect of a variable  $X$  on an outcome  $Y$ , for example, the effect of an additional year of education on earnings. The view of the “experimentalist” school is that this question is very difficult to address precisely because education is not randomly assigned. People with different education levels tend to have different levels of other variables  $U$ , at least some of which are unobserved (e.g., innate ability), that also affect earnings. Thus, the “causal effect” of an additional year of education is hard to isolate.

However, the experimentalist school seems to offer us a way out of this difficult problem. If we can find an “instrumental variable”  $Z$  that is correlated with  $X$  but uncorrelated with the unobservables that also affect earnings, then we can use an instrumental variable (IV) procedure to estimate the effect of  $X$  on  $Y$ . The “ideal instrument” is a “natural experiment” that generates random assignment (or something that resembles it), whereby those with  $Z = 1$  tend, *Ceteris paribus*, to choose a higher level of  $X$  than those with  $Z = 0$ . That is, some naturally occurring event affects a random subset of the population, inducing at least some members of that “treatment group” to choose or be assigned a higher level of  $X$  than they would have otherwise.<sup>1</sup> *Prima facie*, this approach

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<sup>1</sup> As Angrist and Krueger (1999) state: “In labor economics at least, the current popularity of quasi-experiments stems . . . from this concern: Because it is typically impossible to adequately control for all relevant variables, it is often desirable to seek situations where it is reasonable to presume that the omitted variables are uncorrelated with the variables of interest. Such situations may arise if . . . the forces of nature or human institutions provide something close to random assignment”.



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The Solution and Estimation of Discrete Choice Dynamic Programming Models by Simulation and Interpolation: Monte Carlo Evidence

Author(s): Michael P. Keane and Kenneth I. Wolpin

Source: *The Review of Economics and Statistics*, Vol. 76, No. 4 (Nov., 1994), pp. 648-672

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The Career Decisions of Young Men

Author(s): Michael P. Keane and Kenneth I. Wolpin

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Estimating Welfare Effects Consistent with Forward-Looking Behavior. Part II: Empirical Results

Author(s): Michael P. Keane and Kenneth I. Wolpin

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# Empirical applications of discrete choice dynamic programming models

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## ABSTRACT

The development over the past 25 years of methods for the estimation of discrete choice dynamic programming (DCDP) models opened up new frontiers for empirical research in a host of areas, including labor economics, industrial organization, economic demography, health economics, development economics, political economy and marketing. In this paper, we first describe the development of the DCDP framework, showing how it was a natural extension of static discrete choice modeling. We then summarize six papers that adopt the DCDP paradigm that address substantively important social and economic questions. Finally, we consider the issue of the credibility of empirical findings based on the structural estimation of DCDP models.

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## 1. Introduction<sup>2</sup>

The development of methods for the estimation of discrete choice dynamic programming (DCDP) models, that began over 20 years ago, opened up new frontiers for empirical research in a host of areas, including labor economics, industrial organization, economic demography, health economics, development economics and political economy, and has spread to areas outside of traditional economics, such as marketing.<sup>3</sup> There are a number of survey papers that describe the methodology and provide examples of applications found in the literature up to the mid-1990s (Eckstein and Wolpin, 1989a; Miller, 1997; Rust, 1993, 1994), and a recent survey that describes the methodological work that has been ongoing since that time (Aguirregabiria and Mira, in press). Another conventional survey would thus have limited value. The purpose of this essay is, instead, to provide evidence about whether the methodology's promise has borne fruit as a tool for empirical research. The success of what has come to be called, for better or worse, the “structural” approach to microeconomic empirical research should be judged according to the value of the empirical work that the approach has made possible.<sup>4</sup>

To that end, we describe how the DCDP paradigm has been used to address quantitatively six diverse, substantively important and challenging questions. The six papers that we summarize span the fields of economic demography, economic development, labor economics, health economics and political economy. The papers fall into two categories in terms of their goals. One of the papers attempts to explain a set of historical phenomena. Papers of this kind, to the extent that

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<sup>2</sup> This essay derives from the plenary talk by Wolpin at the June 2007 SED conference in Prague.

<sup>3</sup> Indeed, the DCDP approach is now arguably the predominant one in marketing.

<sup>4</sup> The structural approach encompasses continuous as well as discrete choice models and static as well as dynamic models. Explicit modeling of dynamical considerations does not alter the basic rationale for the imposition of structure as contained in Marschak (1953).

## THE EFFECT OF EXPECTED INCOME ON INDIVIDUAL MIGRATION DECISIONS

BY JOHN KENNAN AND JAMES R. WALKER<sup>1</sup>

This paper develops a tractable econometric model of optimal migration, focusing on expected income as the main economic influence on migration. The model improves on previous work in two respects: it covers optimal sequences of location decisions (rather than a single once-for-all choice) and it allows for many alternative location choices. The model is estimated using panel data from the National Longitudinal Survey of Youth on white males with a high-school education. Our main conclusion is that interstate migration decisions are influenced to a substantial extent by income prospects. The results suggest that the link between income and migration decisions is driven both by geographic differences in mean wages and by a tendency to move in search of a better locational match when the income realization in the current location is unfavorable.

KEYWORDS: Migration, dynamic discrete choice models, job search, human capital.

### 1. INTRODUCTION

THERE IS AN EXTENSIVE LITERATURE on migration.<sup>2</sup> Most of this work describes patterns in the data: for example, younger and more educated people are more likely to move; repeat and especially return migration account for a large part of the observed migration flows. Although informal theories explaining these patterns are plentiful, fully specified behavioral models of migration decisions are scarce, and these models generally consider each migration event in isolation, without attempting to explain why most migration decisions are subsequently reversed through onward or return migration.

This paper develops a model of optimal sequences of migration decisions, focusing on expected income as the main economic influence on migration. The model is estimated using panel data from the National Longitudinal Survey of Youth (NLSY) on white males with a high-school education. We emphasize that migration decisions are reversible and that many alternative locations must be considered. Indeed (as we show in Section 2), repeat migration is a prominent feature of the data, and in many cases people choose to return to

<sup>1</sup>The National Science Foundation and the NICHD provided research support. We thank Taisuke Otsu for outstanding research assistance. We also thank the editor and referees for very detailed constructive criticism of several earlier versions of the paper. We are grateful to Joe Altonji, Kate Antonovics, Peter Arcidiacono, Gadi Barlevy, Philip Haile, Bruce Hansen, Igal Hender, Yannis Ioannides, Mike Keane, Derek Neal, John Pencavel, Karl Scholz, Robert Shimer, Chris Taber, Marcelo Veracierto, Ken Wolpin, Jim Ziliak, and seminar and conference participants at the Chicago Federal Reserve Bank, Carnegie–Mellon, Duke, Iowa, IZA, Ohio State, Penn State, Rochester, SITE, the Upjohn Institute, Virginia, Wisconsin, and Yale for helpful comments.

<sup>2</sup>See Greenwood (1997) and Lucas (1997) for surveys.





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A Structural Model of Aircraft Engine Maintenance

Author(s): D. Mark Kennet

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**Economics Department of the University of Pennsylvania  
Institute of Social and Economic Research -- Osaka University**

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An Estimable Dynamic General Equilibrium Model of Work, Schooling, and Occupational Choice

Author(s): Donghoon Lee

Reviewed work(s):

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Optimal Replacement Policies for Rejuvenated Assets

Author(s): John W. McClelland, Michael E. Wetzstein, Richard K. Noles

Reviewed work(s):

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Author(s): Antonio Merlo

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Job Matching and Occupational Choice

Author(s): Robert A. Miller

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**UNCERTAIN INFANT MORTALITY, LEARNING,  
AND LIFE-CYCLE FERTILITY\***

BY PEDRO MIRA<sup>1</sup>

*CEMFI, Spain*

This article examines the links between infant mortality and fertility in an environment with unobserved heterogeneity in infant mortality risk across mothers. In such an environment, replacement behavior (i.e., the fertility response to an experienced child death) might be influenced by mothers' learning about a family-specific component of infant mortality risk. I explicitly introduce learning by mothers in a dynamic stochastic model of life-cycle marital fertility, and I estimate the model's structural parameters using Malaysian panel data. The framework is used to estimate replacement rates and to correct for birth selectivity in the estimation of the relationship between infant mortality risk and "health inputs."

1. INTRODUCTION

The study of the links between infant and child mortality and fertility is useful in our efforts to understand the determinants of infant and child mortality risks, guide the design of policy interventions that seek to reduce such risks and predict the consequences of those policies for population change. In this article, I examine the links between infant mortality and fertility in an environment with heterogeneity in infant mortality risk across mothers. If fertility is correlated with components of infant mortality risk that are not observed by the researcher, a problem arises in the empirical investigation of the determinants of infant mortality risk because this correlation is a potential source of sample selection bias. Furthermore, women may also face uncertainty about an idiosyncratic component of infant mortality risks, and learning about it following the death of a child could influence subsequent fertility behavior.

In this article, I explicitly introduce learning by mothers in a dynamic stochastic model of life-cycle marital fertility behavior. The dynamic model nests a "production function" of infant survival with heterogeneity in endowments and learning about family-specific components in a nonstationary environment. I estimate the model's structural parameters using Malaysian panel data. The framework is used to obtain better estimates of fertility responses to experienced child deaths

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<sup>1</sup> This article draws from my Ph.D. thesis written at the University of Minnesota. Special thanks are due to my advisor, Ken Wolpin, for his support and guidance. I am also grateful for comments and suggestions from editors, referees, and Jim Walker. Remaining errors are my own. Financial support from the University of Minnesota's Walter W. Heller Dissertation Fellowship is gratefully acknowledged. Please address correspondence to: Pedro Mira, CEMFI, Casado del Alisal, 5, 28014 Madrid, Spain. Phone: 34 91 429-0551. Fax: 34 91 429-1056. E-mail: [mira@cemfi.es](mailto:mira@cemfi.es).





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An Empirical Model of Asset Replacement in Dairy Production

Author(s): Mario J. Miranda and Gary D. Schnitkey

Reviewed work(s):

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# A structural model of sales-force compensation dynamics: Estimation and field implementation

Sanjog Misra · Harikesh S. Nair

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**Abstract** We present an empirical framework to analyze real-world sales-force compensation schemes, and report on a multi-million dollar, multi-year project involving a large contact lens manufacturer at the US, where the model was used to improve sales-force contracts. The model is built on agency theory, and solved using numerical dynamic programming techniques. The model is flexible enough to handle quotas and bonuses, output-based commission schemes, as well as “ratcheting” of compensation based on past performance, all of which are ubiquitous in actual contracts. The model explicitly incorporates the dynamics induced by these aspects in agent behavior. We apply the model to a rich dataset that comprises the complete details of sales and compensation plans for the firm’s US sales-force. We use the model to evaluate profit-improving, theoretically-preferred changes to the extant compensation scheme. These recommendations were then implemented at the focal firm. Agent behavior and output under the new compensation plan is found to change as predicted. The new plan resulted in a 9% improvement in overall revenues, which translates to about \$12 million incremental revenues annually, indicating the success of the field-implementation. The results bear out the face validity of dynamic agency theory for real-world compensation design. More generally, our results fit into a growing literature that illustrates that dynamic programming-based solutions, when combined with structural

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Patents as Options: Some Estimates of the Value of Holding European Patent Stocks

Author(s): Ariel Pakes

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Structural versus Reduced-Form Estimation of Optimal Stopping Problems

Author(s): Bill Provencher

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## JOB SEARCH AND ASSET ACCUMULATION UNDER BORROWING CONSTRAINTS\*

BY SÍLVIO RENDON<sup>1</sup>

*Centro de Investigación Económica - Instituto Tecnológico  
Autónomo de México (ITAM), Mexico*

This article examines the relationship between wealth accumulation and job search dynamics. It proposes a model in which risk-averse individuals search for jobs, save, and borrow to smooth their consumption. One motivation for accumulating wealth is to finance voluntary quits in order to search for better jobs. Using data on men from the National Longitudinal Survey (1979 cohort), I estimate the individual's dynamic decision problem. The results show that borrowing constraints are tight and reinforce the influence of wealth on job acceptance decisions, namely that more initial wealth and access to larger amounts of credit increase wages and unemployment duration.

### 1. INTRODUCTION

This article studies the relationship between asset accumulation and imperfect capital markets, and job search and employment dynamics. I develop and estimate a model of job search and savings that replicates observed trends in assets, employment transitions, and wages. I find that asset holdings are related to job search outcomes because they allow wealthier individuals to be more selective and to wait for jobs that offer higher wages. For example, increasing initial asset holdings by \$5,000 raises accepted quarterly wages by \$800 in the first quarter after high school graduation. It also extends average unemployment duration by over two quarters. I also find evidence of tight borrowing constraints; agents can borrow only 14% of the present value of their risk-free income. Simulation results based on the estimated model show that relaxing borrowing constraints has an important effect on labor market outcomes. Increasing an individual's access to credit to half of the present value of his risk-free income causes his wages in

\* Manuscript received November 2002; revised September 2004.

<sup>1</sup> This article is a revision of part of my Ph.D. dissertation submitted to New York University, 1997. I thank Chris Flinn, Ken Wolpin, and Wilbert van der Klaauw for their encouragement and advice. W. Baumol, R. Bénabou, A. Caplin, D. Gale, M. Gertler, B. Jovanovic, R. Kinnunen, Y. Nyarko, F. Peracchi, S. Pratap, N. Quella, G. Rabault, G. Topa, A. Velasco, C. Wilson, and E. Wolff as well as the editor, Petra Todd, and two anonymous referees provided helpful comments and suggestions. I also thank participants of seminars at NYU, U. of Western Ontario, European Institute Florence, U. Carlos III, U. Pompeu Fabra, ITAM, Florida International U., U. of Copenhagen. I gratefully acknowledge financial support of the Spanish Ministry of Science and Technology (Grant SEC 2001-0674) and the Mexican Association of Culture. The usual disclaimer applies. Please address correspondence to: Sílvio Rendon, Department of Economics and Centro de Investigación Económica - Instituto Tecnológico Autónomo de México (ITAM), Av. Camino Sta Teresa #930, Mexico D.F. 10700, Mexico. Phone: +52 55 5628 4000. Fax: +52 55 5628 4058. E-mail: [srendon@itam.mx](mailto:srendon@itam.mx).



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On the Optimal Lifetime of Nuclear Power Plants

Author(s): Geoffrey Rothwell and John Rust

Source: *Journal of Business & Economic Statistics*, Vol. 15, No. 2, Structural Estimation in Applied Microeconomics (Apr., 1997), pp. 195-208

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Author(s): John Rust and Christopher Phelan

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Author(s): Steven Stern

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Compensation Policies and Teacher Decisions

Author(s): Todd R. Stinebrickner

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## A DYNAMIC ANALYSIS OF EDUCATIONAL ATTAINMENT, OCCUPATIONAL CHOICES, AND JOB SEARCH\*

BY PAUL SULLIVAN<sup>1</sup>

*U.S. Bureau of Labor Statistics, U.S.A.*

This article examines career choices using a dynamic structural model that nests a job search model within a human capital model of occupational and educational choices. Wage growth occurs in the model because workers move between firms and occupations as they search for suitable job matches and because workers endogenously accumulate firm and occupation specific human capital. Simulations performed using the estimated model reveal that both self-selection in occupational choices and mobility between firms account for a much larger share of total earnings and utility than the combined effects of firm and occupation specific human capital.

### 1. INTRODUCTION

Over the course of their careers people choose how much education to obtain, which occupations to work in, and when to move between firms. These decisions are inherently interrelated, yet existing research has generally examined educational attainment, occupational choices, and on-the-job human capital accumulation separately from decisions about job search.<sup>2</sup> As a result of this separation in the literature, there is currently no way to assess the importance of interactions between these decisions or to determine the importance of human capital relative to the importance of mobility between firms and occupations in determining wage growth over the career.

The goal of this article is to address this gap in the literature by estimating a dynamic structural model of career choices that incorporates the key features of a job search model within a dynamic human capital model of occupational and educational choices. The model allows workers to accumulate firm- and occupation-specific human capital as they move between firms and occupations over their careers. Estimating the model provides evidence about the relative importance of human capital, job search, and matching between workers and occupations in determining wages and total utility. The parameter estimates reveal that each aspect of the model is quantitatively important and necessary to understand the evolution of wages over the career.

\* Manuscript received September 2006; accepted July 2008.

<sup>1</sup> I would like to thank John Pepper, William Johnson, and especially Steven Stern for their invaluable assistance during this project. I thank three anonymous referees and the editor, Petra Todd, for helpful comments and suggestions. This research has benefited from discussions with Loren Smith, John Bound, Timothy Erickson, Randal Verbrugge, and Daniel Mackay and from the comments of numerous seminar participants. I gratefully acknowledge financial support for this research provided by the Bankard Fund for Political Economy at the University of Virginia, the University of Virginia College of Arts and Sciences, and a National Institute on Aging Post Doctoral Fellowship at the University of Michigan (grant number AG000221-14). All views and opinions expressed in this article are those of the author and do not necessarily represent the views of the Bureau of Labor Statistics. Please address correspondence to: Paul Sullivan, Department of DPINR, Bureau of Labor Statistics, Postal Square Building Room 3105, MC 204, 2 Massachusetts Ave. NE, Washington, DC 20212-0001. Phone: 202 691-6593. Fax: 202 691-6583. E-mail: [Sullivan.Paul.Joseph@bls.gov](mailto:Sullivan.Paul.Joseph@bls.gov) or [pauljsullivan@gmail.com](mailto:pauljsullivan@gmail.com).

<sup>2</sup> See Keane and Wolpin (1997), Lee (2005), and Lee and Wolpin (2006) for examples of dynamic human capital models that focus on occupational choices and human capital accumulation. Heckman et al. (1998) were the first researchers to estimate a general equilibrium model of human capital investment, but their model does not incorporate occupational choices. A recent survey of the extensive job search literature is provided by Eckstein and van den Berg (2006).



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Author(s): Petra E. Todd and Kenneth I. Wolpin

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# Social security and the retirement and savings behavior of low-income households

Wilbert van der Klaauw<sup>a,\*</sup>, Kenneth I. Wolpin<sup>b</sup>

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## ABSTRACT

In this paper, we develop and estimate a model of retirement and savings incorporating limited borrowing, stochastic wage offers, health status and survival, social security benefits, Medicare and employer-provided health insurance coverage, and intentional bequests. The model is estimated on a sample of relatively poor households from the first three waves of the Health and Retirement Study (HRS), for whom we would expect social security income to be of particular importance. The estimated model is used to simulate the responses to changes in social security rules, including changes in benefit levels, in the payroll tax, in the social security earnings tax and in early and normal retirement ages. Welfare and budget consequences are estimated.

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## Executive summary

With the oldest cohort of the baby-boom generation just beginning to reach retirement age, the impending wave of retirements during the next two decades is expected to place mounting budgetary pressures on the federal government. Consequently, the reform of Social Security and Medicare has become a central policy issue, with policy makers facing the difficult task of choosing from among a large set of alternative policy proposals. To help this debate, we develop and estimate a rich dynamic model of retirement and savings decisions for a low-income subsample of households from the Health and Retirement Study. This subset of households is expected to rely heavily on government benefits in retirement, and includes both unmarried individuals and married couples.

Our model of labor supply and consumption choices includes a detailed specification of social security rules, borrowing constraints, stochastic wage offers, uncertain health and survival, Medicare and employer-provided health insurance coverage, as well as a bequest motive. We use the estimates of our model to simulate the impact of several counterfactual experiments corresponding to changes in social security rules on household labor supply, income and consumption. These include reductions in benefit levels, the removal of the earnings test, elimination of early retirement, and postponement of the earliest retirement age to 70.

In all cases, the model predicts sharp increases in average annual hours of work and in full-time employment at ages 62–69, and smaller variable responses in hours before age 62. There is considerable heterogeneity in responses, with those of singles generally exceeding those of married individuals, and those of husbands being considerably larger than those of wives. The employment responses are accompanied by modest, but not inconsequential, changes in net assets holdings, indicating that both labor supply and savings decisions play important roles in mitigating these reforms' impacts on consumption and welfare. Our experiments illustrate the existence of potentially important trade-offs faced by policy makers in balancing consumer welfare losses against revenue increases.

## 1. Introduction

The literature on retirement behavior has grown rapidly during the last twenty years. Much of that growth has been due to recent methodological advances in the structural estimation of dynamic discrete choice models of behavior under uncertainty. Unlike earlier static lifetime models (e.g., Fields and Mitchell (1984)), dynamic models account for the sequential nature of the retirement process in which individuals adjust their behavior as events unfold. Structural estimation of the fundamental parameters of preferences and constraints as opposed to “reduced form” analyses permits the simulation of policy experiments that act directly on constraints and which may be outside of current or prior policy regimes.

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An Estimable Dynamic Stochastic Model of Fertility and Child Mortality

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Public-Policy Uses of Discrete-Choice Dynamic Programming Models

Author(s): Kenneth I. Wolpin

Source: *The American Economic Review*, Vol. 86, No. 2, Papers and Proceedings of the Hundredth and Eighth Annual Meeting of the American Economic Association San Francisco, CA, January 5-7, 1996 (May, 1996), pp. 427-432

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Ex Ante Policy Evaluation, Structural Estimation, and Model Selection

Author(s): Kenneth I. Wolpin

Source: *The American Economic Review*, Vol. 97, No. 2 (May, 2007), pp. 48-52

Published by: [American Economic Association](#)

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