Keeping the ECON in Econometrics: (Micro-)Econometrics in the *Journal of Political Economy*

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In 1970, John Siegfried wrote an instructive short note in the miscellany section of the *Journal of Political Economy* titled "A First Lesson in Econometrics" (Siegfried 1970). The author starts by writing the equation "1 + 1 = 2" but immediately argues that "every budding econometrician must learn early that it is never in good taste to express the sum of two quantities in [this] form" (1378). He then produces two pages of intricate derivations to arrive at an equivalent but extremely cumbersome expression.[1] From the publication of this note, it is reasonable to infer that the *JPE*'s editorial team at the time had some level of distrust in sophisticated econometric analysis.[2] Shortly thereafter, however, the journal began to play a key role in the development of several, novel econometric ideas.

Compared to many of its competitors, the type of econometric research the *JPE* has published has two distinctive features. The first one is the promotion of a type of econometric work that is tightly connected to economic models. In particular, the *JPE* has been a leading vehicle for structural econometric modeling. The second main feature is the emphasis on empirical applications of the methodology. The *JPE* seldom publishes abstract econometric theory. Instead, it promotes econometric analysis mainly through applications. In agreement with the motto of

While the title echoes Leamer's (1983) "taking the con out of econometrics," the expression "keeping the econ" was previously used by Ehrlich and Liu (1999) in a paper that appeared in the *Journal of Law and Economics*, also published at the University of Chicago.

[1] To add to the irony of that note, Eldridge (2014) points out that Siegfried's formula is wrong because of a matrix algebra mistake.

[2] For example, the *JPE* is mentioned only in passing in Christ's (1994) historical account of the Cowles Commission between 1939 and 1955, during which it was hosted at the University of Chicago.

the Cowles Commission, the *JPE*'s style of econometrics is one in which theory and measurement go hand in hand.

Since trying to review all of the econometrics research in the *JPE* would be a daunting task, we will focus on only a handful of contributions, each of which links economics and econometrics in particularly insightful ways. Such a choice necessarily means leaving aside a large number of equally important and influential contributions. In the same spirit, this review will be limited mainly to microeconometric applications, abstracting from key contributions to time-series econometrics, macroeconometrics, and finance that have appeared in the journal.

Econ Meets Metrics: An Econometric Model of Marriage

Becker's (1973, 1974) classical theory of marriage appeared in the *JPE* and is considered a landmark of the journal. Becker proposed a static model of the marriage market in which agents of different types, when matched, share surplus and can transfer utility to each other. Agents rank potential matches according to their preferences. In equilibrium, all matches are stable. Viewing marriage as a rational decision leading to an equilibrium distribution of matches has strong empirical appeal. For example, the model could be used to understand the effect of divorce laws or changes in contraception technology on marriage patterns. Devising an empirical counterpart to the Becker model, however, remained an unsolved question for a long time.

The *JPE* has been a pioneer in the structural econometric analysis of marriage markets, and more generally, it has published some of the most innovative and accomplished work in structural econometrics. The structural approach tries to build and exploit a tight link between the economic model and the empirical econometric model. Its main goal is to estimate primitive structural parameters with the hope that such parameters are invariant to policy and can be used for counterfactual predictions.

Choo and Siow (2006) proposed a structural econometric model of marriage. They completed the Becker theory to make it an econometric model that could be taken to the data. In doing so they faced several challenges: first, how to define an agent's type empirically and how to properly account for heterogeneity in preferences; second, how to deal with the fact that, typically, data on transfers within couples are not observed by the econometrician.

In the Choo and Siow framework, agents (i.e., men and women) have discrete types defined in terms of covariates such as age, education, ethnicity, or geography. Individuals of both genders have preferences for being married to different types of individuals. The structure of preferences is key to the tractability of the framework. Specifically, the utility of

a woman of type i (e.g., defined in terms of age and education) for marrying a man of type j is the sum of an (i, j)–specific systematic preference term, an (i, j)–specific transfer, and an idiosyncratic preference term. Building on McFadden (1974), the latter is assumed to follow a type I extreme value distribution, independent of the other terms and independent across options. For given values of systematic preferences and transfers, women's choices therefore take the form of logit demand models. Symmetrically, men's choices also take a logit form.

In contrast to single-agent choice models, in marriage markets two types of agents interact with each other and equilibrium constraints must be met. An innovation of the Choo and Siow framework is that transfers, which are not observed by the econometrician, are identified as the prices that clear the market and make women's and men's demands equal. As a result, the overall structure of the model is a two-sided logit demand model with equilibrium constraints.

A particular implication of the model is that it delivers a closed-form expression for the utility gains from marriage. A key equation in Choo and Siow (2006) shows that net gains from marriage for agents of types (i, j), relative to being single, can be written as a combination of quantities that are typically easy to estimate: the number of men and women of types (i, j) who are married, divided by the geometric average of the number of unmarried women of type i and unmarried men of type j. This transparent expression illustrates the power of a theory that delivers an economically interpretable quantity that can be directly estimated from the data. Taking advantage of this expression, in a way that is typical of many *JPE* papers, Choo and Siow illustrate the empirical relevance of their framework by estimating net gains from marriage in 1970–71 and 1981–82 by gender, age, and age of the spouse. In addition, they estimate how gains from marriage evolved after the legalization of abortion in *Roe v. Wade* by exploiting variation across states in a difference-in-differences fashion. This exercise nicely showcases the type of applications that can be studied with the framework.

Choo and Siow's (2006) seminal paper has already spurred a long legacy. Important work building on their framework has also appeared in the *JPE* (e.g., Chiappori and Oreffice 2008; Chiappori, Oreffice, and Quintana-Domeque 2012; Dupuy and Galichon 2014; Chiappori, Costa Dias, and Meghir, forthcoming; Fox, Yang, and Hsu, forthcoming).

Structural Econometric Models of the Labor Market

Among the many studies using the structural approach that have appeared in the *JPE*, models of education decisions and career choices have particularly benefited from the development of novel econometric methods. In such models, individuals choose to select into different ca-

reers depending on the costs they face and their expected returns. The econometrician must deal with the fact that returns and costs are largely unobserved. A central challenge is thus how to estimate rates of return to college or to a type of occupation in the presence of self-selection.

The 1970s and 1980s saw great progress on the understanding of selection models. Some of the key contributions appeared in the *JPE* (Gronau 1974; Heckman and Sedlacek 1985). Here, we focus on two contributions to structural econometrics that have built on this work. We note that there are several important *JPE* articles that are closely related to these two papers, such as Cameron and Heckman (1998, 2001), which we do not discuss here because of space constraints.

Willis and Rosen (1979) is an early example of a structural econometric model of education decisions.[3] The empirical model builds on the theory of comparative advantage. This work contains a number of strikingly modern econometric insights that are still relevant to today's research. A notable aspect concerns the way the authors specify and analyze the counterfactual—or "potential"—outcomes corresponding to different education choices. Their classical discussion of the role of exclusion restrictions, which are needed for credible identification, includes an exposition of the distinction between the marginal rate of return to investment and the marginal cost of funds due to Gary Becker. The role of functional form assumptions is also carefully discussed.

Another noteworthy aspect of the analysis is the way the economic model and the econometrics are linked to each other. The model's predictions are assessed for two outcomes: initial earnings in the life cycle and growth rates of earnings. The authors test several of the main structural restrictions of the model, but they do not interpret the fact that those restrictions are not violated as definitive success for the structural model. In the conclusion of the paper, the authors go one step further and include a small out-of-sample prediction exercise as a validation check.

Willis and Rosen's work was extended by Keane and Wolpin (1997), also published in the *JPE*, in several dimensions. Keane and Wolpin build a dynamic life cycle model of human capital investment in which individuals go to school and work in various occupations. Agents, who face uncertainty in the returns to their choices (i.e., wages), are forward looking and have rational expectations. Keane and Wolpin work under the constraint that the restrictions from the theory must be fully imposed in estimation. This structural approach to policy evaluation then allows them to perform counterfactual policy exercises. Taking such a setup to the data raises a number of econometric challenges. Setting up a coherent

[3] The reader may wonder about the unusual ordering of the authors' names. The initial footnote informs us that it was "selected by a random device."

structure that is rich enough to fit the complex heterogeneity in individual trajectories, while keeping the model tractable, remains a very difficult task today.

A central feature of Keane and Wolpin's econometric model is its dynamic nature. Experience is treated as a state variable, and agents form expectations about streams of income conditional on education and career choices. Estimation is based on maximum likelihood. Unlike previous structural dynamic discrete choice models, however, observed wages in their model are self-selected since work and experience are choices—and therefore endogenous, just like schooling. Endogeneity complicates estimation since it is not possible to proceed sequentially. For computation, Keane and Wolpin develop an approximate solution to the dynamic programming problem that allows them to address the computational curse of dimensionality.

A second key feature of the model is the presence of unobserved types. Borrowing from Heckman and Sedlacek (1985), Keane and Wolpin allow for self-selection in multiple dimensions of skill endowments. They deal with the presence of multidimensional heterogeneity using a finite mixture approach, which disciplines the different dimensions of heterogeneity.

Since its publication, Keane and Wolpin's framework has become a blueprint for structural econometric analysis in labor economics and elsewhere. Dynamic structural econometric modeling is still a vibrant research area, and some of the best research in this field is appearing in the *JPE*, such as two recent contributions by Adda, Dustmann, and Stevens (2017) and Heckman, Humphries, and Veramendi (forthcoming).

Partial Identification Meets Economic Theory

Partial identification is one of the most prominent recent themes in econometrics. The *JPE* played an early and important role in promoting the use of such methods in economics. The defining feature of a partially identified model is that the parameter of interest is not uniquely determined by the distribution of the observed data. Instead, it is limited only to a set of values. As we will see below, one of the main attractions of such methods is that they permit researchers to avoid making assumptions that may be deemed unpalatable for one reason or another but that might have been previously made for tractability.

While not fitting within our theme of microeconometrics, an early and influential example of partial identification can be found in Hansen and Jagannathan's (1991) landmark paper on the implications of security market data for asset pricing models. In the case of Hansen and Jagannathan, the parameters of interest are the means and standard deviations of the intertemporal marginal rates of substitution and the observed

data consist of security market data. They observe that under weak assumptions one can restrict the set of possible values for the parameters of interest using the Cauchy-Schwarz inequality. In contrast to previous approaches, Hansen and Jagannathan need not specify parametric functional forms for the intertemporal marginal rates of substitution. In fact, their analysis allows them to conclude that certain specifications are inconsistent with the observed data.

A more recent example of partial identification and one that fits more closely within our theme is Haile and Tamer's (2003) analysis of English or oral ascending auctions. In the case of Haile and Tamer, the parameter of interest is the distribution of bidders' (private) valuations and the observed data consist of bids. Instead of relying on a particular model of bidding behavior, such as the "button model" found in Milgrom and Weber (1982), which they argue may be inconsistent with the observed data, they instead propose assuming only that (i) bidders do not bid more than they are willing to pay and (ii) bidders do not allow an opponent to win at a price they are willing to beat. Using these minimal assumptions on bidder behavior and well-known results from the theory of order statistics, Haile and Tamer derive bounds on the distribution of valuations, which, in turn, permit them to construct bounds on the optimal reserve price in such auctions.

A common criticism of partial identification is that weak assumptions are often accompanied by limited ability to draw meaningful conclusions from the data. Hansen and Jagannathan and Haile and Tamer both show that this need not always be the case. In fact, in both settings, weak assumptions lead to remarkably sharp conclusions. In this way, both papers illustrate clearly the usefulness of approaching empirical work through the combined lens of economic theory and partial identification and have provided ample motivation for further applications of partial identification as well as the development of the accompanying theory for estimation and inference. Recent work in this spirit is the estimation of a structural voting model with deliberation using data from US appellate courts in Iaryczower, Shi, and Shum (forthcoming).

Conclusion

In this brief and partial review of microeconometrics in the *JPE*, we have highlighted the journal's focus on econometric frameworks that propose novel ways of taking fundamental economic theories to the data. Influential examples that we have not discussed include hedonic models (Rosen 1974; Ekeland, Heckman, and Nesheim 2004) and collective models (Chiappori 1992; Browning et al. 1994). In addition to this focus on the interplay between economic models and empirical analysis, we note that the *JPE* has also published several key contributions to traditional areas of economet-

rics such as instrumental variables (Altonji, Elder, and Taber 2005) and measurement error models (Erickson and Whited 2000).

Despite John Siegfried's warning against unnecessarily complicated econometrics, the recent history of the *JPE* demonstrates the power of careful econometric thinking in order to blend economic theory and empirical measurement. We hope that going forward the journal will continue and reinforce its role as a promoter of pioneering econometric research.

References

Adda, J., C. Dustmann, and K. Stevens. 2017. "The Career Costs of Children." *J.P.E.* 125 (2): 293–337.

Altonji, J. G., T. E. Elder, and C. R. Taber. 2005. "Selection on Observed and Unobserved Variables: Assessing the Effectiveness of Catholic Schools." *J.P.E.* 113 (1): 151–84.

Becker, G. S. 1973. "A Theory of Marriage: Part I." *J.P.E.* 81 (4): 813–46.

———. 1974. "A Theory of Marriage: Part II." *J.P.E.* 82, no. 2, pt. 2 (April): S11–S26.

Browning, M., F. Bourguignon, P.-A. Chiappori, and V. Lechene. 1994. "Income and Outcomes: A Structural Model of Intrahousehold Allocation." *J.P.E.* 102 (6): 1067–96.

Cameron, S. V., and J. J. Heckman. 1998. "Life Cycle Schooling and Dynamic Selection Bias: Models and Evidence for Five Cohorts of American Males." *J.P.E.* 106 (2): 262–333.

———. 2001. "The Dynamics of Educational Attainment for Black, Hispanic, and White Males." *J.P.E.* 109 (3): 455–99.

Chiappori, P.-A. 1992. "Collective Labor Supply and Welfare." *J.P.E.* 100 (3): 437–67.

Chiappori, P.-A., M. Costa Dias, and C. Meghir. Forthcoming. "The Marriage Market, Labor Supply, and Education Choice." *J.P.E.*

Chiappori, P.-A., and S. Oreffice. 2008. "Birth Control and Female Empowerment: An Equilibrium Analysis." *J.P.E.* 116 (1): 113–39.

Chiappori, P.-A., S. Oreffice, and C. Quintana-Domeque. 2012. "Fatter Attraction: Anthropometric and Socioeconomic Characteristics in the Marriage Market." *J.P.E.* 120:659–95.

Choo, E., and A. Siow. 2006. "Who Marries Whom and Why." *J.P.E.* 114 (1): 175–201.

Christ, C. F. 1994. "The Cowles Commission's Contributions to Econometrics at Chicago, 1939–1955." *J. Econ. Literature* 32 (1): 30–59.

Dupuy, A., and A. Galichon. 2014. "Personality Traits and the Marriage Market." *J.P.E.* 122:1271–1319.

Ehrlich, I., and Z. Liu. 1999. "Sensitivity Analyses of the Deterrence Hypothesis: Let's Keep the Econ in Econometrics." *J. Law and Econ.* 42 (S1): 455–88.

Ekeland, I., J. J. Heckman, and L. Nesheim. 2004. "Identification and Estimation of Hedonic Models." *J.P.E.* 112 (S1): S60–S109.

Eldridge, D. S. 2014. "A Comment on Siegfried's First Lesson in Econometrics." *Econ. Inquiry* 52 (1): 503–4.

Erickson, T., and T. M. Whited. 2000. "Measurement Error and the Relationship between Investment and *q*." *J.P.E.* 108 (5): 1027–57.

Fox, J. T., C. Yang, and D. H. Hsu. Forthcoming. "Unobserved Heterogeneity in Matching Games." *J.P.E.*

Gronau, R. 1974. "Wage Comparisons—a Selectivity Bias." *J.P.E.* 82 (6): 1119–43.
Haile, P. A., and E. Tamer. 2003. "Inference with an Incomplete Model of English Auctions." *J.P.E.* 111 (1): 1–51.
Hansen, L. P., and R. Jagannathan. 1991. "Implications of Security Market Data for Models of Dynamic Economies." *J.P.E.* 99 (2): 225–62.
Heckman, J. J., J. E. Humphries, and G. Veramendi. Forthcoming. "Returns to Education: The Causal Effects of Education on Earnings, Health, and Smoking." *J.P.E.*
Heckman, J. J., and G. Sedlacek. 1985. "Heterogeneity, Aggregation, and Market Wage Functions: An Empirical Model of Self-Selection in the Labor Market." *J.P.E.* 93 (6): 1077–1125.
Iaryczower, M., X. Shi, and M. Shum. Forthcoming. "Can Words Get in the Way? The Effect of Deliberation in Collective Decision Making." *J.P.E.*
Keane, M. P., and K. I. Wolpin. 1997. "The Career Decisions of Young Men." *J.P.E.* 105 (3): 473–522.
Leamer, E. E. 1983. "Let's Take the Con Out of Econometrics." *A.E.R.* 73 (1): 31–43.
McFadden, D. 1974. "Conditional Logit Analysis of Qualitative Choice Behavior." In *Frontiers in Econometrics*, edited by P. Zarembka. New York: Academic Press.
Milgrom, P. R., and R. J. Weber. 1982. "A Theory of Auctions and Competitive Bidding." *Econometrica* 50:1089–1122.
Rosen, S. 1974. "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition." *J.P.E.* 82 (1): 34–55.
Siegfried, J. J. 1970. "A First Lesson in Econometrics." *J.P.E.* 78 (6): 1378–79.
Willis, R. J., and S. Rosen. 1979. "Education and Self-Selection." *J.P.E.* 87, no. 5, pt. 2 (October): S7–S36.

Life Cycle Wage Dynamics and Labor Mobility

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Introduction

The *Journal of Political Economy* has published a number of seminal papers on individual investments in human capital and how these investments vary with ability, preferences, age, and other individual characteristics.[1]

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[1] Examples include Mincer (1958), Becker (1962), Ben-Porath (1967), Heckman (1976), and Rosen (1976).