Review of Economic Dynamics ••• (••••) •••–•••

Contents lists available at ScienceDirect

Review of Economic Dynamics

www.elsevier.com/locate/red

Identifying agent's information sets: An application to a lifecycle model of schooling, consumption and labor supply ☆

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ARTICLE INFO

Article history:
Received 19 May 2016
Received in revised form 20 January 2017
Available online xxxx

JEL classification:
D81
I24
J22

Keywords:
Uncertainty
Schooling
Dynamic
Adverse selection
Information

ABSTRACT

We adapt the insight of Cunha et al. (2005) to develop a methodology that distinguishes information unknown to the econometrician but forecastable by the agent from information unknown to both, at each point in an agent's lifecycle. Predictable variability and uncertainty have different implications in terms of welfare, especially when markets are incomplete. We apply our procedure in the context of an incomplete markets lifecycle model of consumption, labor supply, and schooling decisions, when borrowing limits arise from repayment constraints. Using microdata on earnings, hours worked, schooling choices, and consumption of white males in the US, we infer the agent's information set. We then estimate the model using the identified agent's information set. We find that 52% and 56% of the variance of college and high school log wages respectively are predictable by the agent at the time schooling choices are made. When we complete the market, college attendance increases from 48% to 59%, about half of this increase is due to uncertainty, and the other half because of the borrowing limits. To illustrate the importance of assumptions about what is forecastable by the agent, we simulate a minimum wage insurance policy under different assumptions about the information available to the agents in the model. When we allow for asymmetric information between the insurance institution and the individual, adverse selection turns profits negative. Consumer welfare, however, increases by about 28% when we give individuals access to their estimated information set regardless of asymmetries.

1. Introduction

The use of empirically implementable stochastic dynamic models to understand agents' behavior is common practice in the Economics literature. These models have been the workhorse of Macroeconomics research for a long time, and are becoming more and more common in Labor Economics (see Keane et al., 2011; Rogerson and Shimer, 2011 for examples and reviews). A common feature of these models is that the analyst needs to specify the information structure of the problem, in

☆ We would like to thank James Heckman, Flavio Cunha, Lance Lochner, Lars Hansen, Paul Schrimpf, Robert Townsend, Alessandro Barbarino, Pedro Carneiro, Victor Chernozhukov, Jeremy Fox, Bruce Hansen, Kenneth Judd, John Kennan, Rasmus Lentz, Rosa Matzkin, Ronni Pavan, David Rivers, Alejandro Rodriguez, Ananth Seshadri, and an anonymous referee for their helpful comments. Navarro acknowledges support from the Canadian Social Science and Humanities Research Council, Grant No. R4895A04. Zhou acknowledges support from the Center for the Economics of Human Development's Asian Family in Transition Initiative.

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http://dx.doi.org/10.1016/j.red.2017.01.011
1094-2025/

Please cite this article in press as: Navarro, S., Zhou, J. Identifying agent's information sets: An application to a lifecycle model of schooling, consumption and labor supply. Review of Economic Dynamics (2017), http://dx.doi.org/10.1016/j.red.2017.01.011

particular what is known to the agent making decisions at each point in time.[1] In this paper we adapt the insight of Carneiro et al. (2003) and Cunha et al. (2005) to develop and implement a methodology that distinguishes information unknown to the econometrician but forecastable by the agent, and information unknown to both at each period. The key to measuring uncertainty using our procedure is to notice that individual choices reflect all the information known to the individual at a given time.[2] From the perspective of the agent, differences between expected outcomes and actual realizations of these outcomes (i.e., innovations) should not help explain current choices (see Sims, 1972). If these "innovations" explain current choices it means that they are not truly innovations, so the expectations we as analysts are assigning to the agent, i.e., the information set we have assumed, is incorrect.

The procedure we propose is semiparametric in nature. It can be used independently of a particular model specification, as long as one considers families of models with the same determinants of choice. In this paper, however, we develop our procedure in the context of a (semiparametrically identified) structural model of schooling choice, labor supply, and consumption allocation under uncertainty, in which borrowing constraints arise from repayment constraints.[3] To implement our procedure, we use an independent factor model to analyze wage dynamics.

In the context of the model we propose, being able to separate what is really ex-ante uncertainty from the perspective of the agent making choices is needed to avoid problems with model misspecification related to expectations. It is also crucial as the welfare consequences of uncertainty are very different from those of predictable (by the agent) variability. Furthermore, as pointed out by Lochner and Monge-Naranjo (2016), information on ex-ante risks facing the individual are a crucial input into the design of optimal policies like student loan programs. It is also an ingredient for exercises that seek to quantify the degree of insurance available to agents (Blundell et al., 2008; Kaufmann and Pistaferri, 2009).

Our paper also contributes to the literature on schooling choice by explicitly looking at the role played by uncertainty as a determinant of schooling. The idea is closely related to the work of Carneiro et al. (2003) and Cunha et al. (2005) in which a similar methodology is applied to extract agent's information at the schooling date. Carneiro et al. (2003) assume no credit markets operate. Cunha et al. (2005) and Cunha and Heckman (2016) assume an economy with perfect credit markets. We investigate an economy in which some credit markets operate, and borrowing limits arise from repayment constraints.[4] In terms of model setup, our paper is closest to Hai and Heckman (2016).[5] The focus of our paper, however, is different from theirs. We focus on the importance of identifying the uncertainty faced by the agent, even after conditioning on unobserved ability, as well as its evolution over time.[6]

We estimate the model using pooled data on white males from the NLSY79 and PSID.[7] Our estimates allow us to study the relative importance of uncertainty as a determinant of college attendance, as well as other determinants that have been studied in the literature, like ability (e.g., Cawley et al., 2000; Taber, 2001; Belzil and Hansen, 2002), and borrowing constraints (e.g., Kane, 1996; Carneiro and Heckman, 2002; Cameron and Taber, 2004; Brown et al., 2012; Lochner and Monge-Naranjo, 2011).

Our empirical results show that, at the time schooling decisions are made, about half of the unobserved (to the analyst) wage variation is predictable to the agent. In particular, the estimates of the model imply that 52% of the unexplained variance in college log wages is predictable by the agent at age 18. This fraction is 56% for high school. This is similar to the results obtained by Cunha et al. (2005) and Storesletten et al. (2004), slightly smaller than Cunha and Heckman (2016), and much smaller than what Keane and Wolpin (1997) obtain. In fact, while the total unobserved variance of college log wages is higher than that of high school (i.e., the unobserved variance from the analyst's perspective), the variance of the uncertain components of wages becomes larger for college compared to high school under our estimated information set for the agent. We also find that, when people are allowed to smooth consumption by operating in a complete market setting, college attendance increases by roughly 12%-points. We decompose this effect into a pure uncertainty effect, which accounts for about half of the increase, while the rest is due to borrowing constraints.

In order to illustrate the importance of assumptions regarding ex-ante uncertainty, we then simulate a policy in which agents can insure against adverse wage shocks. We simulate the effects of this minimum wage insurance policy under

[1] There is a literature that, instead, uses data on individuals' subjective expectations to estimate these models. See van der Klaauw (2012) for an example. The main concern with the use of expectations data is that they are usually measured at a point in time, not repeatedly. However, as the agent's information evolves over time, his expectations are likely to change as well. See Kaufmann and Pistaferri (2009) for a related idea that uses assumptions on the time series process of outcomes to sidestep this difficulty.

[2] A similar idea motivates the work on the permanent income hypothesis of Flavin (1981) and Pistaferri (2001).

[3] See Huggett (1993), Aiyagari (1994) and Gourinchas and Parker (2002).

[4] See Huggett (1993), Aiyagari (1994), and Gourinchas and Parker (2002).

[5] Our specification of the borrowing limit is simpler than theirs as we don't include student loans, consumption floors or post-school endogenous human capital investments. Furthermore, their borrowing limit takes into consideration the individual rationality constraint of working and endogenous human capital accumulation. Also, the data they employ comes from NLSY97 while we pool data from NLSY79 and PSID.

[6] For example, both Keane and Wolpin (2001) and Cameron and Heckman (2001) estimate their dynamic models of schooling assuming that what is known by the agent and what is known by the econometrician at each point in time. While they allow for unobserved heterogeneity, it is essentially treated as an initial condition. Once the econometrician conditions on the initial heterogeneity, the evolution of the information set of the agent is given. However, there is no prior reason why one should assume that the evolution of what is unknown to the analyst and what is unknown to the agent coincide.

[7] We also contribute to the literature on the estimation of the Frisch elasticity of labor supply. By focusing on longer periods, we circumvent the need to distinguish between extensive and intensive margins that has been the focus of the recent literature (see Peterman, 2016). Of course, we have to make the stronger assumption that time within our longer period (6 years as opposed to the standard 1 year period) is "perfectly" substitutable. Our estimated Frisch elasticity of labor supply of 1 is in the middle of the estimates obtained from both the Macro and Micro literatures.

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