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# Discussion of 'Dynamic Models for Policy Evaluation' and 'Microeconometric Search-Matching Models and Matched Employer-Employee Data'

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# 1 Introduction

The papers by Costas Meghir and Postel-Vinay and Jean-Mark Robin provide useful discussions of developments in two important areas in labor economics and public finance. There is little overlap between the two papers, and so I consider them seperately.

Meghir assesses the relative strengths and weaknesses of policy evaluation based on straightforward experimental designs and on structural models. He makes a strong case that the two approaches are complementary, particular when dynamics and general equilibrium effects are likely to be important. Below I begin with a short summary of his most important points. I then discuss the potential to utilize more of a continuum of models between a simple experimental or quasi experimental analysis on the one hand and a dynamic structural model on the other even in complicated dynamic settings where reduced form analysis is difficult. In particular, I suggest using simulation to derive the reduced form implied by the structural model and then treating the implied reduced form as a baseline reduced form around which to expand.

Postel-Vinay and Robin provide a valuable overview of developments in search/matching models and their application using matched employer/employee data. I briefly supplement their coverage of the literature and their research agenda.

# 2 Dynamic Models and Policy Evaluation

Meghir addresses three broad issues of methodology. The first is the role of analysis conducted in a simple "treatment effects" framework in the presence of experimental variation (or plausibly exogenous non-experimental variation) versus analysis based on a structural model. The second concerns the role of structural models in meeting the challenge posed by dynamics in the analysis of policy. The third is the importance of accounting for equilibrium effects of large-scale social programs rather than simply extrapolating from the results of a small-scale program. Meghir appropriately stresses the advantages of experimental and "quasi-experimental" variation in providing a transparent source of identification of the causal effect of a specific program. Few assumptions are needed for experimental evaluation of a specific small-scale program on a specific population studied. However, it is hard to extrapolate the results from a specific program to different populations or to alternative programs. It is also difficult to account for "feedback effects" arising through externalities

or through the general equilibrium effects of large-scale programs operating through prices, congestion, or other mechanisms.

Meghir argues that there is an important synergy between experimental evaluations and structural modeling. In one direction, the sources of exogenous variation provided by an experiment aid in the identification and the testing of the structural model. In the other, a structural model provides a way to extrapolate from the results of the specific experimental variation to consider dynamic responses and, more importantly, to estimate the impact of alternative policies and to consider effects for populations that differ from the control and experimental groups. Furthermore, it is hard to imagine how a simple experimental or quasi experimental design could be used to account for general equilibrium effects that operate at the level of a large region or country.[2]

Meghir draws on three of his own studies to illustrate these points. Attanasio, Meghir and Santiago (2005), (hereafter, AMS), reanalyze Mexico's Progresa program using a dynamic discrete choice model. They use the model to study the optimal age profile of the subsidy. They show that a budget neutral shift of subsidy from younger to older children would boost impact of Progresa on education, because secondary school attendance is a key decision point. The experimental results point strongly in this direction, and the age pattern of the response probably did not come as a surprise to those involved in the original design of Progresa, which has multiple objectives.[3] However, AMS' structural analysis gives a quantitative guide to what the most cost effective design would be if one wishes to maximize school attendance. One cannot draw such inferences from the experimental analysis.

Meghir is very clear about the costs of structural analyses. The main question is whether the structural model is a good enough approximation to reality to provide a useful guide to how agents would respond to alternative policies. AMS (2005) represents work in progress, and there are a number of issues that could be raised, many of which Meghir or AMS touch on. First, not very much is done to validate the fit of the model, although it is encouraging that it can reproduce the main experimental results by and large. Second, data limitations preclude estimation of the returns to education at later ages when considering how monetary benefits influence decisions. AMS simply specify a terminal value for each education level at age 18. Furthermore, wages are not observed for most sample members, and so the

[2] Miguel and Kramer (2004) and Angrist and Lavy (2004) are recent examples of studies that use experimental design to account for externalities that operate over a small geographic group or within a specific institution (such as a school).

[3] See for example Schultz' (2004) analysis of the effects of Progresa on education.

opportunity cost of staying in school is specfied simply as a function of age, education, and region only. The empirical estimates imply that the effects of a subsidy are three times larger than the effect of an equivalent shift in the wage. There are several explanations as to why this might be the case this, and a strength of structural analysis in the context of an experiment is that one can work with less restrictive models. My concern is that the authors lack data on key variables in an economic model of education choice—wages by education level. I would like more discipline to come from the theory of education choice that motivates the structural model, and wonder how much of the identification of the model is coming from specific functional form assumptions and assumptions about dynamics that are not strongly motivated by theory.

Like Meghir, I view experimental and quasi-experimental designs and structural models as complements rather than substitutes. However, I think that it would be productive for researchers to work with more of a continuum between models that rely almost exclusively on the experimental design at one extreme and a full-blown structural model that makes use of the experimental variation at the other. I have in mind models that impose enough structure to permit one to extropolate beyond the specific policies and population groups considered in the experiment, as is possible with a structural model. The study of dynamic decisions such as education choice makes reduced form analysis difficult because behavior is likely to depend both on past choices and on future values of the exogenous variables and the education subsidy. Nevertheless, there are some possibilities

### 2.0.1 Possibility 1: Reduced Form Dynamic Models with Lots of Restrictions on Interactions and Functional Form

First, it is worth exploring what can be learned from a reduced form dynamic model that heavily restricts interactions among the variables and imposes smoothness restrictions on the link between school attendance and the exogenous variables. Consider the following specification for the probability of school attendance at $t$.

$$\begin{aligned} \Pr(Attend_{it} &= 1) = F(\mu_i, grant_{it}, ..., grant_{i18}, z_{it}, ..., z_{i18}, \\ & \quad t, ed_{it}, t, x^p_{it}, x^p_{it+1}, ..., x^p_{i18}, x^s_{it}, ..., x^s_{i18}, w_{it}(ed_{it}), ..., w_{18}(ed_{it})) \end{aligned} \tag{1}$$

where $F(.)$ is a cumulative distribution function such as the normal, $attend_{it}$ is an indicator for school enrollment at age $t$, $grant_{it+j}$ is the size of the grant at age $t+j$, $z_{it+j}$ consists

of age $t+j$ variables that capture the cost of schooling, including parental education, and $x^p_{it+j}$ and $x^s_{it+j}$ capture the costs of primary and secondary school and include distance to the nearest school and $w_{it}$ In the above model the wage at $t+j$ is assumed to depend on education at $t$. Alternatively, one might evaluate the wage in $t+j$ at the average value of education of persons who remain in school up to $t+j$. The initial condition for $ed_{it}$, $ed_{it_0}$, might be treated as in AMS, with

$$ed_{it_0} = f(\mu_i, z_{it_0}, school\_availability_{it_0}). \tag{2}$$

Even if one were to exclude all interactions among the variables from the reduced form model while allowing the coefficients to depend on $t$, the reduced form would have many, many more parameters than the structural model has. The complexity arises from the fact that future values of the grant, costs of school, and other variables influence the decision at $t$ and that the nature of the intertemporal dependence will vary with $t$. However, one could proceed by heavily restricting the reduced form. First, one could use AMS's linear specification of the period $t$ gain from schooling to restrict the way that $grant_{it}$, $z_{it}$, $x^p_{it}$, and $x^s_{it}$ affect $Attend_{it}$. Second, one could heavily restrict how the coefficients relating variables dated $t+j$ to $Attend_{it}$ vary with $t$ and $j$. For example, one might restrict the coefficients on $grant_{it+j}, w_{it+j}(ed_{it}))$, $z_{it+j}$, $x^p_{it+j}$, and $x^s_{it+j}$ to equal a constants plus simple functions of $t$ and $j$. Third, one could heavily restrict the interactions among the variables.

An approach that is complementary is related to Ichimura and Taber (2000), which builds on ideas going back to Marschak. In AMS' structural model, $Grant_{it}$ affects behavior by altering the current utility gained from attending school relative to working through the index $\gamma Grant - w_{it}$. Imposing the same restriction on the reduced form model would lead to

$$\begin{aligned} \Pr ob(Attend_{it} &= 1) = F(\mu_i, \gamma grant_{it} - w_{it}(ed_{it}), ..., \gamma grant_{i18} - w_{18}(ed_{i18}), \\ &\quad z_{it}, ..., z_{i18}, t, ed_{it}, t, x^p_{it}, x^p_{it+1}, ..., x^p_{i18}, x^s_{it}, ..., x^s_{i18}) \end{aligned} \tag{3}$$

In practice, one would have to heavily restrict (3) along the lines mention above.

One could use the reduced form to simulate the effects of alternative grant policies. One might also use it as a benchmark with which to assess the fit of the structural model. In particular, one might use the reduced form to assess the dimensions in which the structural

model fails to fit the data and to guide modifications to it. One could assess whether or not the specific shortcomings of the structural model undermine its usefulness for the policy evaluations AMS perform.

### 2.0.2 Possibility 2: Using the Structural Model to Shape the Reduced Form Model

As a practical matter, in high dimensional problems reduced form specifications are never completely unrestricted. Furthermore, in an experimental setting with limited variation in the treatment such a model could not be used to evaluate alternative policies. In many settings, one writes down a reduced form model that is linear in most variables, with some interaction terms and nonlinear terms. Such a model can be regarded as an approximation to the true reduced form. One can think of an unrestricted reduced form model with lots of interaction terms and nonlinear terms as an expansion around a baseline reduced form model that contains only main effects and linear terms. An alternative is to make explicit use of the structural model to come up with a "baseline" for the reduced form and expand around that baseline. Why is this appealing? Because the structural model incorporates the prior information that the researcher has about how education choices are made. Indeed, the specification of the structural model is almost always the natural place to impose those priors, particularly in complicated dynamic setting such as the Progresa program. Given this fact, I am proposing that one use the structural model as the starting point for a reduced form model that is heavily shaped by but less restrictive than the structural model.

One would proceed as follows. First, one would use the estimates of the structural model to simulate the endogenous variables given the observed distributions of the exogenous variables. From the simulated distribution of the endogenous and exogenous variables, one could arrive at a reasonably parsimonious specification for the reduced form that describes the simulated data well. Let the resulting reduced form be

$$\begin{aligned}
\Pr ob(Attend_{it} &= 1) = H(\mu_i, grant_{it}, ..., grant_{i18}, z_{it}, ..., z_{i18}, t, ed_{it}, x^p_{it}, x^p_{it+1}, ..., x^p_{i18}, \\
&\quad x^s_{it}, ..., x^s_{i18}, w_{it}(ed_{it}), ..., w_{18}(ed_{it}); \hat{\theta}_1) \\
ed_{it_0} &= h(\mu_i, z_{it_0}, school_availability_{it_0}; \hat{\theta}_2)
\end{aligned}$$

where $H$ and $h$ are known up to the parameter vector $\theta_1$ and $\theta_2$. The values $\hat{\theta}_1, \hat{\theta}_2$ are the value of $\theta_1, \theta_2$ that best fit the simulated data according to some standard criterion. One

might then generalize the restricted reduced form by using the real data to estimate the model

$$\begin{aligned}
\Pr ob(Attend_{it} &= 1) = G\{H(\mu_i, grant_{it}, ..., grant_{i18}, z_{it}, ..., z_{i18}, t, ed_{it}, \\
&\quad x^p_{it}, x^p_{it+1}, ..., x^p_{i18}, x^s_{it}, ..., x^s_{i18}, w_{it}(ed_{it}), ..., w_{18}(ed_{it}); \hat{\theta}_1) + X'_{it}\alpha_1\} \\
ed_{it_0} &= h(\mu_i, z_{it_0}, school_availability_{it_0}; \hat{\theta}_2) + X'_{i0}\alpha_2 + \ error
\end{aligned}$$

where $X_{it}$ consists of a small subset of the exogenous variables and interactions among them, $\alpha_1, \alpha_2$ are vectors of parameters to be estimated, and $\hat{\theta}_1$ and $\hat{\theta}_2$ are treated as known. For example, given that AMS are interested in how the effect of the grant depends on age, one might include $grant_{it} \cdot t$ in $X'_{it}$. The estimates of $\alpha_1$ and $\alpha_2$ indicate the dimensions in which the structural model does not capture the relationship between the exogenous variables and school attendance, and might suggest modifications to the structural model. If such modifications are likely to be difficult to carry out (say, because of computational complexity), one could use the "generalized" reduced form of the structural model to provide an alternative set of estimates of the impact of policy reforms. This is a halfway house between the use of a fully structural model and the use of a complex, poorly estimated, atheoretical reduced form. Even a misspecified structural model might provide a good point of departure for the specification of a parsimonius reduced form model.

### 2.0.3 Policy Evaluation and General Equilibrium

Meghir does an excellent job of bringing to forefront the issue of general equilibrium (GE) effects in most econometric studies of program effects. It is important to note that there is in fact a well established literature on "applied general equilibrium modeling."[4] Nevertheless, such issues have been largely neglected by the army of empirically oriented labor and public finance economists who focus on estimation of specific "treatment effect" parameters.

Gheallipoli, Meghir and Violante (2004) (hereafter GMV) use a dynamic GE model of education choice and wages to study the effects of an education subsidy on education choice and inequality. In their model, the response of education to a large scale program may be

[4]Kehoe, Srinivasan, Whalley (2005) contains a number of recent contributions to this literature and provides many references.

amplified by peer effects and dampened by wage responses. Consequently, one needs a GE model to assess the effects of the program. Similar issues arise with other policies, such as the effects of a wage subsidy. GMV incorporate labor supply into a framework that resembles Heckman, Lochner and Taber's (1998) dynamic GE model of human capital investment and inequality in some respects. This addition permits them to assess the effects of taxes used to finance the education subsidy. They also incorporate unobserved heterogeneity that affects non-wage costs of education as well as wages, and use an overlapping generations model to endogenize the wealth distribution. An important omission from the model relative to Heckman, Lochner and Taber is the exclusion of on-the-job training. The authors use a complex estimation/calibration strategy to come up with parameter estimates for the model.

The model is still under development and so the results are preliminary, but they are very interesting. GMV, like HLT, find that subsidies have a large positive effect on educational attainment in a partial equilibrium model, but that GE feedbacks undo most of the effect of the subsidy. The authors raise many questions about the specification of the model and the estimation procedures that underlie these results, and I could add a number of my own. It will be quite some time before GMV and subsequent papers settle the issue of how important GE effects are for the classes of policies the authors consider. However, there is growing evidence that GE effects are a first order issue when considering the effects of large scale programs.

# 3 Microeconometric Search-Matching Models and Matched Employee-Employer Data

Postel-Vinay and Robin (hereafter, PR) ably survey recent developments in the use of search-matching models to study wage inequality, wage dynamics, job mobility, and unemployment. For many questions involving wages in labor economics, one may reasonably abstract from fact that employer and match specific components of wage variation are quantitatively significant. However, labor economists have known for a long time that wages vary substantially across jobs for a given worker. Panel data on individuals indicate that a substantial component of wage variation is specific to the firm and/or the job match. Indeed, one needs only compare the variation in the change in wage rates for jobs stayers and job changers to see this. A number of studies have documented that there is an important variance component of wages associated with jobs and that it is related to job stability and to wage growth over a

career. Examples include Abraham and Farber (1987), Altonji and Shakotko (1987), Topel (1986), and Topel and Ward (1992). A large literature examining dislocated workers using household data and using social insurance earnings records shows the same thing. With only panel data on individuals that lack firm identifiers, one cannot distinguish job match specific error components from firm level error components. Studies of employer wage surveys (eg., Groshen (1992)) show clearly that wages have an important firm specific component. Finally, empirical search models of wages and unemployment suggest that wage variation is substantial.

As PR document, the past ten to fifteen years have brought remarkable advances in our understanding of the role of job search and heterogeneity in wage offers in the distribution of wages, wage dynamics, wage growth over a career, and mobility. The progress stems from three main sources. The first is better data, as PR stress. The growing availability around the world of employer-employee data sets, in some cases with matches to significant amounts of information about the firm and the worker, has lead to an explosion of research in this area, with Abowd, Kramartz, and Margolis' (1999) influential analysis of the French DAS data as the leading example. The advent of additional high-quality household panel data sets with good information on wages, job mobility and unemployment, such as the British Panel and GSEOP, has also been helpful. The second source is a series of important advances in search and matching models, many of which are summarized in the paper. The third is advances in computing power and computational methods that have made implementation of more complex, more realistic models possible.

## 3.1 *Statistical Accounting for Wage Dispersion.*

PR summarize studies that decompose the variance of wages into a number of factors. Abowd, Kramartz, and Margolis made great progress on this important issue. I don't have much to add to their discussion. Future work needs to pay more attention to sampling error in the estimation of firm effects, person effects, experience slopes, and tenure slopes when examining the importance of various sources of wage dispersion. This should not be very difficult to do.

## 3.2 *Search/matching Models.*

After thirty years of steady progress on the theoretical side, search/matching models are approaching a level of realism that will permit them to become workhorse models for empirical labor economists over the next couple of decades. PR mention the theoretical literature and associated empirical studies that demonstrate that even with homogeneous firms and workers an equilibrium wage distribution can emerge. These papers are important from a theoretical point of view but are not very interesting from an empirical point of view given overwhelming evidence that fixed characteristics of workers such as education, test scores, race, and the success of parents have strong links to wages. We also have evidence that firm observables matter for wages. PR note that even the homogeneous equilibrium search model does a reasonable job of fitting wage distributions, but misses the right tail. The fact that such models can roughly fit the wage distribution raises questions about how informative such a comparison is.

The evolution of research toward models with heterogeneity in both firm productivity and worker productivity is a critical development. Within this literature, the sequential auction model of PR (2002) is a promising building block. There is an exciting research program here.

There are two directions for future research that I think are particularly important. The first is directed search models, which are briefly mentioned in the paper and are still in an early stage of development. These models are technically challenging, but it is clear that firms and workers target search on the basis of skills and skill requirements. At some point directed search models will take over the literature. The second is to move beyond wage rates and consider models with multiple job attributes and heterogeneous preferences on the part of workers and firms. Work schedules, health benefits, pension benefits, and location matter to workers, and the costs and benefits of providing these differ across firms. Panel data on job stayers and job changers show that firm effects on hours worked per week or per year are very large (eg., Altonji and Paxson (1986), Senesky (2004)). There has been some progress in the development of equilibrium search models with job packages, heterogenous firms and/or workers, including Lang and Majumdar (2005) and Dey and Flinn (2004)).

## 3.3 *Theoretical Models of Wage Dynamics:Skill Specificity and Employer Learning*

PR discuss recent research that seeks to provide a theoretical foundation for statistical models of wage dynamics. There has long been a need to bring more economics into statistical models of wages over a career. Real progress is being made, and rather than recount the developments they cover, I will discuss two additional factors that eventually need to be incorporated into the search/matching models PR discuss. The first is the role of general, industry specific, occupation specific, and firm specific human capital. A large literature quantifies the importance of these types of skills for wages and for mobility. However, much of the analysis of wages is conducted in a single equation framework. It would be much better to incorporate general, sector specific, and firm specific skills into a search/matching model, although it will not be easy. Specificity of skills and comparative advantage on the basis of general skills are reasons why incorporating directed search by firms and workers into models of mobility and wages is important.

The second issue concerns the role played by employer learning about the skills of workers in wage dynamics and job mobility. The studies surveyed by PR abstract from uncertainty about what the productivity of a worker actually is. Harris and Holmstrum (1982), Farber and Gibbons (1996), and Chiappori, Salanie, and Valentin (1999) explore the implications for wage dynamics of the assumptions that employers learn about the worker productivity over time and information is public. Farber and Gibbons' result that if worker productivity is fixed, employer learning induces a martingale component into the wage process is directly relevant for statistical models of wage dynamics, as they show using NLSY79 data. Altonji and Pierret (2001) and subsequent studies consider the implications for wage models in which employers statistically discriminate on the basis of readily available information but acquire additional information over time. Gibbons, Katz, Lemieux, and Parent (2005) present and estimate a model of wage dynamics and sectoral mobility with public learning and comparative advantage across sectors on the basis of skill. Altonji (2005) considers the implications for employment rates, wages, and occupational attainment of a model in which the sensitivity of productivity to the worker's skills is increasing in the skill requirements of the job and in which employers learn about the worker's skill more rapidly in high skill jobs.

The assumption that employer information about worker skills is public is analytically convenient but very strong. Greenwald (1986), Lazear (1986) and Waldman (1984) and

others analyze models in which information is asymetric, and the incumbent employer has an information advantage. Recently there have been some promising developments in both theoretical and empirical research on the implications of asymmetric information for mobility and wage dynamics. Gibbons and Katz (1991) and a few subsequent studies examine the implications of private learning for wage losses of workers who are laid off. Pinkston (2005) draws on the second price auctions literature (also used by PR (2002)) to formulate a model of bidding between the incumbent firm and the outside firm in a search environment. His model also allows for public learning. Schoenberg (2005) derives tests for both private and public learning from a two period model of wages, mobility and unemployment. Her findings suggest that private learning is important for college educated workers. Theoretical and empirical work on the implications of public and private learning for wage dynamics within and across jobs and for job mobility is still in an early stage, but is a promising development.

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