A Research Proposal for replication of AN EMPIRICAL EQUILIBRIUM SEARCH MODEL OF THE LABOR MARKET* using Labor Market Data of Iran

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Abstract

Search theoretic models of the labor market have always seen as an appropriate substitution for the usual supply and demand model in frictionless labor market. This approach is able to address many issues, including unemployment, duration of unemployment, simultaneous existence of unemployed workers and vacancies, different wages for homogeneous workers, turnover. Even the earliest search models, focusing on a single worker, provide the ability to explain evidences come from the data. The present research proposal aims to replicate an empirical paper based on an equilibrium search model, using the data of Iran's labor market.

Background

"Economics of information and job search" by McCall (1970) introduces the reservation wage property to the literature. In spite of its shortcomings as a partial view towards the problem, this methodology has been widely applied to the literature. Eckstein and Wolpin (1990) empirical analysis of the Albrecht and Axell (1984) model (AA Model) as a step in the right direction takes into account workers' behavior in firms' strategy of wage setting. Knowing that the optimal strategy of the workers has the reservation wage property, firms offer wages equal to workers reservation wage and the wage offer distribution is degenerate. A dispersed wage offer distribution therefore requires a dispersed distribution of reservation wages.

Van den Berg and Ridder (1998) empirical analysis is based on Burdett and Mortensen (1998) model (BM Model), instead. The BM model opposite to the AA model allows job-to-job transitions and layoffs and it is not needed for unemployeds to be heterogeneous to obtain a dispersed wage offer distribution. Possibility of on the job search in the BM model changes the optimal strategy of unemployeds, and makes the reservation wage for an employed his or her current wage. In BM model identical workers can have different reservation wages therefore. In BM model also an explicit solution is obtained for the equilibrium wage offer and earning distributions for homogeneous population of workers and firms. Van den Berg and Ridder (1998) seeks to address heterogeneity to make the model a more appropriate fit to the data. They investigate how some features like minimum wage and productivity heterogeneity affect the findings.

Eckstein and Wolpin (1990) focuses on a single labor market and unobserved differences in the value of leisure between workers and unobserved differences in productivity of firms, without any observed differences, hence allows for within market heterogeneity. However, Van den Berg and Ridder (1998) considers a large number of segments in the labor market each of which is a labor

*An empirical analysis of equilibrium search based on Burdett and Mortensen (1998) model. (Van den Berg and Ridder, 1998) market of its own. All workers and firms are identical. Segments differ in age, educational level, and occupational level of the workers and the jobs as observed differences, and in the productivity of the jobs as unobserved differences. Obviously, the BM model allows for between-market heterogeneity.

Estimation of the parameters in the paper is followed by a maximum likelihood method and using panel data from eighty decade of Netherlands. Some of the remarkable results to emerge from the data is that: the arrival rate of job offers for employed ones is not meaningfully higher than that of unemployed job seekers, sufficient variation in the productivity of firms fits the model to the observed wage distribution.

Equilibrium Search Model

In the first part of this section the aim is to present BM model, keeping in mind that there are continua of workers and firms with measures m and 1, respectively, λ_0 and λ_1 are job offers arrival rates for unemployed and employed workers, a job offer is an i.i.d. drawing from a wage offer distribution with c.d.f. F(w), δ is matches break up rate, utility flow of being unemployed is b, firms have a linear production function with the marginal revenue product of p, and the mandatory minimum wage is $\underline{w}_L$. The supply side of the model is similar to the standard job search model with search on the job, has the reservation wage property. In the case of zero discounting: (Mortensen (1986) and Mortensen and Neumann (1988))

$$r = b + (\lambda_0 - \lambda_1)\int_r^\infty \frac{\overline{F}(w)}{\delta + \lambda_1 \overline{F}(w)}\,dw \qquad \text{with } \overline{F} = 1 - F.$$

G(w) or earning distribution is the distribution of wages received by workers who are currently employed. Using the fact that in a steady-state equilibrium, inflow to and outflow from a specific wage are equal, because of stability of the wage distribution, the relation between G and F is determinable.

$$G(w) = \frac{F(w)}{\delta + \lambda_1 \overline{F}(w)} \cdot \frac{\lambda_0 u}{(m-u)}.$$

The steady-state unemployment rate is u/m and the relation can be explained by setting w=∞.

$$\frac{u}{m} = \frac{\delta}{\delta + \lambda_0}.$$

Highlighting some points is needed before focusing on the behavior of the firms, a match between a worker and a firm has a net revenue flow of $p - b$, this gain must be positive and finite, $p - w$ of this flow is the firm share and $w - b$ is the share that the worker receives, and there is no bargaining over the wage. The level of production is determined by the size of the steady-state workforce l that is available to the firm, and it is a function of w, given r and F. The steady-state profit flow π is $(p - w)l(w; r, F)$ given r and F.

$$l(w; r, F) = \frac{g(w)dw}{f(w)dw}(m - u) = \frac{m\lambda_0 \delta(\delta + \lambda_1)}{(\delta + \lambda_0)\big(\delta + \lambda_1 \overline{F}(w)\big)^2} \quad \text{on } [\underline{w}, \overline{w}].$$

The relation in the steady state and for the value of $\underline{w}$ is just based on parameters, since F($\underline{w}$)=0. $l(w; r, F) = \pi/(p - w)$ so the F(w) and f(W) are determinable.

Substituting F(w) for the relation based on parameters, p, w and $\underline{w}$ in the first equation for the reservation wage, makes it simple. Note that r is smaller than b if λ_1 is larger than λ_0. In that case, searching on a job with a wage equal to b is more rewarding than searching while unemployed.

$$F(w) = \frac{\delta + \lambda_1}{\lambda_1} \cdot \left(1 - \sqrt{\frac{p - w}{p - \underline{w}}}\right) \qquad \text{on} \quad [\underline{w}, \overline{w}]$$

$$f(w) = \frac{\delta + \lambda_1}{2\lambda_1 \sqrt{p - \underline{w}}} \cdot \frac{1}{\sqrt{p - w}} \qquad \text{on} \quad [\underline{w}, \overline{w}].$$

$$r = \frac{(\delta + \lambda_1)^2 \cdot b + (\lambda_0 - \lambda_1)\lambda_1 \cdot p + \delta_0(\lambda_0 - \lambda_1) \cdot \underline{w}_L}{(\delta + \lambda_0)(\delta + \lambda_1)} \qquad \text{if} \quad r < \underline{w}_L,$$

$$r = \frac{(\delta + \lambda_1)^2 \cdot b + (\lambda_0 - \lambda_1)\lambda_1 \cdot p}{(\delta + \lambda_1)^2 + (\lambda_0 - \lambda_1)\lambda_1} \qquad \text{if} \quad r \geq \underline{w}_L,$$

$$\overline{w} = \left(\frac{\delta}{\delta + \lambda_1}\right)^2 \cdot \underline{w} + \left(1 - \left(\frac{\delta}{\delta + \lambda_1}\right)^2\right) \cdot p.$$

The equilibrium earnings density is recognizable by its equation based on F(w), so like F and f, G and g are determinable as functions of parameters, p, w and $\underline{w}$. Both f and g are increasing densities. However, there is abundant empirical evidence that the earning distribution which is similar to the income distribution is not increasing in density. The assumption of homogeneous labor market with identical workers and firms could be the reason for such finding.

$$g(w) = \frac{\delta \sqrt{p - \underline{w}}}{2\lambda_1} \cdot \frac{1}{(p - w)^{3/2}} \qquad \text{on} \quad [\underline{w}, \overline{w}].$$

Given an arbitrary transformation of w, $y = \frac{p-w}{p-\underline{w}}$, the excess wage equation is $w - \underline{w} = (1-y)(p-\underline{w})$ and the density of y for both distributions is displayed. $\eta = \frac{\delta}{\delta+\lambda_1}$, the excess wage $w - \underline{w}$ is a fraction of the excess productivity $p - \underline{w}$. This fraction is a random variable with a distribution that only depends on the expected number of wage offers during a spell of employment. Thus, the moments of $w - \underline{w}$ in either the wage offer or the earnings distribution are the product of $(p - \underline{w})^n$ and an expression that only depends on η.

$$f_y(y) = \frac{1}{2(1-\eta)} y^{-1/2}, \qquad \eta^2 \leq y \leq 1,$$

$$g_y(y) = \frac{\eta}{2(1-\eta)} y^{-3/2}, \qquad \eta^2 \leq y \leq 1,$$

By providing a proper distribution of the productivity p, the moments of any observed wage offer or earnings distribution can be matched and an acceptable fit to the data depends on sufficient heterogeneity in p.

The Likelihood Function

For an individual who is unemployed at the date of the first interview in equilibrium, the probability of being unemployed at a randomly chosen date equals $\frac{\delta}{\delta+\lambda_0}$. The elapsed unemployment duration t_{0b} and the residual unemployment duration t_{0f} are i.i.d. and have an exponential distribution with parameter λ_0. d_{0b} denote a dummy that is one if it is only known that the elapsed duration exceeds a certain value, i.e. is right-censored, and zero otherwise. d_{0f} is for residual duration. The likelihood contribution of the events until and including the moment of exit out of unemployment or censoring is

$$\mathscr{L}_0 = \frac{\delta}{\delta + \lambda_0} \cdot \lambda_0^{1-d_{0b}+1-d_{0f}} \cdot \exp(-\lambda_0(t_{0b}+t_{0f})).$$

The job duration t_1 has an exponential distribution with parameter $\delta + \lambda_1 \bar{F}(w)$. Exit into unemployment occurs with probability $\frac{\delta}{\delta+\lambda_1 \bar{F}(w)}$ and exit into another job with probability $\frac{\lambda_1 \bar{F}(w)}{\delta+\lambda_1 \bar{F}(w)}$. Measurement errors in the wage data is represented by ϵ. The observed wage $\tilde{w}$ equals the true wage w times an error term ϵ. d_1=1 if $\tilde{w}$ is missing and zero otherwise. If $d_{0f} = 1$ or $d_1 = 1$, then we do not follow the individual any further. $d_2 = 1$ if t_1 is right-censored and zero otherwise. $d_3 = 1$ if the destination following exit out of the job is unknown and zero otherwise. $d_4 = 1$ if the destination is another job and zero if the destination is unemployment.

$$\mathscr{L}_1 = f(w) \cdot \exp(-(\delta + \lambda_1 \bar{F}(w)) \cdot t_1) \cdot (\delta + \lambda_1 \bar{F}(w))^{d_3(1-d_2)}$$
$$\cdot (\lambda_1 \bar{F}(w))^{d_4(1-d_2)(1-d_3)} \cdot \delta^{(1-d_4)(1-d_3)(1-d_2)}$$

The total individual likelihood contribution for a respondent who is unemployed at the date of the first interview equals

$$\mathscr{L}_0 \cdot \mathscr{L}_1^{(1-d_{0f})(1-d_1)}.$$

For an individual who is employed at the date of the first interview, the probability of being employed at a randomly chosen date equals $\frac{\lambda_0}{\delta+\lambda_0}$. $d_5 = 1$ if $\tilde{w}$ is unobserved, and zero otherwise. The elapsed job duration t_{1b} and the residual job duration t_{1f} are i.i.d. and have an exponential distribution with parameter $\delta + \lambda_1 \bar{F}(w1)$. d_{6b} denote a dummy that is one if it is only known that the elapsed duration exceeds a certain value, i.e. is right-censored, and zero otherwise. d_{6f} is for residual duration. $d_7 = 1$ if the destination following exit out of the job is unknown and zero otherwise, and $d_8 = 1$ if the destination is another job and zero if it is unemployment. $d_0 = 1$ if t_0, unemployment duration, is right-censored, and zero otherwise. Dummy variables d_{10}, d_{11}, d_{12}, and d_{13} indicate whether w_2 is unobserved, whether t_2 is right-censored, whether the destination state is unobserved, and whether the destination state is another job, respectively.

$$\mathscr{L} = \frac{\lambda_0}{\delta + \lambda_0} \cdot g(w_1) \cdot (\delta + \lambda_1 \bar{F}(w_1))^{1-d_{6b}} \cdot \exp(-(\delta + \lambda_1 \bar{F}(w_1)) \cdot (t_{1b} + t_{1f}))$$
$$\cdot (\delta + \lambda_1 \bar{F}(w_1))^{d_7(1-d_{6f})} \cdot [\delta \cdot \lambda_0^{(1-d_9)} \cdot \exp(-\lambda_0 t_0)]^{(1-d_8)(1-d_7)(1-d_{6f})}$$
$$\cdot \left[\lambda_1 \bar{F}(w_1) \cdot \left[\frac{f(w_2)}{\bar{F}(w_1)} \cdot (\delta + \lambda_1 \bar{F}(w_2))^{d_{12}(1-d_{11})} \right.\right.$$
$$\cdot \exp(-(\delta + \lambda_1 \bar{F}(w_2)) \cdot t_2) \cdot \delta^{(1-d_{13})(1-d_{12})(1-d_{11})}$$
$$\left.\left. \cdot (\lambda_1 \bar{F}(w_2))^{d_{13}(1-d_{12})(1-d_{11})} \right]^{(1-d_{10})} \right]^{d_8(1-d_7)(1-d_{6f})}$$

Heterogeneity

Heterogeneity is imposed to the model by assuming that there are separate labor markets as different segments of the labor market, for different types of individuals and firms. For example, separate markets are categorized based on individuals' different educational backgrounds, age, occupational level. Instead of estimating separate models for different segments, we assume that the deep structural parameters in the model (p, λ_0, λ_1, and δ) do not vary over the different labor markets significantly. Using the data on all markets simultaneously, estimation of the parameters is conducted by vector x. x is the vector of age, education, and occupation dummies (and a constant). We assume that p, λ_0, λ_1, and δ are log-linear functions of x

$$p = \exp(\beta_1' x), \qquad \lambda_0 = \exp(\beta_2' x),$$
$$\lambda_1 = \exp(\beta_3' x), \qquad \delta = \exp(\beta_4' x).$$

In order to capture unobserved heterogeneity, p is represented by $p = v \cdot exp(\beta_1' x)$ that v has a discrete distribution with a finite number of unknown points of support.

Data

As it has previously mentioned in the model section, the estimation process of parameters using this methodology needs some basic knowledge of individuals like age and educational level and complete information about the labor status of a worker. Even though the maximum likelihood method provides us with the opportunity of more relaxed inputs, the availability of accurate data is always helpful.

Labor Force Survey(LFS) data of Iran's labor market contains information on unemployment and employment durations and work hours, but wages are not accessible in any job position. We utilize secondary data from Household Budget Survey(HBS) of Iran's population which provides information on individuals' characteristics like age education level and wages, as well. The next step is to merge HBS and LFS to cover all the information is needed and run the maximum likelihood method. Individuals in these data sets are not the same, however using Mincer Equation (Mincer, 1974) we are going to provide LFS with the wage variable. Obviously, the quality of estimations can be enhanced by providing additional data for wages of individuals.

There exists a considerable body of literature on using the Mincer equation. The existing research, however, uses a simple implementation of the equation. Assuming that the wage variable depends linearly on schooling and quadratically on experience, we estimate coefficients of explanatory variables for this population from HBS. Some control variables like age, sex, work hours, marriage status, and urban/rural are present in the regression, as well. As a measure of explanatory power, R-squared of 0.7 seems enough to get sufficiently accurate estimators. Using these coefficients, we anticipate the wage variable in the LFS data set. It is important to highlight that explanatory variables must be the same in both data sets.

This analysis is confined to the labor force over 15 years old, i.e. full-time workers (Not self-employed) and unemployed job seekers. These assumptions are needed to lower possible errors. In search models, the main motivation is wage, however part-time job seekers, self-employers, and individuals who are out of the labor force for some periods (Educational or medical purposes) can have different incentives and utility functions.

Results

As mentioned before, heterogeneity is imposed to the model by assuming that there are separate labor markets as different segments of the labor market, for different types of individuals and firms. In Iran segments are essentially different based on being in public or private sector. In addition to other explanatory variables, we define private or public sector.

Using distribution functions, we obtain an equation for productivity based on the values of maximum wage and minimum wage. Therefore the final maximum likelihood function has three unknowns, λ_0, λ_1, and δ. As shown in table 1, the first row is estimated based on the assumption that all parameters are constant. δ of 0.6 percent could demonstrate the effect of some labor market rules in Iran, like the burdens against firing employees. The difference between job offer rates is not negligible. It makes job to job transition harder than becoming unemployed and receiving offers with the rate of λ_0.

In the second row each parameter is assumed a linear combination of some variables. These variables identify segments in the economy. The coefficient of age is zero approximately. The effect of schooling is not great, as well. However, being public or private can justify a big portion of parameters.

	Parameters		
	λ_0	λ_1	δ
cons	0.0478689***	0.0032152***	0.0069637***
	(0.0004138)	(0.0000262)	(0.0000286)
age	−0.00000107		
	(0.0000632)		
schooling	−0.0018588***	0.0001008***	0.0001906***
	(0.0001062)	(0.00000641)	(0.00000690)
public	0.183192***	−0.0000905	−0.038258***
	(0.0076975)	(0.0002273)	(0.0006632)
private	0.1146489***	0.0013372***	−0.0340828***
	(0.0027761)	(0.0002274)	(0.0006641)
cons	0.0561333***	0.0014605***	0.0407913***
	(0.0024586)	(0.0002321)	(0.0006673)

Table 1: 2013-2014, ML Estimation

Conclusion

Our results on parameters of Iran's labor market are broadly consistent with some features of the contracts and rules in Iran. Despite the limitations of the data, this analysis provides a good starting point for discussion and further research on Iran's labor market. Therefore, future research should be conducted in more realistic settings to estimate parameters based on a reliable source of wages.

The analysis leads to the following conclusions:

- Job to job transition is not as influential as being an unemployed job seeker.
- δ can present the barriers against the employer and in support of employees.
- Variables like age and schooling do not have the power to explain parameters.
- Future research is needed to explain the result of being in a public or private sector.

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