NEGATIVE EMPLOYMENT EFFECTS OF MINIMUM WAGES IN MARKETS WITH FIXED EMPLOYMENT COSTS

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11/10/2006

ABSTRACT: This paper structurally models the employment effects of minimum wages in inflexible labor markets with fixed employment costs. When there are fixed costs associated with employment, minimum wage regulation not only results in a reduction in employment among low productivity workers but also shifts the distribution of hours for the available jobs in the market and restricts the number of part-time jobs. Part-time jobs play a crucial role in participation decisions of marginal workers, especially women, since women may prefer flexibility with regard to hours over pay while looking for a job. Thus, for sufficiently high employment costs, a minimum wage makes it difficult for these workers to enter and stay in the labor market, and has significant employment effects.

Keywords: Fixed employment costs, inflexibility, minimum wage, employment , female labor force participation, part-time jobs, hours constraints

(JEL: J2 J3 E2)

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†I would like to thank my committee especially John Kennan and Jim Walker for their guidance. I am also grateful for valuable feedbacks provided by Maurizio Mazzocco, John Gordanier, Insan Tunali, Seokjin Woo, Sudip Gupta, Jeremy Sandford, Shiv Saini, Jonathan Hore, Hugette Sun and Lucas Davis. I also thank the participants of 7^{th} International METU Economics Conference, 69^{th} Annual MEA Conference, University of Wisconsin-Madison Labor Workshop and Labor Group Summer Meetings and workshop attendees at Concordia University in Montreal, University of South Carolina, Kansas State University, and Lake Forest College.

I. INTRODUCTION

Most research on minimum wages concentrates on the labor market movements on the margins of employment. Analyses are done to recover the ratio of workers losing their jobs when the minimum wage increases or the ratio of individuals who are motivated by higher wages to get a job. There is no consensus in the literature on the sign of the effect minimum wages have on employment; in fact, rare agreements are on the statistical and economic insignificance of the relationship.

Seldom is a significant effect reported, mostly because minimum wages are barely binding in many of the economic environments analyzed. Moreover, as Card and Krueger (1995) point out in their frequently quoted study, firms can adjust in a variety of ways to moderate increases in minimum wages; reducing non-wage benefits, offering less training on the job, etc. Most of these studies, especially the early contributions (which usually report strong employment effects), work with aggregate data and thus produce little beyond crude correlations. Card and Krueger's (1995) results indicate that estimation techniques, mainly the use of aggregate data instead of micro level data, exaggerate the economic significance of the negative employment effects in these studies. Bernstein and Schmitt (1998), Machin and Manning (1994-for UK), Manning (1996), and Dickens et al (1999) also report similar results. Besides, many of these studies are concentrated on the impact of minimum wages on low-wage employment, especially teenage employment[1], where the subjects rarely are the major part of the labor force.

The effect of institutional inflexibilities on employment is studied extensively in the European context, for example, by Bertola (1990) and Blanchard and Jimeno (1995) among many others, in attempts to explain high unemployment rates.[2] In most of these studies minimum wages are not modeled separately but aggregated in a general measure of labor market flexibility, and employment effects are analyzed on macro data.

In this paper, I isolate the minimum wage, and study its effect on individuals' participation decisions when combined with other labor market "inflexibilities" using micro data. Moreover, I realize that in some economies minimum wages function differently than minimum wages in economies like US. For example, in many developing countries, the level of minimum wage is set as a living wage for a family, not for an individual, since the main

[1] See, for example, Brown et al, 1982; Deere et al., 1995 and Neumark and Wascher, 1995

[2] Please refer to a recent paper by Blanchard (2005) for a detailed review of the history of unemployment in Europe and the literature it inspired.

target group is the male breadwinners. Thus, the employment effects are bound to have different dimensions than what is addressed by the existing literature. This paper provides a framework that enables us to look at the workings of minimum wages beyond the margins of employment. To the best of my knowledge, a structural analysis of employment effects of minimum wages in an inflexible environment has not been done before. In this sense, this is "not another minimum wage paper."[3]

The main claim of the paper is that it may become prohibitively expensive for firms to employ workers for short workweeks at a minimum wage when the labor market is inflexible due to fixed employment costs. Thus, employers offer contracts that specify a minimum number of hours to be worked. This results in a shift in the distribution of hours for the available jobs in the market, restricting the number of part-time jobs. Part-time jobs play a crucial role in participation decisions of marginal workers, especially women, since women may prefer flexibility with regard to hours to pay. Part-time jobs in many cases serve as a gateway to full-time jobs and ease the transition from household production to market work. Thus, for sufficiently high employment costs, a minimum wage makes it difficult for these marginal workers to stay in the labor market.

I model an economy where the demand side constraints on working hours are incorporated into the labor supply decision. I use this model to analyze female labor market activity in Turkey. Over the last fifty years, participation rates among Turkish women declined significantly and stayed unexpectedly low for the last couple of decades especially in urban areas. This pattern is inconsistent with the general worldwide trend of female labor force participation and social and demographic improvements in Turkey. I propose that Turkish women have low participation rates due to the extreme scarcity of part-time jobs, resulting from the constraints on hours implied by the interaction of the minimum wage and market inflexibilities. While the share of part-time employment among females averages around twenty-five percent in OECD countries, in Turkey only 3.5 percent of female employees hold part-time positions. I show that, indeed, if there were fewer restrictions on work hours, the Turkish female labor force participation rate would have been about six times higher.

The paper is organized as follows. The next section introduces the model. The third section gives the econometric specifications used in empirical estimation. Section 4 provides background on female labor force participation behavior in Turkey. Section 5 explains the details of estimation.

[3] Respectfully referring to Freeman and Eccles's 1982 paper.

Section 6 reports the estimation results. Section 7 provides counterfactual simulations and discusses policy implications. Section 8 analyzes how sensitive labor supply behavior is to the changes in demographic variables and introduces related policy discussions. Section 9 concludes the paper.

II. MODEL

This is a model of labor supply where demand side constraints on hours are incorporated in the labor market participation decision. In the model, labor is the only input of production and marginal productivities are constant. However, wages are endogenously determined since there are costs associated with employment; Even though the marginal productivities are constant, average productivities are increasing but less than the marginal product at any number of working hours. Given this cost, there is an interval of hours where average productivity per hour is negative. Therefore, all available jobs require a minimum number of working hours to make average productivities at least equal to zero. With the same logic, when there is a minimum wage in the market, the minimum required number of hours is set to make average productivity of the worker at least as high as the minimum wage, which is higher than the minimums implied by the fixed cost alone. If this minimum is higher than the number of hours the worker would otherwise optimally supply, she faces a choice between working more hours than she would like, and not working at all. In this paper participation is specified to be equivalent to employment. Thus, any potential worker who cannot find a job or the ones who wants to work but choose not to given the market conditions, are considered as non-participants. Even though the economic setting enables detailed identification of several regions of participation, main purpose of the study is to track changes in the employment level.

The model used in this paper builds on the labor supply model introduced in Moffitt (1982). I extend the base model by modeling the marginal productivity determination and letting wages vary by the length of workweek. Addition of increasing average productivities and zero profit condition to the model leads to a different modeling of the constraints on the working hours. This also implies full time wage premium; since the per hour fixed cost of employment decreases as the workweek gets longer, employers would be willing to pay higher hourly wages for longer workweeks. In the base model, if the difference between required minimum and the desired work hours is greater than some estimated level, the worker chooses not to work and if it is not she does otherwise when constrained. This cutoff level is a function of the shape of the individuals' indifference curves, but is treated as constant across workers in Moffitt's model. In my model, instead of estimating such a constant, I allow workers to make utility comparisons when constrained, and choose the utility maximizing option from this constrained set. Thus, I allow this cutoff level to vary across individuals.

I will introduce the model in two subsections: the first subsection analyses how the interaction of the minimum wage and fixed costs results in constraints on hours. The second subsection explains how supply side decisions are affected by these constraints. Table 1 summarizes the notation I use.

Table 1: Notation

w	: Marginal productivity of the potential worker
f	: Fixed cost of employment per week per employee (dollars)
w_h	: Hourly wage = average productivity $\left[w_h = \dfrac{wh - f}{h} < w\right]$
w^{min}	: Minimum hourly wage
h^*	: Desired hours [length of workweek maximizing potential worker's utility]
L^*	: Optimal level of leisure [h*+L*=T=weekly time endowment]
h^{min}	: Required minimum hours [Hours of work required for a worker to produce the value of the minimum wage on average per hour. Required minimum hours is the h that solves $w^{min} = \dfrac{wh - f}{h}$ that is $h^{min} = \dfrac{f}{w_i - w^{min}}$]
$\underline{h^{min}}$	: Absolute required minimum hours $\left[= \dfrac{f}{w} =\right.$ the required minimum hours when there is no minimum wage]

A. Demand Side-Sources of the Constraints on the Hours of Work

Consider an economy where technology is linear and labor is the only input of production. Each potential worker has a constant marginal productivity (w). Given such a technology, firms will offer everyone jobs with working hours they optimally choose to supply (h^*) at an hourly wage (w_h) equal to their average productivity which is equal to their marginal productivity ($w_h = w$).

Now, consider two individuals with different marginal productivities (w_a and w_b) but the same level of desired hours. Any given firm will hire them both and pay hourly wages equal to their average productivities, $w_{ha} = w_a$ and $w_{hb} = w_b$ respectively. However, if there is a minimum wage in this economy (suppose it is set to be at a level between w_{hb} and w_{ha}) no worker with average productivity less than the minimum wage ($w_b = w_{hb} < w^{min}$) will be offered any job. Since average productivities are constant, there will be no constraints on hours worked by the individuals who are offered jobs. That is, a worker with productivity w_a can still work her desired level of hours. Nevertheless, an individual with a productivity w_b will no longer be employed by anybody.

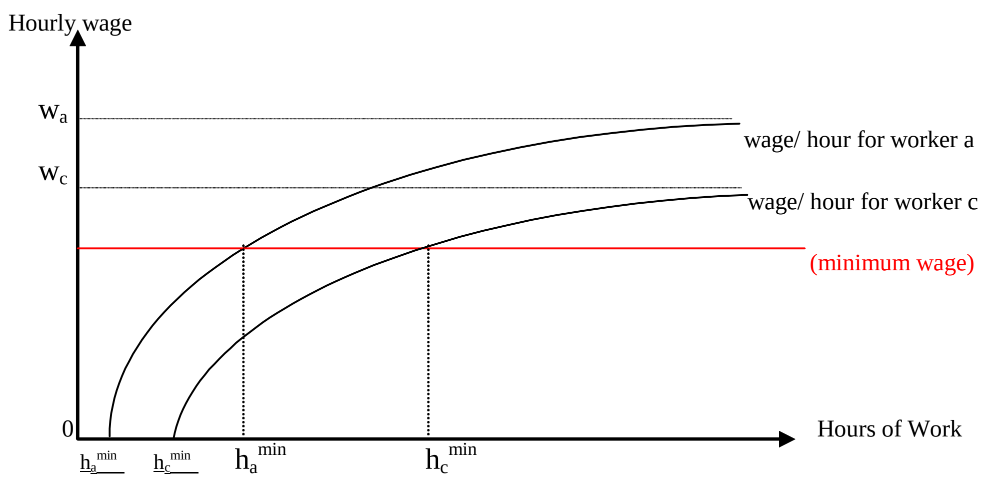

Figure 1

Suppose now there are costs associated with each job equal to f dollars per worker for each workweek. As a result, each worker starts producing a surplus value for the employer after the first $\frac{f}{w}$ hours. I call this "the absolute required minimum hours" and denote it by $\underline{h^{min}}$. The cost of employment will make a worker's average productivity, and hence the hourly wage she earns, dependent on the number of hours she works. This hourly wage is less than what it is when there are no fixed costs since now the total value of the workers production will be reduced by the costs associated with her employment [4]. However, minimum wage regulation is such that

[4] See the notation table for the hourly wage expression

it does not take the existence of fixed costs into account and requires a constant hourly wage independent of the length of the workweek (w^{min}). Therefore, when there are fixed costs, minimum wage regulation creates an interval of hours where the average productivity is lower than the minimum wage for each worker no matter what their marginal productivity is. This results in restrictions on the minimum number of hours each worker can work (h^{min}). Solving the hourly wage equation for h at the point where average productivity is equal to the minimum wage gives

$$h^{min} = g(w^{min}, w_i,\ f) = \frac{f}{w_i - w^{min}} \tag{1}$$

which is an increasing function of the fixed employment cost and the minimum wage and a decreasing function of the worker's productivity. $Figure$ 1 illustrates how the minimum number of hours that a certain worker needs to supply decreases as the productivity level increases ($w_a > w_c \Longrightarrow h_a^{min} < h_c^{min}$)[5].

[5] Here is a numerical illustration of the model. Suppose that the *fixed employment cost*, is equal to 40 dollars. If an individual who can produce 5 dollars worth of goods or services per hour wants to work in this market, her employer will require her to work at least 8 hours. That is, 8 hours is the *absolute required minimum hours* for this worker since only then will her average productivity be greater than zero. Now suppose a minimum wage is set at 4 dollars per hour. It is straightforward to see that this employee would not be affected by this policy if there were no fixed employment costs. However, with 40 dollars of fixed employment cost, the employer will require her to work at least 40 hours weekly since only then will her average productivity be equal to the hourly minimum wage. Minimum wage is equal to the hourly wage (average productivity of the worker) when h is equal to the required minimum hours, that is

$$w^{\min} = w_{\text{h}} = \frac{w * h - f}{h} \quad \text{when} \quad h = h^{\min}$$

in this example

$$4 = \frac{5 * h^{\min} - 40}{h^{\min}} \quad \text{then } h^{\min} = 40$$

That is, 40 hours is her *required minimum hours*. If she willingly supplies more than 40 hours, meaning that her *desired hours of work* is higher than 40 hours, she will not be constrained. However, if she desires to supply fewer than 40 hours, she faces the choice between not working and working more hours than she would ideally. Her taste for work together with any productivity shock she receives will push this worker to either side of the market. Holding everything else constant, as the productivity of a worker increases, her probability of being constrained decreases. For example, if the above worker had a productivity of 6 dollars per hour, her required minimum work hours would be only 20 hours per week

B. Supply Side-Participation Decision with Constraints on Working Hours

Suppose that on the supply side of the labor market, there are individuals maximizing the utility function $U = U(C_i, h_i\ ;\ A_i,\ \epsilon_{1i}, \epsilon_{2i})$ choosing the amount of work hours (h_i^*) they want to supply and the level of a composite market good (C_i^*) given their individual observable characteristics (A_i) and the unobservable heterogeneity in terms of hours preference and productivity $(\epsilon_{1i}, \epsilon_{2i})$.

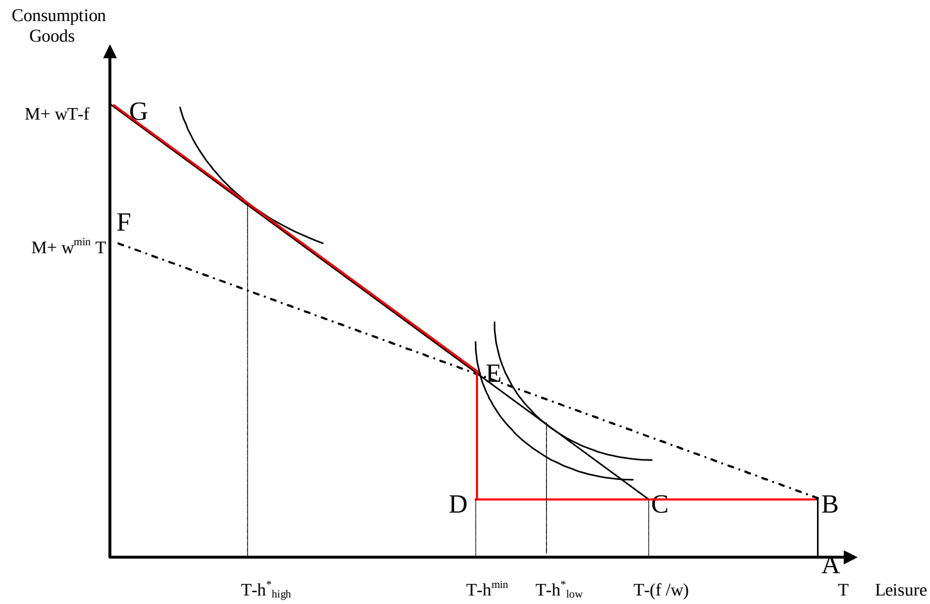

Figure 2

If the potential worker wants to supply a higher number of hours than she is required as a minimum, she will not be restricted. However, even a worker with productivity higher than the minimum wage will face unemployment if she has a low taste for work (or higher opportunity cost of working). *Figure* 2 demonstrates this situation, showing two workers with the same productivity$-w$ (slope of the line CEG) which is higher than the minimum wage (slope of the line BEF)$-$ but different levels of desired hours h_{high}^* and h_{low}^* where $h_{high}^* > h_{low}^*$ as the subscripts suggest. An individual with desired hours equal to h_{high}^* will not be constrained by the demand side. However, an individual with h_{low}^* will face the choice between working h^{min} or not working at all since she will not be offered her optimal job any more. In this picture, $ABCEG$ is the budget constraint when there is a fixed cost but no minimum wage. $ABEF$ is the budget constraint implied by the minimum wage regulation. $ABCDEG$ is the budget constraint faced by these potential workers if a minimum wage equal to w^{min} is imposed and there is a fixed cost of employment equal to f.

The above discussion shows that a minimum wage can have significant negative employment effects when there are high fixed costs. Moreover, these effects are felt more severely by low-productivity individuals and by individuals with a low taste for market work (or high opportunity cost) who supply less hours - two sets of people whose intersection consists mostly of women.

III. **ECONOMETRIC SPECIFICATIONS**

The main econometric difficulty in this analysis arises from the fact that it is not possible to observe which workers are at their required lower bounds and which are working their desired hours. Moreover, I cannot observe which non-participants are constrained and would like to supply positive hours and which would not. I only know who is working and who is not, and the actual working hours for each worker. I need to assume the behavioral structure producing the observed behavior and utilize the model to recover the parameters that maximize its fit. I start by assuming that everybody has the following utility function,

$$
\begin{aligned}
U &= U(C_i, L_i;\ A_i, \epsilon_i) \\
&= \left(\frac{\alpha_2(T-Li)-\alpha_1}{\alpha_2^2}\right)\exp\left(\frac{\alpha_2\left(\alpha_{0+}\alpha_2 C_i+\alpha_3 A_i+\epsilon_{1i}\right)-\alpha_1}{\alpha_2 h_i-\alpha_1}\right)
\end{aligned}
$$

which is maximized subject to the following set of constraints[6]

$$
\begin{gathered}
C_i \leq M_i+\gamma w_i h_i-\gamma f \\
L_i+h_i \leqslant T
\end{gathered}
$$

where A_i is a vector of demographic characteristics, M_i is non-labor income and C_i is the composite good (the numeraire), L_i is leisure, and T is the fixed weekly time endowment that can be divided between leisure and work. γ is a dummy which is equal to 1 if the individual works and 0 if not. If

[6] $C_i \leq M_i+w_h h_i \Longrightarrow C_i \leq M_i+\left(\frac{w_i h_i-f}{h_i}\right) h_i \Longrightarrow C_i \leq M_i+w_i h_i-f$

any positive number of hours is giving higher utility than not working for a particular individual[7], the optimal number of working hours or desired hours will given by the following expression:

$$h_i^* = T - L_i^* = \alpha_0 + \alpha_1 w_i + \alpha_2 (M_i - f) + \alpha_3 A_i + \epsilon_{i1} \tag{2}$$

Restrictions $\alpha 1 \geqslant \alpha_2 h_i^*$ and $\alpha_2 \leqslant 0$ guarantee quasiconcavity of the utility function and its monotonicity in disposable income. While $\alpha 1 \geqslant \alpha_2 h_i^*$ implies that the compensated wage effect is non-negative, the uncompensated wage effect, α_1, can be positive or negative.[8] The second constraint $\alpha_2 \leqslant 0$ assures that leisure is not inferior.

In addition to (1) and (2), I have marginal productivity given by equation (3)

$$w_i = \exp(X_i \beta + \epsilon_{i2}) \tag{3}$$

where X_i represents individual productivity characteristics. Error terms ϵ_1 and ϵ_2 are assumed to be independently distributed as normals with means equal to zero and standard deviations equal to σ_1 and σ_2 respectively.

If an individual desires to work positive hours, is desired in the market, and has higher utility from working her required minimum hours than not working, she will actively participate. Otherwise she will not work. As stated earlier, I do not observe either h^* or h^{min}. However, I know h_i, observed working hours, if the individual is active in the labor market. Since, in this model, h_i is either desired hours or minimum required hours, I can use the conditions governing the participation decision, and construct the rules determining the choice of work hours. $Figure$ 3 illustrates the regions regarding participation behavior in the plane of "desired" and "required minimum" hours.

As long as the individual desires longer workweeks than the minimum workweek that she is offered, she is not going to be constrained by the minimum hours requirement and she is going to work her desired hours. However, when the desired length of her workweek, given that it is more than zero, is shorter than the minimum offered to her, she is going to be forced to choose between not working and working the required minimum. She is going to work h^{min} hours at minimum wage only if it is more desirable

[7] See the first section in the appendix for an illustration using the possible utility-hours mappings given personal characteristics.

[8] See Hausman(1980) or Pencavel (1986)

to do so than not working. That is,

$$
\begin{aligned}
h_i \quad &= h_i^* & \text{if} \quad h_i^* > h^{min} \text{ and } w_i > w^{min} & \qquad (I) \\
&= h^{min} & \text{if} \quad h^{min} > h_i^* \text{ and } U(h_i = h^{min}) > U(h_i = 0) & \qquad (II)
\end{aligned}
$$

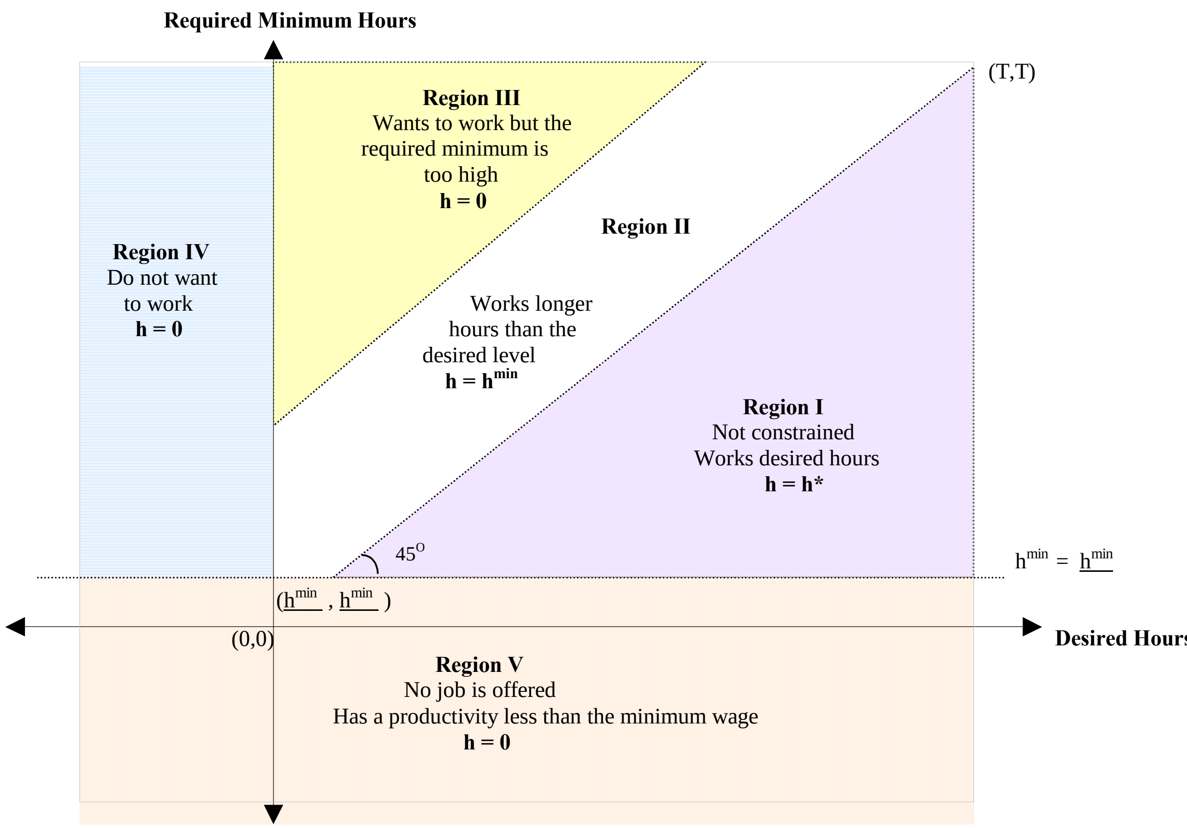

Figure 3

Similarly, there are three groups among the non-participants. The first group is the group of individuals who would supply positive hours if they were not constrained. They are asked to work longer hours than they are willing to supply. When facing this set of choices, they prefer not to participate. On the other hand, for the second group of non-participants, the desired workweek is less than or equal to zero. They are the ones who willingly choose not to participate. The last group of non-workers consists of individuals who are undesirable in the market when there is a minimum wage, that is, their productivity is lower than the minimum wage.

In summary,

$$
\begin{array}{llll}
h_i = 0 & & \text{if } \ h^{min} > h_i^* \ > 0 \text{ but } \ U(h_i = h^{min}) < U(h_i = 0) & (III) \\
 & \text{or} & \text{if } \ w_i > w^{min} \text{ but } h_i^* \leq 0 & (IV) \\
 & \text{or} & \text{if } \ w_i < w^{min} & (V)
\end{array}
$$

Given these regions of participation, the probability of working $h_i = h$ hours can be written as probability of observing h either as h^*or as h^{min}, that is

$$
Q = \left(\begin{array}{c} \Pr(h_i = h^*, \ h_i^* > h^{min} > 0 \ |X_i, \ A_i, \ \sigma_1, \ \sigma_2, \ w^{min}, \ M_i) \\ + \Pr \left[\begin{array}{c} h = h^{min}, \ h^{min} > h_i^* > 0, \ U(h_i = h^{min}) \\ < U(h_i = 0)| \ X_i, \ A_i, \ \sigma_1, \ \sigma_2, \ w^{min}, \ M_i \end{array} \right] \end{array} \right)
$$

The probability of not working, on the other hand, is the combined probability of being in regions III, IV or V and can be formulized as

$$
q = \left(\begin{array}{c} \Pr(h^{min} > h_i^* > 0, U(h_i = h^{min}) < U(h_i = 0)| \ X_i, A_i, \sigma_1, \sigma_2, w^{min}, M_i) \\ + \Pr(h_i^* = 0 \ , \ w_i > w^{min}| \ X_i, A_i, \sigma_1, \sigma_2, w^{min}, M_i) \\ + \Pr(w^{min} > w_i \mid X_i, A_i, \sigma_1, \sigma_2, w^{min}, M_i) \end{array} \right)
$$

Thus[9], the log likelihood function, $\log L$, is

$$
\log L = \sum_{h>0} \log Q + \sum_{h=0} \log q
$$

The model is identified by the non-linear structure of the generalized Tobit-type models.

[9] See the second section in the appendix for details of this derivation.

IV. FEMALE LABOR FORCE PARTICIPATION IN TURKEY

Contrary to the expectations and despite the demographic and social changes over the last 50 years, the female labor force participation rate has decreased significantly in Turkey over this period. The female labor force participation rate was 72 percent in 1955 and it declined to 23 percent in February 2005. In 2005, the participation rate was only 18 percent among urban women (SIS HLFS, 2005). Over this same period, participation rates on average doubled worldwide, and almost tripled for married women in most countries going through similar social changes. (See $Figure\ A-3$ in the third section of the Appendix)

The initial drop in the participation rate is attributed to the massive urbanization of the workforce after the 1950s. Small scale, family-level agriculture had been employing nearly all of the women in rural areas. Since the distinction between household duties and work is blurred in agriculture, it is easier for rural women to meet the conditions to be considered as employed. It has been argued that when these women leave their villages and move to the cities, they cannot find a place for themselves in the labor force of urban Turkey (Dayioglu, 1998; Ozar, 1996; Tunali, 1997). In cities, market work and household duties are incompatible. Hence, women have to concentrate on one of them. Most of these women have little human capital, so they are forced into "marginal" jobs. Faced with this, most choose not to participate in the workforce. However, the continuing decline in the participation rate is unexpected since the social status of women has improved significantly over these years.

There is no study yet that provides a convincing explanation why the Turkish economy is incapable of utilizing the increasing productivity of women. The model developed in this paper is estimated with Turkish female labor force data in order to explain the low participation rates among urban females through constraints on hours in the job markets, or by the lack of part-time jobs. $Figure$ 4 illustrates the importance of part-time jobs for female participation. There is certainly a positive correlation between existence of part-time jobs and labor force participation rate of females. Apparently, an increase in the number of part-time positions makes market work attractive for more women.

This is not the first paper that calls attention to the link between the lack of part-time jobs and the low female labor force participation rate in Turkey (See for example Baslevent, 2001). However, there is no study yet that models the dynamics causing in the scarcity of part-time jobs. The stylized model of a labor market analyzed in this paper captures the fundamental characteristics of the Turkish labor market to a great extent. According to various OECD reports, Turkey is among the least flexible labor markets worldwide with regards to employment. The main source of inflexibilities in this market are the policies regarding non-wage monetary burdens associated with employment implied by the labor law which was in effect between 1947 and 2003, roughly the time period we are interested in. The absence of a linear relationship between tax and benefit payments, and hours of work [see Tunali(2005) for further information] makes part-time employees very undesirable in Turkish market.[10]

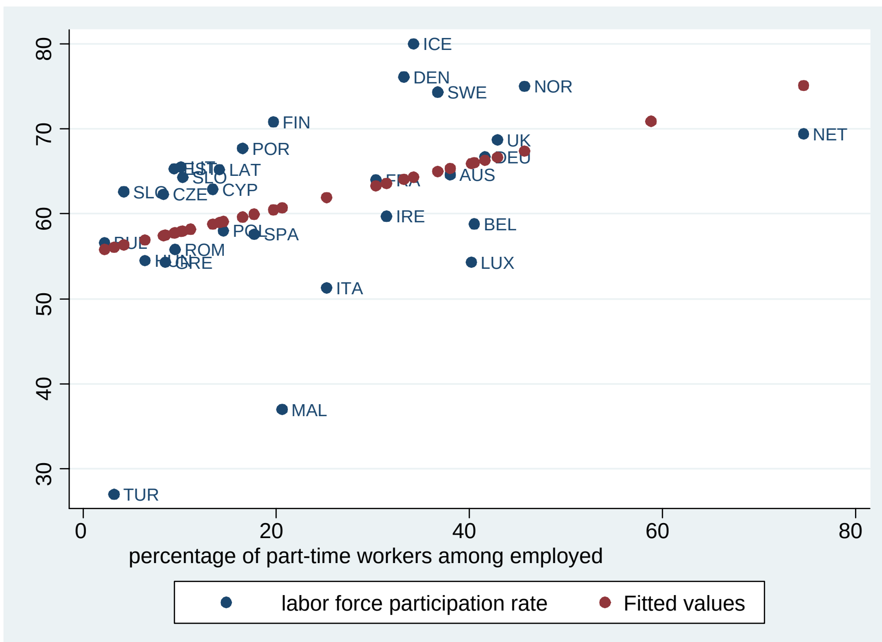

Figure 4

(For details see the table in the forth section of the appendix)

Women, while looking for a job, may prefer flexibility with regard to hours over pay. For example, Falzone(2001) shows with US data that part-time work offers an efficient alternative for married women in the labor

[10] The new Labor law, enacted in 2003, promises to define and regulate part-time employment and associated benefits separate from full time employment. This should change the general characteristics of the part-time jobs available in coming years.

market when earnings are not the only consideration. Part-time positions are observed as low-pay, low-benefit jobs occupied by [married] women, in nearly all of the countries in *Figure* 4. However, in Turkey, existing part-time jobs exhibit different characteristics as illustrated in *Table* 2. In Turkish labor market part-time workers on average earn almost three times as much as the full-time workers. *Tables* 3 and 4 help clarify this picture providing support for the motivating idea of my model. Most part-time workers are university graduates or, we can say, high productivity workers. Share of part-time workers is 31 percent among college graduate women. Among women with lesser education, on the other hand, this ratio is only 10 percent. Summary of working hours within each educational group shows that the higher the years of schooling completed, the lower the average number of hours worked per week.

Table 2: Wages - Part-time vs. Full-time Jobs

	# of obs.	mean	st.dev.	min.	max.	median
if $h < 40$	87	1.85	5.29	0.11	48.94	1.17
if $h >= 40$	474	0.74	0.97	0.05	18.43	0.58

Table 3: Share of Part-timers and Education

	# of obs.	% part-timers
college graduates	154	31.13
non-college graduates	407	10.03

Table 4: Hours of Work and Schooling

	# of obs.	mean	st.dev.	min.	max.	median
primary school or less	189	42.79	9.03	15	84	40
middle school	35	42.48	4.68	40	58	40
high school	183	40.36	5.98	20	64	40
college	154	35.58	9.19	15	54	40

These observation surprises many scholars and some even claim that there is a wage premium to part-time jobs in Turkey. This interesting phenomenon can be explained with the model introduced in this paper. It can be shown that average part time wages are higher simply because there are almost no part-time jobs among the low paying jobs in the market.

V. ESTIMATION

A. Data

The data set used is from the Turkish Household Labor Force Supply Survey. This survey is conducted biannually by the State Institute of Statistics of Turkey from 1988 to 1999, and quarterly since 2000. In total, $14,000$ to $23,000$ households are surveyed each time, both from rural and urban areas. The analysis here uses the data from the October 1988 round of this survey.

In the 1988 round, $102,062$ individuals residing in $22,320$ households nationwide are surveyed. In this data set, participation for women is around 18 percent in cities, very similar to the census results. Participation rates vary greatly with education and marital status. There are significant drops in participation rates as education falls below college level (73 percent at college level and 8 percent for primary school graduates) and as women get married (38 percent for singles, 11 percent for married). In the survey, nonworking women are asked if they would like to work and the ratio of those who are ready to start working is higher among married and low-educated (although slightly in some cases) suggesting that more of those women are the ones who are unwillingly staying out of the market.

For my empirical analysis, I use a sub-sample of $6,445$ women between the ages of 20 and 55 who are married and living together with their husband in cities with $400,000$ or more people. Women in the sample either did not work the week preceding the interview or they were employed as wage and salary workers. I use data only on women who are working at most one job and who are not currently enrolled in school, either full time or part time. *Table* 5 gives descriptive statistics for the women in my sample.

Table 5: Descriptive Statistics

Variables	# of obs.	mean	st.dev.	min.	max.	median
Hours worked (if working)	561	40.01	9.16	15	84	40
# of children of ages 0-5	2804	1.38	0.61	1	4	1
# of children of ages 6-14	3753	1.86	0.94	1	6	2
Education	6445	4.66	3.671	0	15	5
Age	6445	34.62	9.16	20	55	34

In this sub-sample, the mean education is about five years. Seventy-four percent of the women interviewed have seven or less year of schooling (Last degree they have completed is primary school). University graduates constitute six percent of the women and about thirty-seven percent of the workers in the sub-sample. The labor force participation rate for this sub-sample is about nine percent . These women work forty hours on average. Eighty-three percent of working women work forty hours or more and only five percent work twenty hours or less (Eight percent of women work between twenty-five and forty hours, nine percent work less than twenty-five hours).

Table 6: Variable Definitions

Ai	demographic variables	
	age	between 20-55
	squared age	age squared/100
	years of schooling	0 = no schooling
		3 = literate but has no degree
		5 = primary school
		8 = middle school
		11 = high school
		15 = college or more
	squared years of schooling	years of schooling squared/100
	young children	number of children between ages 0-5
	squared young children	number of young children squared
	older children	number of children between ages 6-14
	squared older children	number of older children squared
Xi	productivity variables	
	middle school	dummy (0-1)
	high school	dummy (0-1)
	college	dummy (0-1)
	potential experience	age - years of schooling - 6
		(6 is the age at schooling begins)
	squared potential experience	potential experience squared/100
Mi	non-labor income	$\frac{\text{household income-own labor income}}{\text{number of household members}}$

I use different educational indicators, family variables and individual demographic indicators as the explanatory variables in the estimation. Table 6 gives the list of all variables used in all steps of estimation with explanations. There are a few problems with the data; for example, wages and a non-labor income measure are not directly available. There is also no record of asset income. I use weekly value of per member income of the household excluding women's own earnings as a proxy for the non-labor income. I only have monthly incomes recorded, thus I divided the figures by four to get an approximate weekly number. The problem I have with the wages is more complicated than of the non-labor income. In the survey, individuals are asked their usual per week working hours, and how much they worked last week. However, they report how much they earned in the month preceding the interview. I approximate the weekly labor income using these figures, making sure that the individuals were working for the whole month for which they report the income. Three observations which are not meeting this criterion are excluded from the sample used for the analysis

The data set is cross-sectional and the nominal level of minimum wage is constant across the country. I create variations in the minimum wage using the province level CPI (I used price indexes supplied by the Central Bank of Turkey for 1995 since there are none available for 1988 for most of the provinces). I keep the Ankara (the capitol city) prices as the base and divide the minimum wage in the other provinces with ratio of their prices to the prices in the capital. This measure should reflect the differences in the real value of minimum wage across individuals even though they all face the same nominal level. I made the same adjustment to non-labor income and wage measures, too. I convert all values into US Dollars using average Dollar/Turkish Lira exchange rate for October 1988, the month that the survey took place.

B. Estimation Method

I estimate the model using Maximum Simulated Likelihood (MSL). This method replaces the actual probabilities defining the likelihood function with simulated ones. In this paper, simulated probabilities are generated by a Logit-Smoothed Accept-Reject Simulator (LS-AR Simulator).

The general class of AR simulators is used whenever the models do not have tractable closed form solutions. The first step in generating an AR simulator is taking random draws (many of them) for exogenous shocks from a pre-specified distribution. Say we take R random draws and suppose we have N individuals in the data. The next step is, for each draw, determining whether it would result in alternative I (not working or if working, working any particular number of hours) which is observed in the data or not, when combined with the individual characteristics. If so, the draw is called an "accept"(1) and if it results in any other outcome it is a "reject"(0). A counter records the number of "accept"s. The ratio of the "accept"s to the total number of repetitions (that is total number of draws, R) is the simulated probability. Maximization is done over parameters to fit what we observe in the data to be the most likely outcome.

Simulation of the discrete participation choice is quite straight forward. However, the simulation used for fitting the hours distribution may not seem obvious. Thus, I'd like to illustrate the simulation of this continuous portion with an example. Suppose I have a worker who is working 30 hours a week in my data. I observe her education, her age, her husband's income and the number of kids she has, but nothing else. However, I assume there are two sorts of external shocks she receives, one affecting her taste for work and the other affecting her productivity. Here I assume these two shocks are independently and normally distributed. I draw 10000 draws for each shock. Then among this ten thousand different combinations, I count the times where the created hours of work (which can be either desired hours or the required minimum) falls within a ± 0.5 interval of the observed number of hours. That is, I have an "accept" if generated hours is between 29.5 and 30.5 in this example. The ratio of total number of accepts to the number of repetitions is the simulated likelihood.

An AR simulator can be problematic for MSL estimation since the simulated probabilities are not smooth in the parameters. The AR simulated probability is a step function. An infinitesimally small change in a parameter will usually not change any draw from a reject to an accept or vice versa. Therefore, the simulated probability is constant with respect to small changes in the parameters. The numerical procedures of maximization use the first derivatives, and sometimes the second derivatives, of the choice probabilities. If these derivatives do not exist, or do not point toward the maximum, then the numerical procedure will not perform effectively. One way to solve this problem is to replace the 0-1 AR indicator with a smooth, strictly positive function (here this function is a logit function). The fifth section of the appendix gives detailed description of this simulation procedure.

There are several problematic issues with MSL estimation, the main one being the bias arising from the log transformation. Even though these simulated probabilities are unbiased estimators of the actual probabilities, logarithms of simulated probabilities are biased estimators for logarithms of actual probabilities. Fortunately, this is an easy-to-solve sort of problem: the bias disappears as N and hence R rises without bound. The MSL estimation is consistent in this case. If R rises faster than $\sqrt{N}$, the MSL is not only consistent but also efficient, asymptotically equivalent to maximum likelihood on the exact probabilities[11]. The other problematic issues with MSL estimation are sensitivity of probabilities to the number of draws and to the smoothing parameter chosen[12]. These are harder problems to solve.

VI. ESTIMATION RESULTS

Married women have higher-valued outside options since the division of labor in the household requires them to be the main producers at home in most cultures. Thus, females of a given market productivity are expected to supply fewer hours of labor than their male counterparts. These women are also expected to make the non-participation decision more easily if they are forced to work long hours. This is what we observe in the data. The share of housewives among non-participating women is strikingly high in Turkish data; Seventy-nine percent of women who do not participate in the labor force stated being a housewife as the reason. Household duties keep women at home when the labor market options are not attractive enough. My estimates provide support to this not-so-new idea. Looking at the *Table* 7 we can see that having young kids in the household decreases the desired workweek at an increasing rate. While having only one young child at the household reduces the desired hours by little less than six hours, having two young children will reduce desired hours by more than ten. The effect of having older kids is similar on hours choice but its negative effect evades as the number of children in this age group increases in the household. Woman who has a child between ages six and fourteen wants to work about three hours less compared to her "twin" with no children of ages six to fourteen.

The estimates of the marginal productivity parameters suggest significant economic returns to education especially at the college and high school level. Everything else equal, college graduate women earn about hundred percent more per hour compared to women with no education. The wage returns to a college education is more than double the wage returns to a high school degree compared to the women with no education. This should partially explain the big discrepancy between participation rates across different education levels.

The mean of the productivity estimates is fifty-four cents for the working individuals, that is, the average worker produces fifty-four cents worth of goods or services per hour. The distribution of these productivity measures

[11] See McFadden (1989) for further theoratical background

[12] See the appendix(section II) for an illustration. You can find more on applications in Train, 2000.

has a standard deviation of seventeen cents, values ranging between three cents and two dollar and thirty-four cents for the entire sample. According to these estimates, nine percent of the women have simulated productivities that are less than the minimum wage level, which ranges between thirty-two and thirty-four cents across fourteen cities.

The number of desired work hours decreases in non-labor income, but the effect is not very significant economically. In this case, non-labor income is approximated using the labor incomes of the other family members. The sum of family income excluding the wife's income is divided by the family size. Keeping this in mind, the estimate for α_2 suggests that by every ten extra dollars the other family members earn per person (that is, total of "10 x family size" increase in the family income) the desired hours of a potential worker will decrease by one hour per week.

Table 7: MSL Estimates

Desired and Required Minimum Hours	estimate	st.dev
constant (α_0)	21.49	2.88
wage (α_1)	4.81	1.05
non-labor income(α_2)	-0.03	2.37
years of schooling	0.88	0.09
squared years of schooling	-3.55	0.65
age	0.84	0.17
squared age	-1.67	0.25
young kids	-2.47	0.77
older kids	-3.49	0.42
squared young kids	-2.71	0.59
squared older kids	0.52	0.17
fixed employment cost (f)	5.38	0.26
Marginal Product		
constant	-1.54	0.01
middle school	0.20	0.01
high school	0.44	0.02
college	0.93	0.03
potential experience	1.6E-03	3.03E-04
squared potential experience	-5.4E-05	5.23E-06
σ_1	8.11	0.09
σ_2	0.42	0.01
log likelihood	-3028	

The coefficients on age variables imply that desired hours increases by age up to age thirty-three and declines then on. Data does not show such a pattern in terms of hours. However, we know that not all workers work their desired hours; according to the simulations about forty percent of the workers are constrained to work at their required minimum. Given this, the following graph can illustrate why we fail to observe such a pattern with hours data. According to this graph the hours worked by low and high end of age distribution is still high due to the higher proportion of constrained workers in those age groups. In other words, by having higher desired hours smaller proportion of the workers in the mid section of age distribution is constrained.

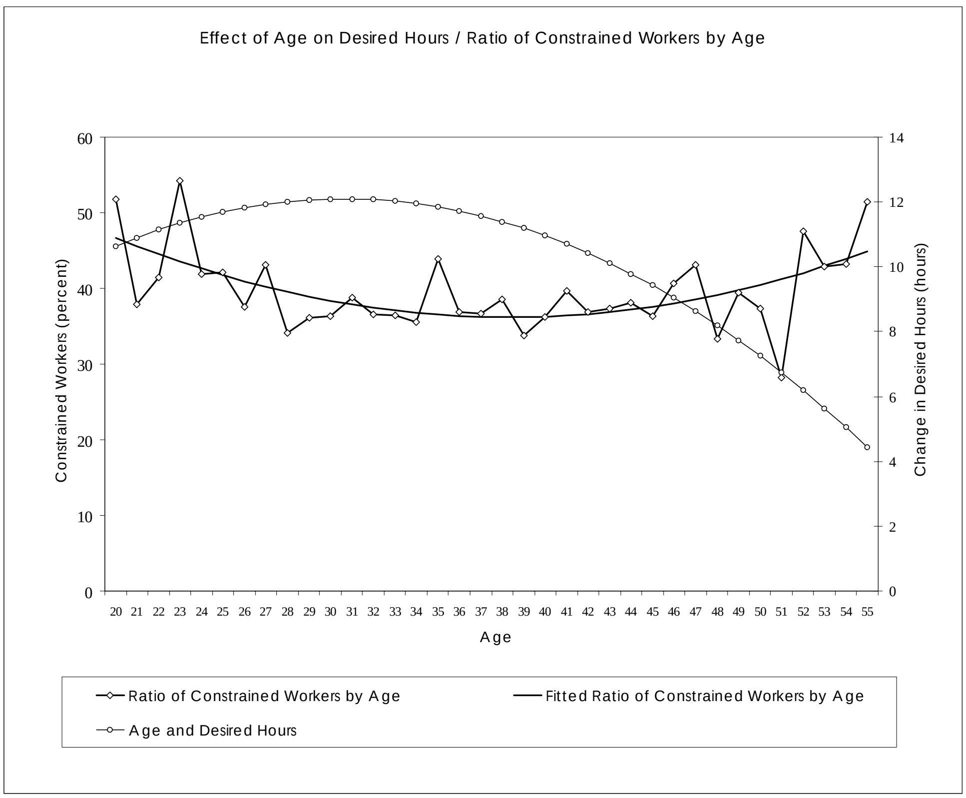

Figure 5

The estimate for α_1 may seem to be small suggesting that a dollar increase in the wage will increase the desired hours by five hours given the range of wage estimates. For the average worker one extra dollar per hour is about two hundred percent increase in hourly wages. This is in line with findings of several papers on Turkish female labor market activity. Tunali (1995), for example, finds that wage elasticity of hours supply is almost zero among Turkish women.

The fixed employment cost is estimated to be about five dollars and forty cents. As mentioned before, an average worker works forty hours per week and makes about fifty-four cents per hour. In this case, five dollars and forty cents corresponds to about twenty-five percent of the weekly earnings. This is a good estimate of non-wage expenses given that about thirty-one percent of all labor cost in Turkey in 1990 (do not have the figure for 1988) was non-wage payment.

A. Participation Regions

The estimated participation rate is 8.87 percent. *Table* 8 summarizes the participation probabilities associated with regions in *Figure* 4. According to these estimates, eighty percent of all women are restricted in the sense that they want to supply positive hours of work but either are not desired as workers or are constrained by high required minimum hours. Conditional on being a non-participant, about twenty-five percent of women want to work and are welcome in the market but are asked to work more hours than they are willing to supply. About sixty percent of women are not offered any job.

Table 8: Participation Regions

Event	Definition	Probability
$h>0$	participation	0.09
$h=h^*$	working desired hours - Region I	0.04
$h=h^{min}$	working required minimum - Region II	0.05
$w^{min}<w$, $h^*>0$, $h=0$	required minimum too high - Region III.	0.25
$w^{min}<w$, $h^*<0$, $h=0$	not want to work - Region IV	0.04
$w^{min}>w$	no job offer - Region V	0.62

B. Fitting the Hours Distribution

Table 9 reports the distribution of the estimated hours. In the simulated data, the average length of workweek is about forty-one hours. For the women working their required minimum hours, the mean workweek is forty-seven hours long, and for women working their desired hours the mean workweek is thirty-five hours.

Table 9:	Distribution of Hours			
	mean	st.dev.	min	max
estimated	40.61	13.52	8.54	89.67
h=h^{min}	46.81	15.31	13.64	89.67
h=h*	34.88	8.19	8.54	61.34

Figure 6 graphs the simulated hours distribution and also shows the distributions for the restricted and unrestricted workers. The relatively high concentration of workweeks around thirty to forty five hours can be considered as a possible- but weak- explanation for the concentration of hours distribution around forty hours in the data.

There appears to be some discrepancy between this distribution and the distribution of actual hours. One reason might be the very low number of workers in the data. The huge concentration at zero working hours is very likely to distort the distribution of hours.

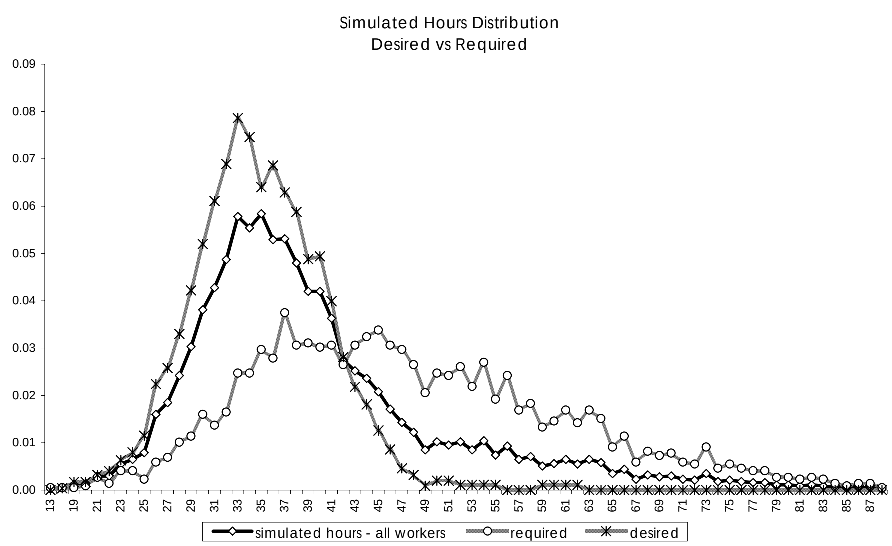

Figure 6

Considering this possibility, I estimated the same model with only the workers in the data. As one would expect the estimated distribution of hours resembles the observed distribution more with the worker only data. The simulated hours line in *Figure* 7 is the graph of working hours simulated with these new estimates. It fits the mean and standard deviation of the distribution better, and captures the spike at forty better than the distribution simulated using full sample estimates. More importantly, *Figure* 8 implies that the workers who are working around thirty-two to forty-two hours of work are mostly unconstrained workers. And the workers on the right tail of the distribution are working their required minimum number of hours.

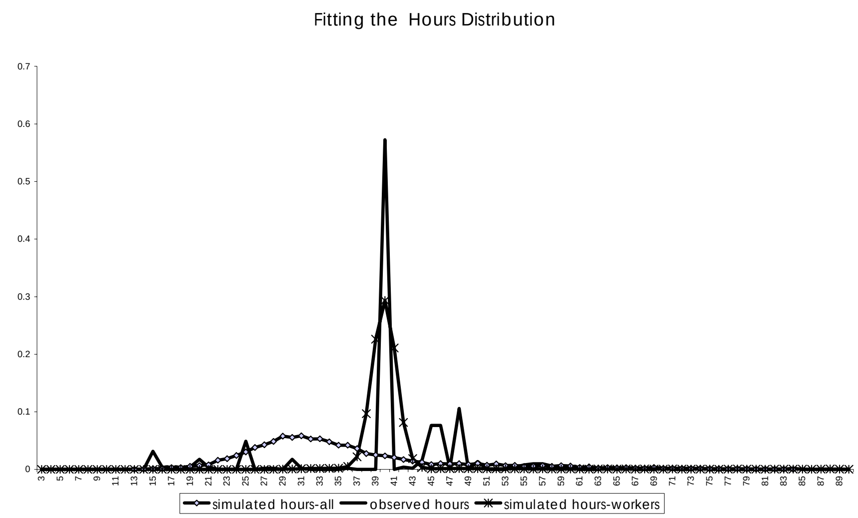

Figure 7

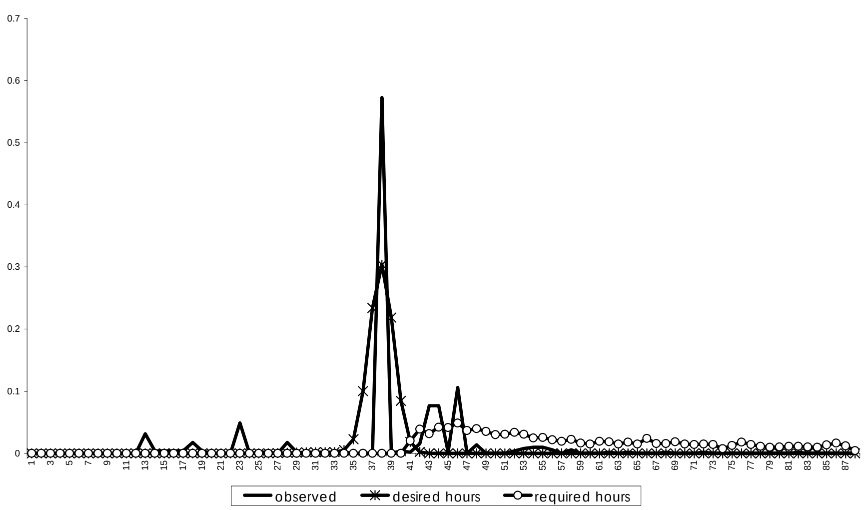

Figure 8

VII. COUNTERFACTUALS

Having a structural model allows me to understand how the minimum wage in this economy affects the employment and the hours distribution. Given the estimates and the data I can simulate the participation and hours choices under different minimum wage policies. Moreover, I can see how the participation and hours choices could have been with the same minimum wage in a different economic environment, in this case, a labor market with no employment costs.

Table 10: Participation Regions under Counterfactuals

	$f=f_{estimate}$, $w^{min}=0$	
$h>0$	participation	0.48
$w^{min}<w$, $h^*>0$, $h=0$	required minimum too high	0.43
$w^{min}<w$, $h^*<0$, $h=0$	not want to work	0.09
	$f=0.5*f_{estimate}$, $w^{min}=w^{min}_{data}$	
$h>0$	participation	0.15
$w^{min}<w$, $h^*>0$, $h=0$	required minimum too high	0.19
$w^{min}<w$, $h^*<0$, $h=0$	not want to work	0.04
$w^{min}>w$	no job offer	0.62
	$f=0.5*f_{estimate}$, $w^{min}=0$	
$h>0$	participation	0.75
$w^{min}<w$, $h^*>0$, $h=0$	required minimum too high	0.16
$w^{min}<w$, $h^*<0$, $h=0$	not want to work	0.09

Table 10 contains the participation probabilities generated via simulations under these counterfactuals. If the minimum wage is zero (in presence of the fixed cost), the share of women who are restricted drops to forty-three percent. Decreases in the minimum wage have the expected effect on participation: the ratio of women working increases when the minimum wage is zero, even when there are still fixed costs, to forty-eight percent.

Fixed costs in this model represents not only technological burdens but also policy implied costs of employment. Thus, although it is theoretically not reasonable to think of an environment without any fixed employment costs, we can think of an environment sans the institutional costs imposed by the regulations, taxes etc. About fifteen percent of women participate when fixed costs are reduced by fifty percent. If there is no minimum wage and half as much fixed costs, participation rate is seventy-five percent. These changes also affect the distribution of working hours. *Table* 11 shows that the mean, minimum, and maximum hours worked are lower, indicating more women working at the low end of hours distribution.

Table 11: Counterfactual Distribution of Hours

	mean	st.dev.	min	max
f=$f_{estimate}$,w^{min}=0	31.91	7.78	10.28	68.62
f=f=0.5*$f_{estimate}$,w^{min}=w^{min}_{data}	36.08	12.05	5.99	89.72
f=f=0.5*$f_{estimate}$,w^{min}=0	28.76	8.56	5.14	68.54

VIII. LABOR SUPPLY ELASTICITIES

For this model, unconditional expectation of hours supply can be written in two parts; expected value of hours of work given it is the minimum required hours and expected value of hours of work given it is the desired level, that is:

$$\begin{aligned} E\left[h_i\right] = {} & E\left[h_i|h_i^* > h_i^{\min}, w_i > w^{\min}\right] \quad P(\ T > h^* > h_i^{\min},\ w_i > w^{\min}) \\ & + \left[\begin{array}{c} E\left[h_i|h_i^{\min} > h_i^* > 0, U(h_i = h_i^{\min}) > U(h_i = h_i^{\min})\right] \\ \Pr(\ 0 < h^* < h_i^{\min} < T,\ U(h = h_i^{\min}) > U(h = 0)) \end{array} \right] \end{aligned}$$

Then the marginal change in the unconditional hours supply due to a marginal change in a given variable $Y(X_i\ ,\ A_i)$ can be written as

$$\begin{aligned} \frac{\partial E\left[h_i\right]}{\partial Y} = {} & \left(\frac{\partial E\left[h_i|h_i^* > h_i^{\min}, w_i > w^{\min}\right]}{\partial Y} \ P(\ T > h^* > h_i^{\min},\ w_i > w^{\min}\ ) \right) \\ & + \left(E\left[h_i|h_i^* > h_i^{\min}, w_i > w^{\min}\right] \frac{\partial P(\ T > h_i^* > h_i^{\min},\ w_i > w^{\min}\ )}{\partial Y} \right) \\ & + \left(\begin{array}{c} \frac{\partial E\left[h_i|h_i^{\min} > h_i^* > 0, U(h_i = h_i^{\min}) > U(h_i = h_i^{\min})\right]}{\partial Y} \\ \Pr(\ 0 < h_i^* < h_i^{\min} < T,\ U(h_i = h_i^{\min}) > U(h_i = 0)) \end{array} \right) \\ & + \left(\begin{array}{c} E\left[h_i|h_i^{\min} > h_i^* > 0, U(h_i = h_i^{\min}) > U(h_i = h_i^{\min})\right] \\ \frac{\partial \Pr(\ 0 < h_i^* < h_i^{\min} < T,\ U(h_i = h_i^{\min}) > U(h_i = 0))}{\partial Y} \end{array} \right) \end{aligned}$$

This expression decomposes the total changes in the expected hours into four parts: (1) changes in the hours for those who are working their desired hours conditional on being able to work the desired workweek; (2) the change in the probability of being able to work the desired hours weighted by the expected value of hours for who work desired hours; (3) changes in the hours for those who are working imposed required minimum workweeks conditional on being restricted; and (4) the change in the probability of being required to work minimum hours weighted by the expected value of hours for the constrained workers. $Tables$ $12-14$ summarize the hours supply and participation elasticities with respect to productivity variables and household characteristics.

Table 12: Responses to a ten percent change in

	hour	participation rate
nonlabor income	39.65	0.088
productivity	39.31	0.117

Table 13: Responses to one more kid in each family

	hour	participation rate
young kids+1	35.75	0.082
older kids+1	37.83	0.085

Table 14: Elasticity of Expected Hours Supplied

nonlabor income	0.010
wage	0.096
young kids	0.060
older kids	0.049

IX. CONCLUSION

In this paper, I show that the interaction of minimum wages and fixed costs of employment impose limits on the working hours and as a result can cause a shortage of part-time jobs. I show that for sufficiently high employment costs, institution of a minimum wage affects employment among all workers who prefer flexibility in terms of hours regardless of the productivity level. I estimate the model with Turkish data. My estimates indicate that about eighty percent of all women in Turkey are restricted; they wish to supply positive hours of work, but either have lower than minimum wage productivities and thus are not desired as workers or are constrained by required minimum hours. The key parameter in the model is the fixed cost of employment, which is estimated to be about 5 dollars per week for each employee. The average worker in the sample works forty hours per week and makes about 54 cents per hour. The 6 dollars fixed cost thus corresponds to about 25 percent of weekly earnings. Given that on average 30 percent of all labor costs in Turkey are non-wage expenses, this estimate is a good approximation.

Based on the estimates, I simulate several counterfactual scenarios and analyze transitions across labor market groups under these alternative policies. If there were no constraints in the market, my simulations show that about 60 percent of currently non-working women would obtain jobs. This would increase total female labor force participation to 75, about 9 times the current estimated rate. A simulation without fixed costs indicates that the minimum wage alone explains 42 percent of this total increase. Similarly, a simulation including fixed costs but no minimum wage shows that fixed costs account for only 7 percent of the change. Thus, the interaction of the minimum wage with fixed employment costs accounts for most of the difference.

In the current functional specification of the model, there is no place for a non-monotonic relationship between hours supplied and fixed costs. Moreover, there is no room for non-linear responses to wages. Implications of the model for employment decisions do not change if the technology is modified in order to allow alternative constraints and wage structures. For example, an S-shaped hours-productivity relationship (See Borjas, 1973 or Moffitt, 1984), which is considered a more realistic approach, would lead to both lower and upper bounds on the length of workweeks acceptable to the employers. This would strengthen the impact of minimum wage on the level of employment even without the fixed costs. In the data, the distribution of hourly wages by workweek is weakly concave, which rejects the idea of a full-time wage premium. I take this as a sign that this model is a reasonable choice for the environment. It implies that part time jobs will be in short supply and high productivity workers will occupy the existing jobs. Low productivity workers will be constrained with higher working hours. Thus, in this environment, the part-time job market may have higher hourly wages on average than the full-time job market. This is quite different from the markets that are explained with S-shaped budget constraints.

Allowing constraints only on the minimum number of hours workers can work may seem limiting. However, an upper limit on working hours does not seem to be an issue in the data. Moreover, I choose not to discretize the choice set of hours, unlike some other studies in the literature, since the main concern is not fitting the distribution of observed hours (mainly the spikes at certain length of workweeks, like 40 hours) but understanding how important these constraints are in explaining the concepts of voluntary and involuntary unemployment. I cannot capture the spikes of observed hours distribution with the estimates. However, model successfully fits the external margins of participation. I also ignore possible heterogeneity of fixed costs due to the lack of variables needed to identify such variation across workers.

The available data set lacks potentially significant information, the inclusion of which may increase the explanatory power of the model. Re-estimation of the model with a data set, which reports the hours of work over a longer period of time, and reports a greater variety of individual variables such as non-labor income, education of parents, or health status indicators should be considered in the future. This data set only asks about hours worked in the week preceding the survey. This may not be a true indicator of participation behavior. For a better understanding of the effects of minimum wage restrictions, it would be helpful if I were able to follow the sample over time as real minimum wage changes. Moreover, other sources of hours-dependency of wages can be considered for the analysis. When possible nonlinear structures of marginal productivity are considered, the demand side can be more effectively studied.

This paper offers a stylized model of employment costs. Model restricts the usage of information on employers since this information does not exist for non-workers, thus cannot be used to approximate the latent indices created for each individual. Estimating the model only on workers can improve this aspect of the estimates. However, workers constitute a minority in this data set, which reduces the power of estimation. Thus, next step is to estimate the model on a data set where employment rates are higher, like the CPS data. In the mean time, data set can be enriched by inclusion of single females and maybe males. Married women make non-participation decision easier compared men and single women since they usually have a higher non-labor income to rely on compared to their husbands. It will be interesting to model household as the unit of analysis and estimate the impact that the minimum wages and market inflexibilities have on the intra-household division of labor. Turkish married men work on average 52 hours in my data. This is very high compared to many other countries.

Another natural extension is estimation of the model in a different economic environment. Among Turkish females the employment effects of the minimum wage is magnified since the productivity levels are very low, minimum wage is quite binding and fixed costs, as estimated, are substantial. I plan to estimate the model with US data, where female productivity levels are higher and participation rates are very high. I expect to estimate economically and statistically significant fixed costs, in presence of which the minimum wage fails to impose restrictions on most workers since its level is rarely binding.

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APPENDIXES

I. UTILITY FUNCTION AND WORK DECISION

Following two graphs show the relationship between the work hours and the utility, keeping everything else constant for two different individuals. Both individuals have the same characteristics, except for the number of young kids. X-axis crosses the y-axis at U(h=0), that is at the utility level from not working.

This first figure illustrates the utility function of an individual for whom not working is superior to working at any h. This individual is not going to work at h^*, since this local maximum implies a lower utility level than what he gets at $h = 0$.

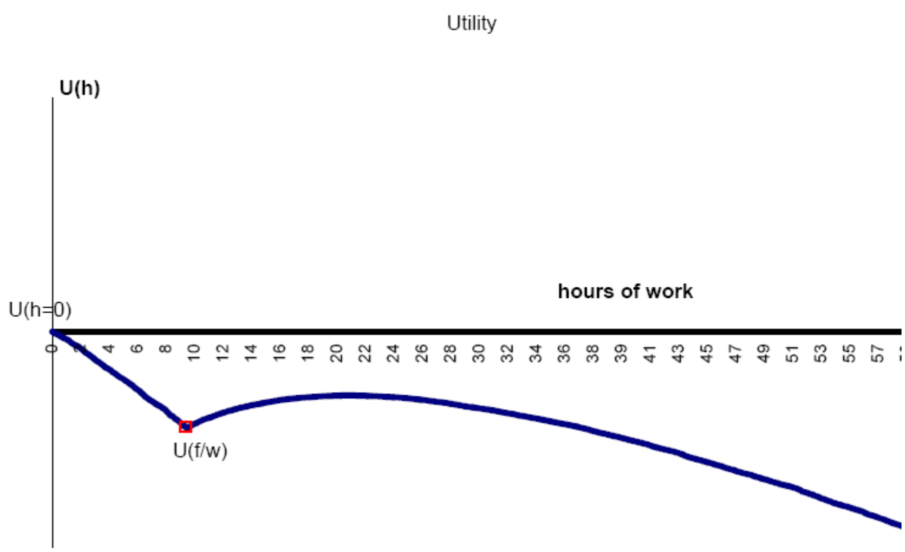


Figure A-1

The following individual has the same characteristics with the above individual except the number of young kids. As you can see the absolute required minimum is same for both individuals since only the productivity variables affect the location of this minimum. Unlike the above case, there is a positive h for this individual where her utility is maximized. She will work h^* (point C) if the require minimum hours is between points B and C. She will work her required minimum hours if the minimum is between C and D (note that for these points utility is higher than what it is at $h = 0$).

If the required minimum is more than D, she will not work, since now not working gives a higher utility compared to working at h^{min}

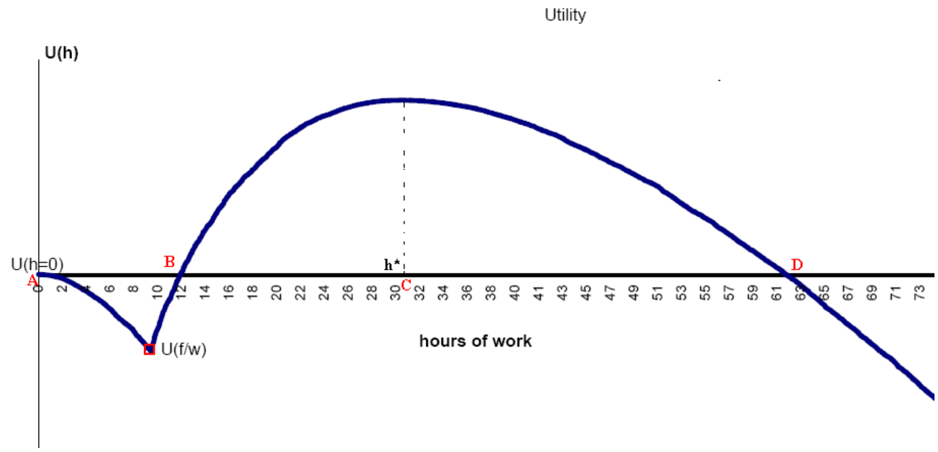


Figure A-2

II. DERIVATION OF THE LIKELIHOOD FUNCTION

The individual's problem is to maximize

$$\begin{aligned} U &= U(C_i, L_i;\ A_i, \epsilon_i) \\ &= \left(\frac{\alpha_2(T - Li) - \alpha_1}{\alpha_2^2}\right) \exp\left(\frac{\alpha_2\left(\alpha_{0+}\alpha_2 C_i + \alpha_3 A_i + \epsilon_{1i}\right) - \alpha_1}{\alpha_2 h_i - \alpha_1}\right) \end{aligned}$$

subject to the following set of constraints

$$C_i \leq M_i + \gamma(w_i h_i - f)$$
$$L_i + h_i \leqslant T$$

where A_i is a vector of demographic characteristics, M_i is non-labor income and C_i is the composite good (the numeraire), L_i is leisure, and T is the fixed weekly time endowment that can be divided between leisure and work. γ is a dummy which is equal to 1 if the individual works and 0 if not. Solution to this optimization problem gives

$$h_i^* = T - L_i^* = \alpha_0 + \alpha_1 w_i + \alpha_2(M_i - f) + \alpha_3 A_i + \epsilon_{i1}$$

as the desired hours equation. This model has two more latent indexes:

$$w_i = X_i \beta + \epsilon_{i2}$$

$$h_{ij}^{\min} = \frac{f}{w_i - w_j^{\min}}$$

Then for a worker

$h_i = h_i^*$ *(works desired hours)* if

$$h_i^* > h_{ij}^{\min} \text{ and } w_i > w_j^{\min}$$

$h_i = h_{ij}^{\min}$ *(works required minimum hours)* if

$$0 < h_i^* < h_{ij}^{\min} \text{ and } U(h_i = h_{ij}^{\min}) > U(h_i = 0)$$

$h_i = 0$ *(desires to work but is restricted)* if

$$0 < h_i^* < h_{ij}^{\min} \quad \text{and} \quad U(h_i = h_{ij}^{\min}) < U(h_i = 0)$$

$h_i = 0$ *(does not want to work but is offered a job)* if

$$h_i^* \leq 0 \quad \text{and} \quad w_i > w_j^{\min}$$

and

$h_i = 0$ *(can not work-no job is offered)* if

$$w_i < w_j^{\min}$$

Then the log-likelihood function is:

$$\log L = \sum_{h>0} \log Q + \sum_{h=0} \log q$$

where

$$Q = \left(\begin{array}{c} \left(\begin{array}{c} k(h|\ \textit{Region}\ \ I\ ,\ X_i,\ A_i,\ \sigma_1,\ \sigma_2,\ w_j^{\min},\ M_i) \\ \Pr(\ \textit{Region}\ \ I \mid X_i,\ A_i,\ \sigma_1,\ \sigma_2,\ w_j^{\min},\ M_i) \end{array} \right) \\ + \\ \left(\begin{array}{c} k(h|\ \textit{Region}\ II,\ X_i,\ A_i,\ \sigma_1,\ \sigma_2,\ w_j^{\min},\ M_i) \\ \Pr(\ \textit{Region}\ \ II \mid X_i,\ A_i,\ \sigma_1,\ \sigma_2,\ w_j^{\min},\ M_i) \end{array} \right) \end{array} \right)$$

and

$$q=\begin{pmatrix} \Pr(Region\ III \mid X_i,\ A_i,\ \sigma_1,\ \sigma_2,\ w_j^{\min},\ M_i) \\ +\Pr(Region\ IV \mid X_i, A_i, \sigma_1, \sigma_2, w_j^{\min}, M_i) \\ +\Pr(Region\ V \mid X_i,\ A_i,\ \sigma_1,\ \sigma_2,\ w_j^{\min},\ M_i) \end{pmatrix}$$

[$k(.)$ is the conditional probability density function of the hours of work variable given dependent variables, non-labor income and minimum wage levels and the unobserved preference and productivity shocks].

$$k(h|Region\ I,.)=\frac{\Phi\ \left[\frac{(h_i-f)X_i\beta-w_j^{\min}h_i}{\sqrt{(f-h_i)^2\ \sigma_2^2}}\right]\phi\left[\frac{h_i-\alpha_0-(\alpha_1-\alpha_2 f)X_i\beta-\alpha_2 M_i-\alpha_3 A_i}{\sqrt{(\alpha_1-\alpha_2 f)^2\ \sigma_2^2+\ \sigma_1^2}}\right]\frac{1}{\sqrt{(\alpha_1-\alpha_2 f)^2\ \sigma_2^2+\ \sigma_1^2}}}{\Pr(0<h_{ij}^{\min}<h^*, U(h=h_{ij}^{\min})\ >U(h=0)\mid X_i, A_i, \sigma_1, \sigma_2, w_j^{\min}, M_i)}$$

$$k(h|Region\ II,.)=\frac{[\Phi\,(Z_1)\quad-\quad\Phi(Z_2)]\ \left(\frac{w_j^{\min}f}{(h_i-f)^2\sigma_2}\right)\ \phi\ \left(\frac{w_j^{\min}\dfrac{h_i}{h_i-f}\ -\ X_i\beta}{\sigma_2}\right)}{\Pr(0<h_i^*<h_{ij}^{\min},\ U(h_i=h_{ij}^{\min})\ >U(h_i=0)\mid X_i, A_i, \sigma_1, \sigma_2, w_j^{\min}, M_i)}$$

where

$$Z_1=\frac{\log\left(\frac{\alpha_1-\alpha_2 h_i}{\alpha_1}\right)[(\alpha_1-\alpha_2 h_i)\ (\alpha_1)]-\alpha_2^2\alpha_0 h_i-\alpha_2^3 h_i M_i-\alpha_2^2\alpha_3 A_i h_i+\alpha_2\alpha_1 h_i-\alpha_2^2\alpha_1 w_j^{\min}h_i}{\alpha_2^2 h_i\sigma_1}$$

and

$$Z_1=\frac{h_i-\alpha_0-(\alpha_1-\alpha_2 f)X_i\beta-\alpha_2 M_i-\alpha_3 A_i-(\alpha_1-\alpha_2 f)\left[w_j^{\min}\dfrac{h_i}{h_i-f}\ -X_i\beta\right]}{\sigma_1}$$

And

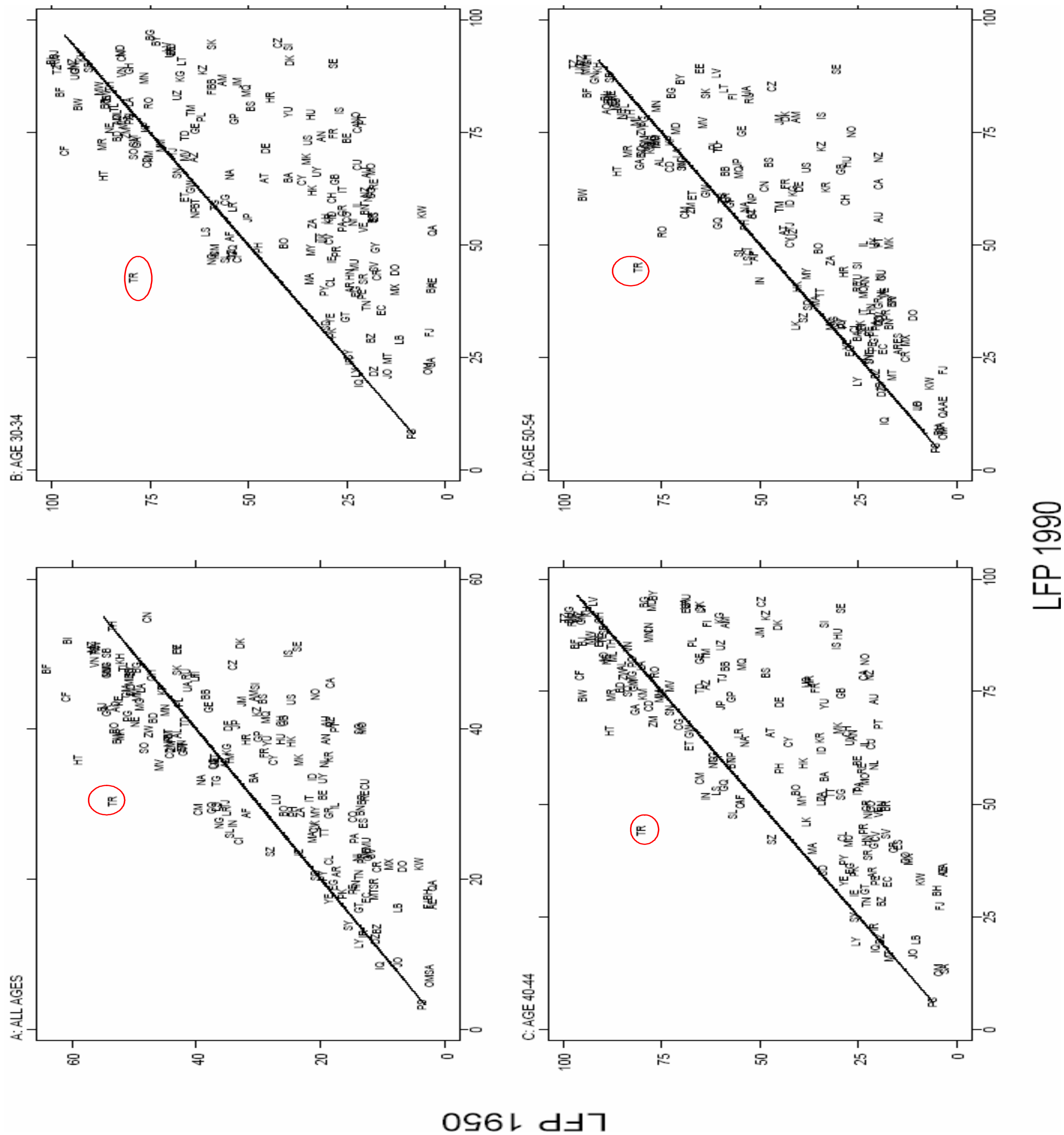
$$q=\begin{pmatrix} \Pr\left(\begin{bmatrix} \left(\alpha_2 h_{ij}^{\min}-\alpha_1\right)\exp\left(\frac{\alpha_2\left(\alpha_0+\alpha_2 M_i+\alpha_2 h_{ij}^{\min}w_j^{\min}+\alpha_3 A_i+\epsilon_{1i}\right)-\alpha_1}{\alpha_2 h_{ij}^{\min}-\alpha_1}\right) \\ < \\ (-\alpha_1)\exp\left(\frac{\alpha_2(\alpha_0+\alpha_2 M_i+\alpha_3 A_i+\epsilon_{1i})-\alpha_1}{-\alpha_1}\right) \end{bmatrix} \begin{matrix} \\ ,\ h_i^*>0, \\ w>w_j^{\min}\mid X_i, A_i, \sigma_1, \sigma_2, w_j^{\min}, M_i \end{matrix}\right) \\ +\Pr\left[h_i^*<0,\ w>w_j^{\min}\ \mid\ X_i, A_i, \sigma_1, \sigma_2, w_j^{\min}, m_i\right] \\ +\Pr\left[w<w_j^{\min}\ \mid\ X_i, A_i, \sigma_1, \sigma_2, w_j^{\min}, M_i\right] \end{pmatrix}$$

$$= \left(\begin{array}{c} \Pr \left(\begin{array}{c} \left[\begin{array}{c} \left(\alpha_2 h_{ij}^{\min} - \alpha_1\right) \exp\left(\frac{\alpha_2\left(\alpha_0 + \alpha_2 m + \alpha_2 h_{ij}^{\min} w_j^{\min} + \alpha_3 A_i + \epsilon_{1i}\right) - \alpha_1}{\alpha_2 h_{ij}^{\min} - \alpha_1} \right) \\ < \\ (-\alpha_1) \exp\left(\frac{\alpha_2(\alpha_0 + \alpha_2 M_i + \alpha_3 A_i + \epsilon_{1i}) - \alpha_1}{-\alpha_1} \right) \end{array} \right] \\ ,\ X_i\hat{\beta} - w_j^{\min} > -\epsilon_{2i}, \\ \alpha_0 + (\alpha_1 - \alpha_2 f) X_i\hat{\beta} + \ \alpha_2 M_i + \alpha_3 A_i > \epsilon_{1i} + \epsilon_{2i}(\alpha_1 - \alpha_2 f) \end{array} \right) \\ + \Pr \left[\begin{array}{c} \alpha_0 + \alpha_1 \left(X_i\hat{\beta} + \epsilon_{i2} \right)_i + \alpha_2 \left(M_i - f(X_i\hat{\beta} + \epsilon_{i2}) \right)_i \\ + \alpha_3 A_i + \epsilon_{1i} < 0,\ X_i\hat{\beta} + \epsilon_{i2} > w_j^{\min} \end{array} \right] \\ + \Pr\left[X\hat{\beta} + \epsilon_{i2} < w_j^{\min} \right] \end{array} \right)$$

$$= \left(\begin{array}{c} \Pr \left(\begin{array}{c} \left[\begin{array}{c} \left(\alpha_2 h_{ij}^{\min} - \alpha_1\right) \exp\left(\frac{\alpha_2\left(\alpha_0 + \alpha_2 M_i + \alpha_2 h_{ij}^{\min} w_j^{\min} + \alpha_3 A_i + \epsilon_{1i}\right) - \alpha_1}{\alpha_2 h_{ij}^{\min} - \alpha_1} \right) \\ < \\ (-\alpha_1) \exp\left(\frac{\alpha_2(\alpha_0 + \alpha_2 M_i + \alpha_3 A_i + \epsilon_{1i}) - \alpha_1}{-\alpha_1} \right) \end{array} \right] \\ ,\ X_i\hat{\beta} - w_j^{\min} > -\epsilon_{2i}, \\ \alpha_0 + (\alpha_1 - \alpha_2 f) X_i\hat{\beta} + \ \alpha_2 M_i + \alpha_3 A_i > \epsilon_{1i} + \epsilon_{2i}(\alpha_1 - \alpha_2 f) \end{array} \right) \\ + \Phi \left[\frac{-\left[\alpha_0 + (\alpha_1 - \alpha_2 f) X_i\hat{\beta} + \alpha_2 M_i + \alpha_3 A_i\right]}{\sqrt{\sigma_1^2 + (\alpha_1 - \alpha_2 f)\sigma_2^2}},\ \frac{-X_i\hat{\beta} + w_j^{\min}}{\sigma_2} \right] + \Phi \left[\frac{X_i\hat{\beta} - w_j^{\min}}{\sigma_2} \right] \end{array} \right)$$

III. FEMALE LABOR FORCE PARTICIPATION 1950 VS 1990

Next figure has 4 different graphs. All graphs have 1990 female labor force participation rates on x-axis and 1950 female participation rates on the y-axis. The straight line is the 45 degree line; for countries (you can find the names of the countries and corresponding abbreviations on the list following the picture) below this line participation rates increased over the 40 year period, and for the countries above this line participation rates decline. The first picture shows the change for women of all age groups, the second picture for ages 30-39, the third picture for ages 40-49 and the last picture for ages 50-59. Turkey's position is circled in the graphs. As you can see, female labor force participation rates declined in all age group in Turkey. Turkey is an outlier in all four groups, especially for the younger population.


A: ALL AGES
B: AGE 30-34
C: AGE 40-44
D: AGE 50-54
LFP 1950
LFP 1990

Country Names

AE	U. Arab Emirates	DO	Dominican Republic	KR	Korea, Republic of	PS	West bank and Gaza Strip
AF	Afghanistan	DZ	Algeria	KW	Kuwait	PT	Portugal
AL	Albania	EC	Ecuador	KZ	Kazakhstan	PY	Paraguay
AM	Armenia	EE	Estonia	LA	Lao People's D. R.	QA	Qatar
AN	Netherlands	EG	Egypt	LB	Lebanon	RE	Réunion
An	tilles	ER	Eritrea	LK	Sri Lanka	Re	p. of
AO	Angola	ES	Spain	LR	Liberia	RO	Romania
AR	Argentina	ET	Ethiopia	LS	Lesotho	RU	Russian Federation
AT	Austria	FI	Finland	LT	Lithuania	RW	Rwanda
AU	Australia	FJ	Fiji	LU	Luxembourg	SA	Saudi Arabia
AZ	Azerbaijan	FR	France	LV	Latvia	SB	Solomon Islands
BA	Bosnia and	GA	Gabon	LY	Libyan Arab Jamahiriya	SD	Sudan
BB	Barbados	GB	United Kingdom	MA	Morocco	SE	Sweden
BD	Bangladesh	GE	Georgia	MD	Moldova, Rep. of	SG	Singapore
BE	Belgium	GH	Ghana	MG	Madagascar	SI	Slovenia
BF	Burkina Faso	GM	Gambia	MK	Macedonia, Rep. of	SK	Slovakia
BG	Bulgaria	GN	Guinea	ML	Mali	SL	Sierra Leone
BH	Bahrain	GP	Guadeloupe	MM	Myanmar	SN	Senegal
BI	Burundi	GQ	Equatorial Guinea	MN	Mongolia	SO	Somalia
BJ	Benin	GR	Greece	MO	Macau, China	SR	Suriname
BN	Brunei Darussalam	GT	Guatemala	MQ	Martinique	SV	El Salvador
BO	Bolivia	GW	Guinea-Bissau	MR	Mauritania	SY	Syrian Arab Republic
BR	Brazil	GY	Guyana	MT	Malta	SZ	Swaziland
BS	Bahamas	He	rzegovina	MU	Mauritius	TD	Chad
BT	Bhutan	HK	Hong Kong, China	MV	Maldives	TG	Togo
BW	Botswana	HN	Honduras	MW	Malawi	TH	Thailand
BY	Belarus	HR	Croatia	MX	Mexico	TJ	Tajikistan
BZ	Belize	HT	Haiti	MY	Malaysia	TL	Timor-Leste
CA	Canada	HU	Hungary	MZ	Mozambique	TM	Turkmenistan
CD	Congo, Democratic Republic of	ID	Indonesia	NA	Namibia	TN	Tunisia
CF	Central African R.	IE	Ireland	NE	Niger	TR	Turkey
CG	Congo	IL	Israel	NG	Nigeria	TT	Trinidad and Tobago
CH	Switzerland	IN	India	NI	Nicaragua	TZ	Tanzania, United Rep. of
CI	Côte d'Ivoire	IQ	Iraq	NL	Netherlands	UA	Ukraine
CL	Chile	IR	Iran, Islamic Rep.	NO	Norway	UG	Uganda
CM	Cameroon	IS	Iceland	NP	Nepal	US	United States
CN	China	IT	Italy	NZ	New Zealand	UY	Uruguay
CO	Colombia	JM	Jamaica	OM	Oman	UZ	Uzbekistan
CR	Costa Rica	JO	Jordan	PA	Panama	VE	Venezuela
CU	Cuba	JP	Japan	PE	Peru	VN	Viet Nam
CV	Cape Verde	KE	Kenya	PG	Papua New Guinea	YE	Yemen, Rep. of
CY	Cyprus	KG	Kyrgyzstan	PH	Philippines	YU	Serbia and Montenegro
CZ	Czech Republic	KH	Cambodia	PK	Pakistan	ZA	South Africa
DE	Germany	KM	Comoros	PL	Poland	ZM	Zambia
DK	Denmark	KP	Korea, D. People's	PR	Puerto Rico	ZW	Zimbabwe

IV. PARTICIPATION AND PART-TIME JOBS IN SELECTED EUROPEAN COUNTRIES

Country	Share of Part-timers	Participation Rate
Austria	38.00	64.60
Belgium	40.50	58.80
Bulgaria	2.20	56.60
Cyprus	13.40	62.90
Czech	8.30	62.30
Denmark	33.20	76.10
Estonia	9.40	65.30
Finland	19.70	70.80
France	30.30	64.00
Germany	41.60	66.70
Greece	8.50	54.30
Hungaria	6.40	54.50
Iceland	34.20	80.00
Ireland	31.40	59.70
Italy	25.20	51.30
Latvia	14.10	65.20
Lithuania	10.10	65.50
Luxembourg	40.20	54.30
Malta	20.60	37.00
Netherlands	74.60	69.40
Norway	45.70	75.00
Poland	14.50	58.00
Portugal	16.50	67.70
Romania	9.50	55.80
Slovakia	4.20	62.60
Slovenia	10.30	64.30
Spain	17.70	57.60
Sweden	36.70	74.30
Turkey	3.50	27.00
UK	42.90	68.70

Source: EUROSTAT

V. SIMULATING THE PROBABILITIES

1. Draw vectors of error terms from standard normal density (I work with 10000 draws per individual. I checked for the possible dependency of probabilities on the number of repetitions using different number of draws ranging from 10000 to 100000)

2. Think of the random errors as states of the world and using these values of the errors, calculate the desired hours, required minimum hours and utility levels for certain lengths of workweek for the individual (I think of this step and the next as "sliding doors phase").

3. Apply the decision rule of the model. If 0-1 A-R simulator was used, the probabilities will be ratio of the number of times that observed state is obtained with random draws to the total number of draws. However, with smoothed A-R, put the choice (a) and the alternative (b) in the logit formula as follows (In a simple probit setting, for example, "a" could be the utility from working for a worker and "b" could be the utility from not working)

$$C = \frac{e^{a/\lambda}}{(e^{a/\lambda} + e^{b/\lambda})}$$

where $\lambda > 0$ is a scale factor specified by the researcher (I set it to be 0.05- as this number gets closer to zero, smoothed A-R simulator gets closer to 0-1 A-R estimator. I was using 0.005 initially which proved to be problematic). Following figure illustrates the role of smoothing parameter:

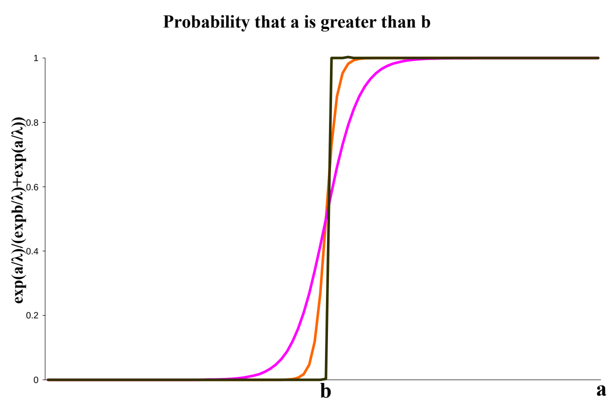


Figure A-4: Choice of the Smoothing Parameter

4. I check if the individual is working or not working. For the non-workers, the probability I am looking for is $(1 - B)$ where B is the probability that the individual desires to work positive hours, is desired in the market and has higher utility from working her required minimum hours than from not working, that is

$$B = Pr(h_i^* > 0,\ w_i < w^{min}, \text{and } U(h_i = h^{min}) > U(h_i = 0))$$

I check if given the draw of errors desired number of hours is positive and if productivity of the worker is higher than the minimum wage. If so I put the values corresponding to the utilities at zero hours and required minimum hours into the logit formula. Any function will work here as long as it takes values between zero and one and increase with "a" (in this case $U(h_i = h^{min})$) and decrease with "b" ($U(h_i = 0)$). For the workers I am simulating the conditional pdf of hours of work given that individual is working. This is a continuous object which I discretize for simulation. Given the calculated desired and required minimum hours and the utility levels at required minimum hours and zero hours, I apply the decision rule in the model and see if the individual is working. If so $h^{simulated} = max\{h^*, h^{min}\}$. The choice here is the absolute value of the distance between simulated working hours and observed hours. Let us call it s. And the alternative is 0.5. Basically if 0.5 is greater than the distance, s , that is, if $max\{h^*, h^{min}\} \in h \mp 0.5$, it is an accept. Then, when smoothed, the value of C is $\frac{e^{0.5/\lambda}}{(e^{s/\lambda} + e^{0.5/\lambda})}$.

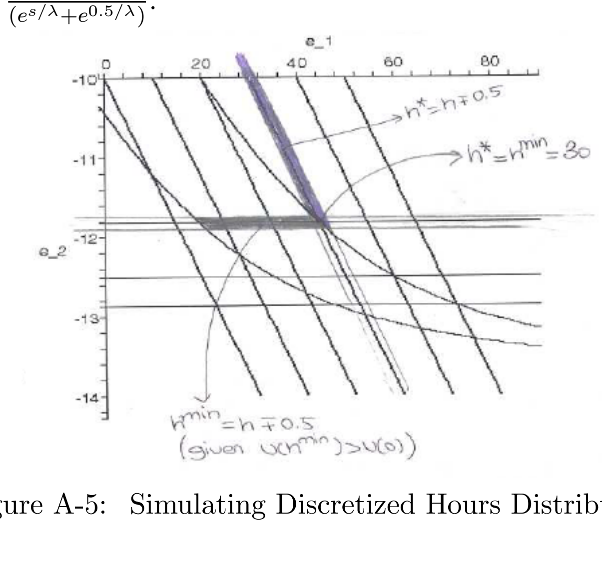


Figure A-5: Simulating Discretized Hours Distribution

5. Repeat steps 2–3 for each pair of error draws and sum the C's realized at each repetition. Label the number of repetitions as R.
6. The simulated probability is the sum of C's divided by the number of repetitions, R.