Why do unemployed workers leave the labor market?

A theoretical and empirical investigation of a search model with time-dependent reservation wages

Abstract

The paper presents a search model with time-dependent offer arrival rate, which leads to reservation wages declining over time. The paper shows that there exists some critical point in time after which is not optimal to search anymore and, hence, workers withdraw from the labor market. Thus, the optimal time an unemployed worker spends looking for a job is the solution to a maximization problem in the model and is not treated as a competing risk to exit from unemployment into employment. The empirical results presented in the paper show that there is significant variation in search behavior across age groups. However, the optimal search time goes down with inequality in the left tail of the wage offer distribution for all age groups.

I. Introduction

Since the pioneering work of Stigler (1962), search models have been widely used in labor market theory. Applications of search theory give predictions about individuals' reservation wages, unemployment durations and reemployment opportunities. Most of the search model frameworks imply time-invariant reservation wages. Economic reality suggests, however, that they are not. As early as 1967, Kasper provided empirical evidence of declining reservation wages over the search span. Attempts have been undertaken to explain this phenomenon theoretically. Gronau (1971) claimed that constant reservation wage hypothesis does not hold if the infinite life horizon assumption is relaxed. However, as suggested in Mortensen (1986) this is rather an aging effect which cannot explain relatively large rates of decline in reservation wages for relatively young workers reported in several studies. Hence, with the exception of elderly workers close to the retirement age, infinite time horizon is not a stumbling point.

Mortensen (1986) provides an elegant explanation of declining reservation wages by imposing a credit market constraint. Technically it is not really different from imposing a retirement constraint. The difference is that searchers run out of available credits much earlier than they approach retirement age.

Modeling withdrawals from the labor market received very little attention in the search literature. However, as I will show here there is close connection between declining reservation wages and withdrawals from the labor force.

I provide here an alternative explanation to declining reservation wages, namely – discrimination of long-term unemployed by firms. Firms could use the length of the unemployment spell as an indicator for a possible depreciation of skills. As a consequence, they would favor short-term unemployed workers if they had the choice. However, as noted by Blanchard (1996), if unemployed gradually lose their skills over time they should be willing to work for less and hence not be discriminated by firms. The model presented here assumes that discrimination against the long-term unemployed workers affects the job-offer arrival rate *only* (everything else being equal). As a result, the model predicts a decline in reservation wages with time of search. The *hazard* itself (of exiting from unemployment into employment) must not necessarily go down. An important consequence of the model is that individuals, once they start looking for jobs, set the maximum time (which is their optimal time of staying in the market) they are willing to search for jobs, after which, if still unemployed, they withdraw from the labor market.

The paper organized as follows: section II provides the theoretical explanation of declining reservation wages and dropouts from the labor market, section III presents empirical results, and section IV concludes.

II. Theoretical Model

Continuous Time, Time Dependent Arrival Rate

Consider a standard search model in the tradition of McCall (1970) and Mortensen (1984). Unemployed workers are identical and live forever. Job offers arrive according to Poisson process. Workers have no information about the wage associated with a job until the offer arrives. The only knowledge they have about wages is they know the parameters of the wage offer distribution $F(w)$, which is assumed to be time-invariant. Once accepted by a firm, workers must immediately reply (accept the job or decline), so no waiting is possible. Once the job is rejected it cannot be recalled. If unemployed, workers earn net value of leisure $b-c$, where b is the value of leisure and c is the search cost (per period). In a standard search model jobs arrive to the unemployed with a time-invariant Poisson arrival rate λ. In this model I introduce a time dependent arrival rate $\lambda(t)$, with $\frac{\mathrm{d}\lambda(t)}{\mathrm{d}t} < 0$ and $\lim_{t\to\infty}\lambda(t) = 0$. This specification means that the longer the search, the less likely is an offer to arrive. The highest possible arrival rate happens at $t = 0$.

The Bellman equation for the optimal value of search can be given as[1]

[1] A simpler version of time dependent reservation wage without assuming the Poisson process and therefore not introducing the arrival rate can be found in Kiefer and Neumann (1979).

$$\Omega\left(t\right)=(b-c)\tau+\beta(\tau)\left[\sum_{m=1}^{\infty}q(m,\tau,t)\int_{0}^{\infty}\max[\Omega\left(t\right),W(w)]\,\mathrm{d}\,G(\tilde{w}_m)+q(0,\tau,t)\Omega\left(t+\tau\right)\right]=$$

$$=(b-c)\tau+\beta(\tau)\left[\sum_{m=1}^{\infty}q(m,\tau)\int_{0}^{\infty}\max[0,W(w)-\Omega(t)]\,\mathrm{d}\,G(\tilde{w}_m)+\sum_{m=1}^{\infty}q(m,\tau)\Omega(t)+q(0,\tau,t)\Omega\left(t+\tau\right)\right]$$

(1.1)

In continuous time, i.e. assuming $\tau\to 0$, after some manipulations[2] the equation simplifies to:

$$w^r\left(t\right)=b-c+\frac{\lambda\left(t\right)}{r}\int_{w^r}^{\infty}\left(w-w^r\left(t\right)\right)\mathrm{d}\,F(w)+\frac{\mathrm{d}\,w^r\left(t\right)}{r\,\mathrm{d}\,t} \tag{1.2}$$

Which gives the reservations wage as a function of time. The arrival rate is declining over time and approaches zero in the limit. At $t=\infty$ we assumed $\frac{\mathrm{d}\,\lambda(t)}{\mathrm{d}\,t}=0$, hence:

$$\lim_{t\to\infty}w^r\left(t\right)=b-c \tag{1.3}$$

The time dependent arrival rate specification yields a reservation wage as a decreasing function over time approaching in the limit its lowest value given in (1.3).

[2] Derivations are given in the Appendix 1.1

One must be aware however, that the reservation wage cannot fall below b because a worker has always an option to drop out of the labor force and "earn" pure leisure which is worth b per period[3]. The implication of that is that there is a critical time, denote it as t^*, such that $w^r\left(t^*\right)=b$ and $w^r\left(t>t^*\right)<w^r\left(t^*\right)<w^r\left(t<t^*\right)$. Since $w^r\left(t>t^*\right)<b$ it is not optimal anymore for a worker to search after t^* and t^* is the time at which the worker drops out of the labor market. Figure 1 shows the reservation wage as a function declining with time (red curve) with an asymptote $b-c$. The green line indicates the value of leisure b, which intersects the reservation wage function at t^*. At t^* the worker drops out and receives b. The reservation wage equation can be rewritten as a differential equation:

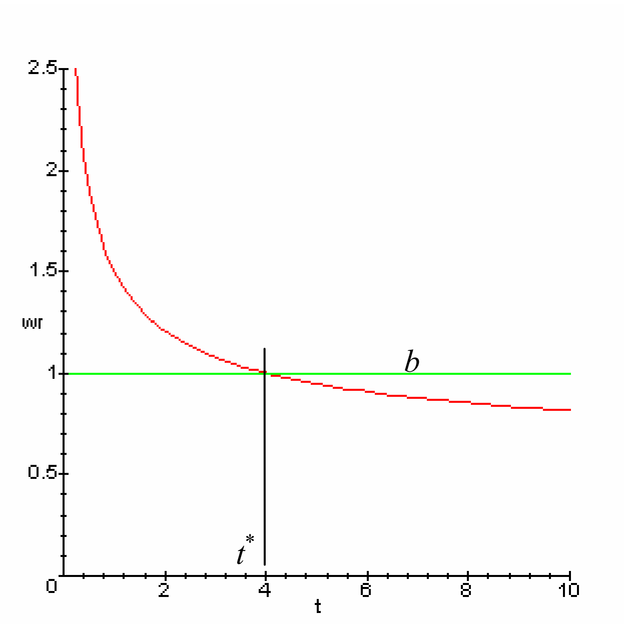

Figure 1.1: The critical drop-out time

$$w^r\left(t\right)=\max\left[b,b-c+\frac{\lambda\left(t\right)}{r}\int_{w^r}^{\infty}\left(w-w^r\left(t\right)\right)\mathrm{d}F(w)+\frac{\mathrm{d}w^r\left(t\right)}{r\,\mathrm{d}t}\right] \qquad (1.4)$$

For a special case $\lambda(t)=\frac{\lambda}{t^2+1}$, $\lambda(0)=\max\left[\lambda(t)\right]=\lambda$ with $\frac{\mathrm{d}\lambda(t)}{\mathrm{d}t}=0$ at $t=0$. Solving (1.4) for $w^r(0)$ for this special case yields[4]:

[3] By staying out of the labor force agents do not sustain the cost c.
[4] See Appendix 1.1

$$w^r(0) = b - c + \frac{\lambda}{r}\int_{w^r}^{\infty}\left(w - w^r(t)\right)\mathrm{d}F(w) \tag{1.5}$$

With this specification, the reservation wage immediately after becoming unemployed is identical to the reservation wage with exogenous arrival rate.

An important implication of this model is that it introduces dropouts into the search model framework. Moreover, it gives alternative explanation to the declining with time reservation wages[5].

Optimal dropout time

The model shows that at time t^*, when an agent drops out of the labor force, his/her reservation wage equals b. Solving the differential equation in (1.4) for w^r and substituting b for w^r gives the solution for optimal dropout time. An astounding result is that the dropout time is not a random variable, it is the *choice* variable for searchers, and is independent of the probability of transition from unemployment into employment. Looking at the figure 1.1 one can see that optimal dropout time is increasing with reservation wages. Hence, exogenous factors which push reservation wage up increase the optimal dropout time.

The comparative statics for the reservation wage are time-dependent in terms of magnitude. However, since the arrival rate is monotonically declining over time and the wage distribution is time-invariant, the comparative statics for the reservation wage in terms of the sign of the effect are the same across all time periods.

[5] For other models see Kifer and Neumann (1979) and Mortensen (1986).

The standard results of the search models[6] are that the reservation wages go up with the mean of the wage offer distribution and with the mean-preserving spread of the wage distribution.

This is true for the symmetric distribution. But what happens if the spread parameters for the left tail of the wage distribution and for the right tail may vary separately? The complication arising here is that changing the spreads in the left and right tail unproportionally will affect the mean. The problem can be handled by introducing the *median-preserving spread*. This implies that:

$$F\left(\overline{w}, \sigma_L, \sigma_R\right) = 1/2\,, \tag{1.6}$$

where $\overline{w}$ is the median wage and σ_L and σ_R are the median-preserving spreads in the left and right tail respectively which can vary freely. Suppose $\sigma_L < \sigma'_L$ and $\sigma_R < \sigma'_R$, then for any arbitrary constants $a < \overline{w}$ and $b > \overline{w}$, the following inequalities hold:

$$\begin{aligned} \int_a^{\overline{w}} F(w, \sigma_L)\,\mathrm{d}\,w &< \int_a^{\overline{w}} F(w, \sigma'_L)\,\mathrm{d}\,w \\ \int_{\overline{w}}^{b} F(w, \sigma_R)\,\mathrm{d}\,w &> \int_{\overline{w}}^{b} F(w, \sigma'_R)\,\mathrm{d}\,w \end{aligned} \tag{1.7}$$

To calculate the comparative statics for median-preserving spreads let for simplicity $b - c = 0$ and $\lambda / r = 1$. This will not change the qualitative results as these variables are exogenous and are independent of the parameters of the wage distribution. Rewrite the equation for the reservation wage:

$$w_r = \int_{w^r}^{\infty} \left(w - w^r\right) \mathrm{d}\,F(w) = \int_{w^r}^{\overline{w}} \left(w - w^r\right) \mathrm{d}\,F(w) + \int_{\overline{w}}^{\infty} \left(w - w^r\right) \mathrm{d}\,F(w) \tag{1.8}$$ [7]

[6] See Mortensen (1984)

[7] If reservation wage is above the median then it will be independent of the spread in the left tail.

Integrating (1.8) by parts one gets:

$$w^r = \frac{1}{2}\left(\overline{w} - w^r\right) - \int_{w^r}^{\overline{w}} F(w)\,\mathrm{d}\,w + \int_{\overline{w}}^{\infty} w\,\mathrm{d}\,F(w) - \frac{1}{2}w^r \tag{1.9}$$

Define an implicit function $\Psi\left(w^r, \sigma_L, \sigma_R\right)$, so that:

$$\Psi\left(w^r, \sigma_L, \sigma_R\right) = 2w^r - \frac{\overline{w}}{2} + \int_{w^r}^{\overline{w}} F(w)\,\mathrm{d}\,w - \int_{\overline{w}}^{\infty} w\,\mathrm{d}\,F(w) = 0 \tag{1.10}$$

By the means of the implicit function theorem $\frac{\mathrm{d}\,w^r}{\mathrm{d}\,x} = -\frac{\partial\Psi\left(w^r, \sigma_L, \sigma_R\right)/\partial x}{\partial\Psi\left(w^r, \sigma_L, \sigma_R\right)/\partial w^r}$.

Hence, $\frac{\mathrm{d}\,w^r}{\mathrm{d}\,\sigma_L} < 0$, $\frac{\mathrm{d}\,w^r}{\mathrm{d}\,\sigma_R} > 0$, and $\frac{\mathrm{d}\,w^r}{\mathrm{d}\,\overline{w}} > 0$.[8]

These results show that when higher inequality in the left tail of the distribution leads to reduction in reservation wages, which would make the agents leave the labor market earlier.

III. Empirical results

For the empirical testing of the implications of the search model with declining arrival rate I took the 2% random sample from the employment register of the Federal Labor Office (IAB-REG). The data set covers the years 1975 to 2001 for the old- and 1992 to 2001 for the new laender. The dataset contains employees in the private sector who are obliged to pay social insurance contributions and registered unemployed receiving unemployment benefits. The data provides the information on the beginning and end of the unemployment spell. The end of the spell for the unemployed means in the dataset the time when the unemployed stopped receiving the unemployment benefits. As it was

[8] Derivations are given in the Appendix 1.2

already discussed in the literature[9], the IABS sample contains only information on the unemployed who receive unemployment benefits so those unemployed who do not receive benefits are not observed in the sample. In Fitzenberger and Wilke (2004) the authors provide an alternative measure of unemployment which they call nonemployment. However, as the authors themselves note this indicator contains those out of the labor force and thus overestimates real unemployment.

The purpose of this paper is to analyze exits from unemployment into nonparticipation. In this respect nonemployment is problematic as in this case it is not possible to identify whether a person is unemployed or out of the labor force, which is crucial in this analysis. To define the exits into nonparticipation I use the information on the reason why an unemployed stopped receiving benefits. The data have an indicator "not available to the labor market". So the length of the spell until withdrawal would be defined as the length from the beginning of the unemployment spell until the worker becomes "unavailable to the labor market"; all other spell treated as censored. I restricted the analysis to the last three years in the data (1999-2001). I confined estimation only for the intermediate skill group[10], which comprises about 65% of the sample. This leaves in total 255193 observations, out of which 14779 are uncensored.

From the sample on employed workers on a "Stichtag"[11] I calculated regional median wages and the ratios of 8^{th} to 5^{th} decile (D8D5 ratio) and 5^{th} to 2^{nd} (D5D2) decile for the intermediate skill group separately for female and male and separately for each year for each county[12]. I constructed dummies for three regional types.[13]

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[9] See Wilke (2004) and Fitzenberger and Wilke (2004)
[10] Workers having completed an apprenticeship but having no formal university education.
[11] 30^{th} of June for each year
[12] NUTS3 level (Kreise)

The functional relationship set by the theoretical model is rather complex so I choose the log-normal relationship between the dropout time and the set of covariates.[14] The empirical relationship has the following form:

$$\ln t_{iR}^{*} = c + x_i'\beta + z_R'\delta + \varepsilon_{iR}, \tag{1.11}$$

where x_i denotes the vector of the individual-specific characteristics, z_R - vector of the region-specific characteristics and t_{iR}^{*} is the length of the spell until withdrawal from the labor market for individual i in region R and ε_{iR} is the error term which assumed to be normally distributed.

The set of covariates include: the regional log median wage and D8/D5 and D5/D2 ratios, a gender dummy, log age and two regional dummies. Tables 1-7 present the results of the censored regression. The standard errors are corrected for clustering due to the Moulton's problem[15]. Since some individuals have several spells it is possible to account for some unobserved heterogeneity. Table 8 gives the results of the random-effects censored panel regression.

Contrary to the expectations, the results in tables 1 and 2 do not find any significant effect of regional wages on the optimal search time. However, the effect of inequality in the lower tail of the distribution is negative and highly significant as predicted by the theoretical model. Dispersion in the upper tail of the wage distribution is positive and highly significant which is in line with theory.

To get a clearer view of the effect of wages on search time I split the data into three age groups: $20 \le age1 < 30$, $30 \le age2 < 40$, and $40 \le age3 < 55$. Separate regressions were

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[13] Description provided in the Appendix 3

[14] Kernel density plot given in Appendix 2.1 shows that log-normal distribution can fairly describe the process

[15] Moulton (1990)

run for each age group. The results are presented in tables 3-7. It appears to be that for the younger age group (20-30 years) there is no significant difference in behavior between men and women. The effect of wages for this age group is positive and highly significant. The magnitude of the effect of regional wages is twice as large as without splitting into age groups, thus indicating that for the workers at their early search stages wages have very strong influence on their reservation wages. Inequality in the left tail has a strong positive effect suggesting thereby positive relationship between dispersion in the left tail of the wage distribution and reservation wages. Surprisingly, inequality in the right tail seems to produce no significant effect on search behavior of young workers. The unemployed in East Germany stay active in the labor market longer than their Western counterparts (controlling for other factors). It is hard to say why it is so. It could be due to more active governmental programs in the East or could be due to the "hysteresis" phenomenon.[16] The longest search spells correspond to core cities (with their surroundings) whereas the shortest spells are for the rural areas. There is no big difference between rural areas and central cities (with their vicinities). This could be explained by higher employment opportunities in the core cities (higher arrival rates).[17] For the middle age group there is gender difference in search behavior. Women seem to drop out earlier than men. This could probably be explained by maturity leaves or also by higher non-labor opportunities (household managing, raising children). The coefficient for the East Germany is almost twice as large as for the young age group. So the difference in search patterns between East and West is even more prominent for this

[16] Aldashev and Möller (2005) reported higher participation rates in East Germany compared to the West controlling for other factors.

[17] Unfortunately I don't have information on vacancies so to control for the difference in the arrival rates across regions.

age group. Inequality in the left and right tail of the wage distribution is highly significant for this age group. However, wages seem to play no role. There is no difference among regional types as well. I re-estimate the model for the middle age group excluding the regional type dummies. The results are given in table 6. Now wages appears to be significant at 6% level. But the coefficient is much lower than for the young workers! For the age group 40-55 years no significant effect of wages and inequality in the right tail of the distribution is observed. The gender difference is highly significant thought the magnitude is less than for the middle age group. Interestingly the magnitude of the coefficient for the dispersion in the lower tail of the wage distribution does not vary much across age groups! The difference in search pattern between East and West is highly significant for this age group as well although the magnitude is lower than for the young workers and middle age workers. Family status seems to play a role for the elderly age workers but not for other age groups. Regional variations are also highly significant. People seem to search longer in the core cities. The shortest spells are observed for the rural areas.

Random effect censored panel produced much similar coefficients as the simple censored regression. There is slight improvement in the efficiency of the estimates for the individual specific variables. Regional specific variables (regional wage and inequalities) cannot be directly compared as the censored panel did not account for clustering. Hence, the standard errors for these coefficients in the panel regression are downward biased.

IV. Conclusions

The search theoretical model with declining arrival rates over time provides an explanation for exits of the unemployed workers from the labor force. It is also shown that the implications of the standard search theory need to be reconsidered once the wage distribution is non-symmetrically and unproportionately dispersed in tails. The model shows that higher inequality in the lower tail of the wage distribution results in lower reservations wages, which has not yet been considered in the search literature.

The theory predicts longer spells of search activity at higher wages and higher inequality in the upper tail of the wage distribution and shorter spells of search activity at higher inequality in the lower tail of the wage distribution. Empirical results corroborate the implications of the theoretical model. Another major finding is the difference in the search behavior between East and West Germany. Controlling for other factors, East Germany exhibits longer spells of labor activity, which could indicate some persistence in behavior. The results find variation in search behavior across age groups. For young workers no gender differences in search behavior are observed. However, there are substantial differences across regional types. Workers stay active longer in core cities. It seems that for young aged workers wage is an important determinant of the search activity. For middle aged workers the effect of wage is less significant. There is also virtually no difference with respect to regional type. For workers above 40 wages do not seem to play a crucial role. But there is a significant difference across regional types. The effect of dispersion in the lower tail of the wage distribution is negative and significant for all age groups in all models.

Some problems concerning data still remain. On of these is the definition of unemployment as the data provide information only on the unemployed receiving unemployment benefits. The other concerns the measurement errors in defining exits into nonparticipation. Finding suitable proxies for formal unemployment and nonparticipation remains an area for future research.

Appendix 1.1

Collecting terms in equation (1.1) yields:

$$\begin{aligned}\Omega(t)-\Omega(t+\tau)&=(b-c)\tau+\beta(\tau)\sum_{m=1}^{\infty}q(m,\tau)\int_{0}^{\infty}\max[0,W(w)-\Omega(t)]g(\tilde{w}_m)dw+\\&+\beta(\tau)\sum_{m=1}^{\infty}q(m,\tau)\Omega(t)+\beta(\tau)q(0,\tau,t)\Omega(t+\tau)-\Omega(t+\tau)\end{aligned} \tag{2.1}$$

Note that $\beta(\tau)=e^{-r\tau}$ and $q(0,\tau,\lambda)=e^{-\lambda(t)\tau}$, hence one could simplify equation (2.1):

$$\begin{aligned}\Omega(t)-\Omega(t+\tau)&=(b-c)\tau+\beta(\tau)\sum_{m=1}^{\infty}q(m,\tau)\int_{0}^{\infty}\max[0,W(w)-\Omega(t)]g(\tilde{w}_m)dw+\\&+\beta(\tau)\sum_{m=1}^{\infty}q(m,\tau)\Omega(t)-\Omega(t+\tau)\left(1-e^{-r\tau}e^{-\lambda(t)\tau}\right)\end{aligned} \tag{2.2}$$

Moreover:

$$\begin{aligned}&\lim_{\tau\to 0}\left[\frac{\Omega(t+\tau)-\Omega(t)}{\tau}\right]=\frac{\mathrm{d}\Omega(t)}{\mathrm{d}t};\\&\lim_{\tau\to 0}\frac{q(1,\tau,\lambda)}{\tau}=\lambda(t);\qquad \lim_{\tau\to 0}\frac{q(m,\tau,\lambda)}{\tau}=0,\ \text{ for } m>1\\&\lim_{\tau\to 0}\frac{\left(1-e^{-r\tau}e^{-\lambda(t)\tau}\right)}{\tau}=r+\lambda(t);\end{aligned} \tag{2.3}$$

Hence, dividing (2.2) by τ and collecting terms yields:

$$\begin{aligned}-\frac{\mathrm{d}\Omega(t)}{\mathrm{d}t}&=b-c+\lambda(t)\int_{0}^{\infty}\max[0,W(w)-\Omega(t)]\,\mathrm{d}F(w)+\\&+\lambda(t)\Omega(t)-\Omega(t)\left(\lambda(t)+r\right)=\\&=b-c+\lambda(t)\int_{0}^{\infty}\max[0,W(w)-\Omega(t)]\,\mathrm{d}F(w)-\Omega(t)r\end{aligned} \tag{2.4}$$

Remembering that $\Omega(t)r=w^r(t)$ we can rewrite (2.4) as:

$$w^r(t)=b-c+\frac{\lambda(t)}{r}\int_{w^r}^{\infty}\left(w-w^r(t)\right)\mathrm{d}F(w)+\frac{\mathrm{d}w^r(t)}{r\,\mathrm{d}t} \tag{2.5}$$

or:

$$\frac{\mathrm{d}\,w^r(t)}{\mathrm{d}t} = -r(b-c) - \lambda(t)\int_{w^r}^{\infty}\left(w - w^r(t)\right)\mathrm{d}\,F(w) + rw^r(t) \tag{2.6}$$

At $t = 0$ $\lambda(t)$ assumes its maximum value and $\frac{\mathrm{d}\lambda(t)}{\mathrm{d}t} = 0$ at $t = 0$. Hence, $\frac{\mathrm{d}\,w^r(t)}{\mathrm{d}t} = 0$

at $t = 0$ and $w^r(0)$ simplifies to:

$$w^r(0) = b - c + \frac{\lambda}{r}\int_{w^r}^{\infty}\left(w - w^r(0)\right)\mathrm{d}\,F(w) \tag{2.7}$$

Appendix 1.2

The implicit function given in (1.10):

$$\Psi\left(w^r, \sigma_L, \sigma_R\right) = 2w^r - \frac{\overline{w}}{2} + \int_{w^r}^{\overline{w}} F(w)\,\mathrm{d}\,w - \int_{\overline{w}}^{\infty} w\,\mathrm{d}\,F(w) = 0 \tag{3.1}$$

$$\frac{\partial\Psi\left(w^r, \sigma_L, \sigma_R\right)}{\partial w^r} = 2 - F\left(w^r\right) > 0 \tag{3.2}$$

Hence, $\mathrm{sign}\left(\frac{\mathrm{d}\,w^r}{\mathrm{d}\,x}\right) = -\mathrm{sign}\left(\frac{\partial\Psi\left(w^r, \sigma_L, \sigma_R\right)}{\partial x}\right)$

The following result would necessary:

$$\frac{\partial}{\partial\overline{w}}\int_{\overline{w}}^{\infty} w\,\mathrm{d}\,F(w) > 0 \text{ and } \frac{\partial}{\partial\overline{w}}F(w) < 0 \tag{3.3}$$

This can be explained by the fact that shifting the median does not change the probability mass above the median (by the definition of the median) but this reassigns more probability mass to higher wages. In some way this is analogous to the truncated mean. Differentiating the implicit function with respect to the median yields:

$$\frac{\partial \Psi\left(w^r, \sigma_L, \sigma_R\right)}{\partial \overline{w}} = -1/2 + 1/2 + \int_{w^r}^{\overline{w}} \frac{\partial}{\partial \overline{w}} F(w)\,\mathrm{d}\,w - \frac{\partial}{\partial \overline{w}} \int_{\overline{w}}^{\infty} w\,\mathrm{d}\,F(w) = \\ = \int_{w^r}^{\overline{w}} \frac{\partial}{\partial \overline{w}} F(w)\,\mathrm{d}\,w - \frac{\partial}{\partial \overline{w}} \int_{\overline{w}}^{\infty} w\,\mathrm{d}\,F(w) < 0 \tag{3.4}$$

By the means of (3.3).

And differentiating the implicit function with respect to the spread in the left tail yields:

$$\frac{\partial \Psi\left(w^r, \sigma_L, \sigma_R\right)}{\partial \sigma_L} = \frac{\partial}{\partial \sigma_L} \int_{w^r}^{\overline{w}} F(w)\,\mathrm{d}\,w > 0, \tag{3.5}$$

By the means of (1.7).

Differentiating the implicit function with respect to the spread in the right tail yields:

$$\frac{\partial \Psi\left(w^r, \sigma_L, \sigma_R\right)}{\partial \sigma_R} = \frac{\partial}{\partial \sigma_R} \int_{\overline{w}}^{\infty} w\,\mathrm{d}\,F(w) > 0, \tag{3.6}$$

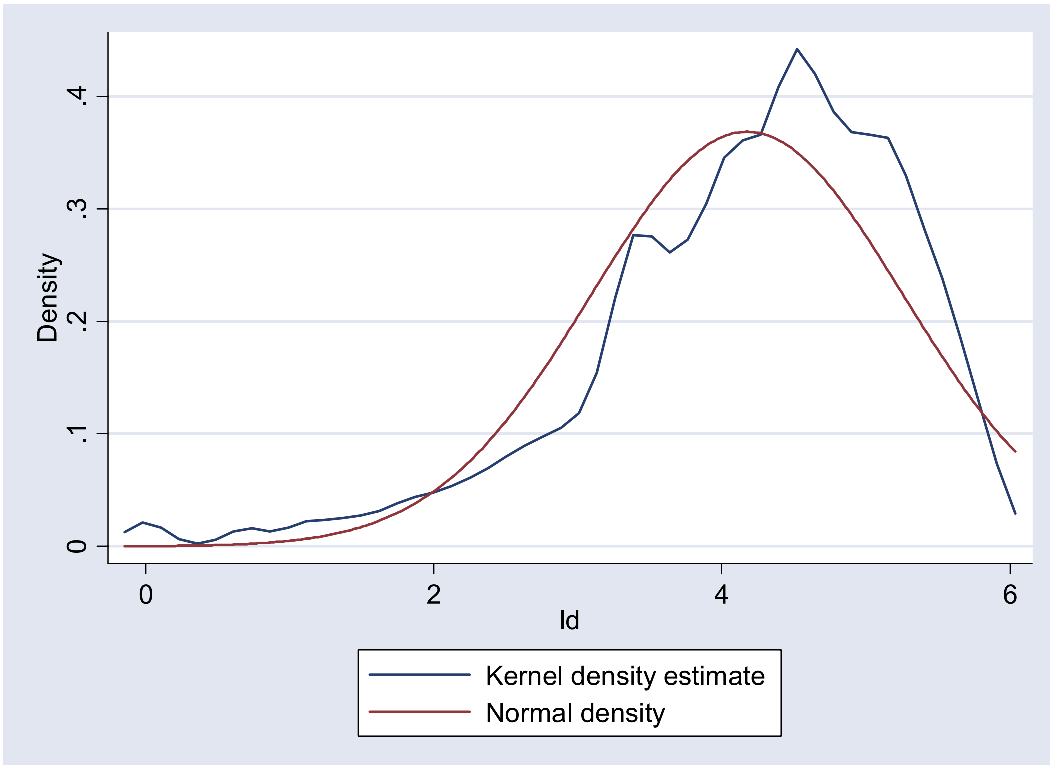
The result in (3.6) is straightforward as the higher spread in the right tail would mean taking away probability mass from lower wages and redistributing this probability mass to the higher wages.[18]

As a result $\frac{\mathrm{d}\,w^r}{\mathrm{d}\,\sigma_L} < 0$, $\frac{\mathrm{d}\,w^r}{\mathrm{d}\,\sigma_R} > 0$, and $\frac{\mathrm{d}\,w^r}{\mathrm{d}\,\overline{w}} > 0$.

[18] Think of the truncated mean

Appendix 2.1

Kernel density plot (log search spell until dropout vs. normal distribution)



Appendix 2.2 (tables)

Table 1. Optimal withdrawal time (logs) (all significant at 5% level)
(drops – unemployed are not available to the labor market)

variable	coefficient	robust stand. error
sex	-0.22871	0.063315
east	0.28156	0.048572
log wage	0.204157	0.138328*
log age	1.011733	0.05195
d5d2	-0.14891	0.037798
d8d5	0.525799	0.215342
k1	0.105392	0.039839
k4	-0.00638	0.033591*
constant	3.625671	0.756845
sigma	2.246548	0.017349

* - insignificant
14779 uncensored observations
240414 right-censored observations

Table 2. Optimal withdrawal time (logs) (all significant at 5% level)
(drops – unemployed are not available to the labor market)

variable	coefficient	robust stand. error
sex	-0.21886	0.063915
east	0.275733	0.048845
log wage	0.195922	0.138963*
log age	1.088065	0.051803
d5d2	-0.15042	0.037784
d8d5	0.544954	0.215848
fam status	-0.11939	0.022142
k2 and k3	-0.10293	0.03957
k4	-0.10897	0.045682
constant	3.519215	0.765415
sigma	2.245412	0.017316

* - insignificant
14779 uncensored observations
240414 right-censored observations

Table 3. Optimal withdrawal time (logs) (all significant at 5% level), age group: 20-30 years
(drops – unemployed are not available to the labor market)

variable	coefficient	Robust stand. error
sex	-0.03357	0.080703*
east	0.262842	0.052709
d5d2	-0.14813	0.047947
d8d5	0.383422	0.304433*
log wage	0.466127	0.153935
k2 and k3	-0.17171	0.049752
k4	-0.18884	0.05933
constant	5.718641	0.874994
sigma	2.135198	0.025668

* - insignificant
5415 uncensored observations
74465 right-censored observations

Table 4. Optimal withdrawal time (logs) (all significant at 5% level), age group: 30-40 years
(drops – unemployed are not available to the labor market)

variable	coefficient	Robust stand. Error
sex	-0.69019	0.081723
east	0.504208	0.059076
d5d2	-0.15177	0.066041
d8d5	0.944059	0.348254
log wage	0.288971	0.200562*
k2 and k3	-0.03241	0.05825*
k4	0.014482	0.077141*
constant	7.225309	1.158594
sigma	2.449406	0.031919

* - insignificant
3451 uncensored observations
78340 right-censored observations

Table 5. Optimal withdrawal time (logs) (all significant at 5% level), age group: 40-55 years
(drops – unemployed are not available to the labor market)

variable	coefficient	robust stand. error
sex	-0.18486	0.074033
east	0.181106	0.085821
d5d2	-0.12084	0.059132
d8d5	0.190691	0.262083*
log wage	-0.21316	0.223413*
k2 and k3	-0.12748	0.057959
k4	-0.16867	0.067462
constant	9.607217	1.163582
sigma	2.227831	0.022722

* - insignificant
5913 uncensored observations
87609 right-censored observations

Table 6. Optimal withdrawal time (logs) (all significant at 5% level), age group: 30-40 years
(drops – unemployed are not available to the labor market)

variable	coefficient	robust stand. error
sex	-0.68766	0.073951
east	0.504815	0.052992
d5d2	-0.15425	0.06533
d8d5	0.952319	0.345691
log wage	0.296315	0.154088**
constant	7.17773	0.945403
sigma	2.449473	0.031897

** - significant at 6%
3451 uncensored observations
78340 right-censored observations

Table 7. Optimal withdrawal time (logs) (all significant at 5% level), age group: 40-55 years (family status variable added; for other age groups the effect of family status insignificant)
(drops – unemployed are not available to the labor market)

variable	coefficient	robust stand. error
sex	-0.17917	0.075079
east	0.181948	0.088179
d5d2	-0.12757	0.059904
d8d5	0.219297	0.261093*
log wage	-0.22561	0.226776*
k2 and k3	-0.11995	0.057387
k4	-0.15843	0.066908
fam status	-0.17491	0.033223
constant	9.725397	1.177426
sigma	2.223519	0.022758

* - insignificant
5913 uncensored observations
87609 right-censored observations

Table 8. Optimal withdrawal time (logs) (all significant at 5% level), random effects
(drops – unemployed are not available to the labor market)

variable	coefficient	stand. error
sex	-0.22747	0.033463
east	0.281586	0.02982
log age	1.033507	0.030909
d5d2	-0.14775	0.029021
d8d5	0.525184	0.141195
log wage	0.1975	0.085538
k1	0.104573	0.025634
k4	-0.00795	0.02456*
constant	3.536693	0.490982
sigma	2.166862	0.013903
rho	0.04392	

* - insignificant
14779 uncensored observations
240414 right-censored observations

Appendix 3

Regional type dummies:

K1 - Core cities, highly urbanized districts in regions with large agglomerations

K2 and ***K3*** - Urbanized districts in regions with large agglomerations, rural districts in regions with large agglomerations, central cities in regions with intermediate agglomerations, urbanized districts in regions with intermediate agglomerations

K4 - Rural districts in regions with intermediate agglomerations, urbanized districts in rural regions, rural districts in rural regions

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