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Abstract:
A phenomenon observed in many labor markets is that the supply of labor appears to depend on business cycles. In other words, workers who are searching for work become "discouraged" under unfavorable business cycle conditions because they believe that their chances of finding an acceptable job are so small that the costs of searching for work outweigh the benefits from searching. In this paper we present a new theoretical framework for job searching based on aggregate rational expectations, which is then used to analyze separately the discouraged worker effect for married/cohabiting immigrant women from non-Western countries and women born in Norway. The empirical results show that the search cost per unit of time is much higher for women born in Norway than for immigrant women. This means that an immigrant woman facing the same probability of obtaining work as a woman born in Norway is less likely to be discouraged from looking for work than a woman born in Norway. However, the actual expected search cost is ☐ on ave
higher for immigrant women than for women born in Norway. The reason for this is that the probability of obtaining an acceptable job is essentially lower for immigrant women compared to women born in Norway. Consequently, the fraction of discouraged workers is, for some groups, much higher for immigrant women than for women born in Norway, despite the fact that the search costs per unit of time for immigrant women are much lower than those for women born in Norway.

Keywords: Discouraged workers; Aggregate rational expectations; Female immigrants; Labor force participation; Panel data; Random utility modelling.

JEL classification: C33; C35; J21; J22; J61; J64.

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Sammendrag

Et fenomen som observeres i mange arbeidsmarkeder, er at yrkesdeltakingen ser ut til å variere i takt med konjunktursvingningene. Med andre ord virker det som om arbeidssøkere blir «motløse» når konjunkturene er dårlige fordi de tror at sjansene for å finne en akseptabel jobb er så lave at kostnadene knyttet til arbeidssøking overstiger verdien av å lete etter arbeid. I denne artikkelen presenterer vi et nytt teoretisk rammeverk for analyse av jobbsøking, som deretter er anvendt til å analysere «motløs arbeidereffekten». Det er gjennomført separate analyser for gifte/samboende kvinner som har innvandret til Norge fra ikke-vestlige land og for gifte/samboende kvinner født i Norge. De empiriske resultatene viser at estimater for kostnaden pr. tidsenhet av å søke (som representerer pekuniære og psykologiske kostnader) er vesentlig høyere for kvinner født i Norge sammenliknet med innvandrerkvinner. Derimot er forventede kostnader ved arbeidssøking høyere for kvinner født i ikke-vestlige land enn for kvinner født i Norge. Grunnen til dette er at sannsynligheten for å få en akseptabel jobb er vesentlig lavere for kvinner fra ikke-vestlige land enn for kvinner født i Norge. Følgelig er andelen «motløse arbeidere» mye høyere for noen grupper av innvandrerkvinner fra ikke-vestlige land enn for kvinner født i Norge, til tross for at kostnadene per tidsenhet ved å søke arbeid er vesentlig lavere for innvandrerkvinner fra ikke-vestlige land.

1. Introduction

A common phenomenon observed in many labor markets is that the supply of labor appears to depend on business cycles. Workers who are searching for work become “discouraged” under unfavorable business cycle conditions because they believe that their chances of finding an acceptable job are so small that the costs of searching for work outweigh the expected benefits from searching. The size of this effect is seen as depending on the expected search costs. The expected search costs depend on the instantaneous search costs (search costs per unit of time) as well as on the chances of finding an acceptable job. Search costs include monetary as well as psychological costs.

The discouraged worker effect is of interest for at least two reasons. For economies in a boom, discouraged workers provide a hidden source of manpower since they participate to a larger extent in the labor market when chances of getting an acceptable job increase. In contrast, if the economy is in a recession, potential workers withdraw from the labor market and by doing so they reduce observed unemployment.

In a previous paper (Dagsvik et al., 2013) we analyzed the discouraged worker affect among women living in Norway without analyzing separately the behavior of immigrant and non-immigrant women. In this paper we analyze labor force participation and the discouraged worker effect among immigrant and non-immigrant married or cohabiting women. The motivation for comparing these two groups is that the proportion of women in paid work is observed to be significantly lower among immigrant women than it is among women born in Norway and it is of interest to examine why. There are two explanations that have been offered for this phenomenon. Women might decide to search for work but fail to find an acceptable job due to barriers against employment. In Norway many immigrant groups seem to experience particular difficulties when searching for work and the unemployment rate is significantly higher among these groups than it is among women born in Norway, in particular when the economy is in a recession. Many immigrant women are from countries where women are not expected to participate in the labor market and in addition they tend to have more children than Norwegian-born women. Differences in cultural background, then, might be a possible reason for the observed difference in labor supply among immigrant women and women born in Norway. In addition, women may decide voluntarily to stay outside the labor market because the psychological as well as the monetary costs of searching for work are higher than the expected payoff from continuing their search.

In this paper we develop a new search-theoretic framework, based on what we call aggregate rationality, which differs from the approach in Dagsvik et al. (2013). Our new approach allows the individual agent to make errors when assessing the value of search, whereas the restrictions that follow from optimal search are supposed to hold on average (across the population). This type of bounded rationality approach has the advantage of appearing to be more realistic and it leads to a simple expression of the value of search, as a function of search costs and the arrival rate of job offers. From our theoretical approach we derive an empirical model for the probability of participating in the labor force. Based on this model we use micro data to analyze labor force participation and the discouraged worker effect separately for married/cohabiting non-Western immigrants and women born in Norway.

Several studies of the discouraged worker phenomenon are based on macro data (Ehrenberg and Smith, 1988).[1] Empirical studies based on micro data include Ham (1986), Blundell, Ham, and Meghir (1987, 1998), Connolly (1997), Başlevent and Onaran (2003), Bloemen (2005), and Hotchkiss and Robertson (2006), but apart from these there are surprisingly few studies on this phenomenon based on micro data. The present study adds to the sparse evidence from these studies by using micro data from the Norwegian Labor Force Surveys over a fairly long period of time: that is, for each quarter from the second quarter of 1988 to the fourth quarter of 2010. The reason why we focus on married women is that this subgroup of people is most responsive to market incentives because their incomes do not only depend on own labor income but also on income from the husbands.[2]

The empirical results show that the estimated search cost per unit of time is much higher for women born in Norway than for immigrant women. This means that an immigrant woman facing the same probability of obtaining work as a woman born in Norway is less likely to be discouraged from looking for work than the woman born in Norway. However, the fraction of discouraged workers is, for some groups, much higher for immigrant women than for women born in Norway because the estimated expected cost of search is, on average, higher for immigrant women than for women born in Norway because the former group has lower probability of obtaining an acceptable job.

The paper is organized as follows. In the next section the search-theoretic framework is developed. In Section 3 the empirical model is derived. Data issues are the topic of Section 4. In Section 5 we provide

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[1] Some recent studies that have analyzed the discouraged worker issue using macro time series data are Benati (2001), Darby et al. (2001), Vendrik and Cörvers (2009), Österholm (2010), and Emerson et al. (2011). All these studies find significant discouraged workers effects, at least for subgroups in their samples.

[2] To simplify the verbal exposition, we refer to both these types of female as married in the rest of the paper.

estimation results, while in Section 6 we quantify the discouraged worker effect. Section 7 contains derived elasticities and results from counterfactual predictions. The conclusions are provided in Section 8.

2. The theoretical model

This section discusses a novel approach for characterizing the value of search under uncertainty and with bounded rational agents. Although agents may live in a non-stationary environment, we assume that they form their optimal policy as if the environment were stationary. Furthermore, we assume that agents have only fragmentary information about their chances in the labor market and have knowledge only about the unemployment rate for the qualification group they belong to. Also, agents may not be capable of determining the value of search precisely, due to the fact that they may be unsure about the distribution of the utility of future job opportunities.

2.1. The conventional search-theoretic approach

For the sake of comparison it may be useful to start with a short review of the traditional search-theoretic approach. In this setup, job offers arrive according to a Poisson process with intensity Λ (say). Let U_1 be the present value of search, U_2 the utility of the arriving job offer, and *R* and *C* the interest rate and instantaneous cost of search. The agent is viewed as uncertain about which and when job offers will arrive. However, she is supposed to know *R*, *C*, Λ and the distribution of future values of U_2 conditional on the workers information, $F(u)$. By applying Bellman's optimality principle (Lippman and McCall, 1981, p. 220), it follows that

$$(1+R\Delta t)U_1 = (1-\Lambda\Delta t)U_1 + \Lambda\Delta t\tilde{E}(\max(U_1,U_2)) - \Delta tC + o(\Delta t)$$

where Δt is a small time change and $\tilde{E}$ denotes the expectation operator conditional on the information of the agent. From this relationship it follows that

$$(\Lambda + R)U_1 = \Lambda\tilde{E}\max(U_1,U_2) - C \tag{2.1}$$

which can also be expressed as

$$U_1 R = \Lambda\int_{U_1}^{\infty}(1-F(u))du - C. \tag{2.2}$$

In principle, one can solve (2.2) for U_1 as a function of *R*, *C*, Λ and $F(\cdot)$. The application of (2.2) in empirical analysis poses, however, several problems. First, the econometrician does not know the information set of the agent, or the distribution function $F(u)$. This distribution function may vary across agents because the information set may be individual-specific. Second, the agent may use a highly subjective arrival rate, Λ, and search cost, *C*, when computing U_1. Third, the restriction represented by the integral equation in (2.2) is cumbersome to work with. Fourth, perfect rational behavior, as represented by (2.2), may not hold because, as indicated above, the agent may have difficulties assessing the precise value of U_1 – as represented by (2.2), even if she knew perfectly the search cost, job offer arrival rate, the interest rate and the conditional c.d.f. of the utility of the arriving job offers.

Finally, a recent laboratory study by Brown et al. (2011) seems to cast serious doubt on conventional search theory. They have found that despite the stationarity of the agent's environment, there is a strong tendency of subjects in their experiment to lower their value of search U_1 over elapsed time of search. Furthermore, according to their findings it appears that the primary factor determining the time path of reservation wages in their experiments is the uncertain wait.

2.2. The alternative approach based on aggregate rational expectations

The alternative approach we propose here assumes that the individual agent has very limited information about her chances on the labor market and may adjust her arrival rate and distribution of job opportunities as time of search increases. This starting point is consistent with the findings of Brown et al. (2011). Thus, as time goes without the agent receiving an acceptable job offer she may lower her estimate of the job arrival rate and possibly the distribution of U_2. Hence, in this case the search cost and the job offer distribution may depend on elapsed duration of search which we denote *S*. Consequently, in this case with bounded rational behavior (2.1) is replaced by

$$(2.3) \qquad (\Lambda(S)+R)U_1(S)=\Lambda(S)\tilde{E}\max(U_1(S),U_2(S))-C(S)+\psi(S)$$

where $\psi(S)$ represents a possible (non-systematic) deviation from perfect rational behavior, as represented by (2.1), $\Lambda(S)$ and $C(S)$ represent the subjective job arrival rate and search cost, depending on *S*. Here, the subjective expectation operator $\tilde{E}$ may also depend on *S* but this is suppressed in the notation above.

Consider now the situation from the observing econometrician's point of view. The econometrician does not observe the individual and subjective job offer distribution, search costs and interest rates. From her point of view it is convenient to view these variables as stochastic variables in the sense that they vary across the population according to some unknown distributions. Let E_p denote the population expectation operator. That is, E_p is the expectation with respect to the population distribution of $(\Lambda(S), C(S), U_1(S), U_2(S), R)$. It follows from (2.3) by aggregating across the population that

(2.4) $$E_p((\Lambda(S)+R)U_1(S)) = E_p(\Lambda(S)\tilde{E}\max(U_1(S),U_2(S))) - E_pC(S) + E_p\psi(S).$$

The equation in (2.4) is still far to general to be useful in an empirical context. Thus, further plausible restrictions are called for. To this end we shall make further assumptions.

Assumption 1

Equation (2.4) holds with $E_p\psi(S) = 0$. Furthermore, R, $\Lambda(S)$, are independent (with respect to the population distribution).

Note that for a given agent $\Lambda(S)$ and $\varepsilon_1(S)$ will most likely depend on S. For example, it is likely that $\Lambda(S)$ is decreasing in S for a given individual. However, when agents are observed only once in each unemployment spell it may not be unrealistic to assume that $\Lambda(S)$, $U_1(S)$, and $U_2(S)$ are independent, and also that they only depend on S in a non-systematic way.

Assumption 2

The stochastic variables U_0, $U_1(S)$ and $U_2(S)$ have the following structure:

$$U_j(S) = u_j + \theta^{-1}\varepsilon_j$$

for j = 1, 2, and

$$U_0 = u_0 + \theta^{-1}\varepsilon_0$$

where $\{u_j\}$ are deterministic functions, $\{\varepsilon_0, \varepsilon_1, \varepsilon_2\}$ are independent and identically distributed random error terms with a given distribution, and θ is a positive scalar. Moreover, $\{\varepsilon_0, \varepsilon_1, \varepsilon_2\}$ are stochastically independent of S and of $\Lambda(S)$.

The random error terms, $\varepsilon_0, \varepsilon_1$ and ε_2 are supposed to capture the effect of unobservables that may or may not be perfectly known to the agent. These error terms depend on *S* in a non-systematic manner but for simplicity this is suppressed in the notation above. The parameter θ represents the precision of the random error term and θ^{-2} is proportionate to the corresponding variance. Evidently, ε_2 is only known to the agent upon arrival of the associated job offer, as well as factors such as moods and whims, implying that the utilities fluctuate from one moment to the next in a way that cannot fully be predicted by the agent. In order to justify the distributional properties of the random error terms $\{\varepsilon_0, \varepsilon_1, \varepsilon_2\}$, we shall make a further assumption. To this end let Ω be a set consisting of the alternatives "working", "searching for work", and "out of the labor force". Let $B \subset \Omega$ where *B* contains at least two alternatives and let $J(B)$ denote the most preferred alternative in *B*.

Assumption 3

The distribution of the error terms $\varepsilon_0, \varepsilon_1, \varepsilon_2$ *is such that*

$$P(J(\Omega) = j \mid J(\Omega) \in B) = P(J(B) = j)$$

for $j \in B \subseteq \Omega$.

The above relationship states that given that the most preferred alternative belongs to *B*, then the probability of choosing alternative *j* from Ω is equal to the probability of choosing *j* from *B*. Luce (1977) refers to the assumption expressed in (2.5) as a *probabilistic rationality* postulate, and it is in fact equivalent to the property known as Independence from Irrelevant Alternatives (IIA).

Theorem 1

Under Assumptions 1, 2 and 3 it follows that the stochastic error terms $\varepsilon_0, \varepsilon_1, \varepsilon_2$ *are distributed according to the extreme value distribution with c.d.f.*

$$\exp(-\exp(0.5772 - x)) \tag{2.5}$$

for real x. Moreover,

$$\left(1 + \frac{r}{\lambda}\right) u_1 \theta + \frac{c}{\lambda} = \log(\exp(\theta u_1) + \exp(\theta u_2)) \tag{2.6}$$

where $r = E_p R$, $c = E_p C(S)$ *and* $\lambda = E_p \Lambda(S)$. *When* $1 + r / \lambda \cong 1$, *then a closed form solution for* u_1 *is given by*

(2.7) $$\theta u_1 = \theta u_2 - \log(\exp(c/\lambda) - 1)).$$

The proof of Theorem 1 is given in Appendix A. Equation (2.6) determines u_1 uniquely as a function of r, c, λ, and u_2. A great advantage in empirical contexts is that u_1 does not depend on *S* or the individual costs, job offer arrival rates and distribution of the utilities of job offers. Note that the relationship in (2.7) has the intuitively reasonable property that when the mean cost of search $c/\lambda \to 0$, then $u_1 \to \infty$. This property follows because when search costs are small there is no substantial loss of welfare in remaining unemployed. Note that since our theoretical approach is based on aggregate rational expectation, there are no further restrictions on the error terms other than those given in (2.6) or (2.7).

2.3. Choice probabilities

So far we have only considered the distributional properties of the random terms of the utility functions at a given point in time. The next assumption deals with the serial dependence structure of the random error terms.

Assumption 4

The random error terms $\{\varepsilon_{ijt}\}$ have the structure $\varepsilon_{ijt} = \tilde{\varepsilon}_{ijt} + Z_{ij}$, where $\tilde{\varepsilon}_{ijt}$, $j = 0,1,2$, are independent random variables that are serially independent and Z_{ij}, j = 0, 1, are independent random variables that are constant over time and are independent of $\{\tilde{\varepsilon}_{ijt}\}$. The distributions of $\{Z_{ij}\}$ and $\{\tilde{\varepsilon}_{ijt}\}$ satisfy the condition

$$P(J_{it}(\Omega) = j \mid J_{it}(\Omega) \in B, \{Z_{ir}\}) = P(J_{it}(B) = j \mid \{Z_{ir}\})$$
for $j \in B \subseteq \Omega$.

Similarly to Assumption 3, Assumption 4 is an assertion about conditional probabilistic rationality given the random effects, and it is equivalent to IIA, conditional on $\{Z_{ij}\}$. In fact, the conditional probabilistic rationality property asserted in Assumption 4 seems more reasonable than the corresponding unconditional statement in Assumption 3. This is so because it is well known that even if IIA holds at a disaggregate level it may not hold at a more aggregate level. Taken together one could express the assertion of Assumptions 3 and 4 as a statement that probabilistic rationality being invariant under aggregation of unobservables.

Theorem 2

Assume that Assumptions 2, 3 and 4 hold. Let $Z_i = Z_{i0} - Z_{i1}$. Then $\tilde{\varepsilon}_{ijt}$ has the same distribution as $\alpha\varepsilon_{ijt}$. Furthermore

(2.8) $$P(U_{i1t} > U_{i0t} \mid Z_i) = \frac{1}{1+\exp(\theta\alpha^{-1}u_{i0t} - \theta\alpha^{-1}u_{i1t} + \alpha^{-1}Z_i)}$$

And

(2.9) $$P(U_{i1t} > U_{i0t}) = \frac{1}{1+\exp(\theta u_{i0t} - \theta u_{i1t})}$$

where α is a parameter, $0 < \alpha \le 1$, that is related to the variance by

(2.10) $$VarZ_i = \left(1-\alpha^2\right)\frac{\pi^2}{3}.$$

The random effect Z_i has p.d.f. $f(z)$ defined on $(-\infty,\infty)$ and given by

(2.11) $$f(z) = \frac{1}{\alpha\pi}\cdot\frac{\sin(\alpha\pi)}{e^z + e^{-z} + 2\cos(\alpha\pi)}.$$

The proof of Theorem 2 is given in Dagsvik (2016) but in order to make this paper self-contained it is reproduced in Appendix A.[3] The distribution of $Z_i\alpha^{-1}$ is symmetric around zero and has variance that increases without bounds as $\alpha \to 0$. The distribution has more mass close to the origin than a corresponding normal distribution. In Figure A1 in Appendix A we have plotted the probability density of $Z_i\alpha^{-1}$ for $\alpha = 0.5$. From (2.10) we note that the variance of Z_i decreases toward zero as α approaches 1. Thus, the parameter α is an alternative measure of the dispersion of the random effect. Furthermore, it is easy to show that the structure of the error terms implies that

[3] The results in Theorem 2 are related to results obtained by Cardell (1997). He proves that if the random effect is distributed as in (2.9) then (2.9) follows from (2.8).

$$Corr(\varepsilon_{ijt}, \varepsilon_{ijs}) = 1 - \alpha^2.$$

It is interesting to note that under the above assumption of aggregate rational expectations, information about expected search costs computed by using the arrival rate of job offers can be achieved by using the arrival rate of acceptable job offers. To see this let μ be the intensity of acceptable job offers. We have

(2.12) $$\mu = \lambda P(U_2 > U_1) = \frac{\lambda}{1 + \exp(\theta u_1 - \theta u_2)}.$$

When inserting for u_1 given by (2.7) into (2.12) we obtain

(2.13) $$\frac{c}{\mu} = \frac{c / \lambda}{1 - \exp(-c / \lambda)}.$$

It is easy to show that the right-hand side of (2.13) is strictly increasing in $c / \lambda.$ The relation in (2.13) shows that there is a one-to-one correspondence between c / μ and $c / \lambda.$ Note that when c / λ is large, (2.7) and (2.13) imply that

(2.14) $$\theta u_1 \cong \theta u_2 - c / \lambda \cong \theta u_2 - c / \mu.$$

3. Empirical model

In this section it is convenient to introduce indexation of time and individuals. Let q_{it} denote the probability that individual *i* shall receive an acceptable job offer at time *t*. In most cases the individuals do not have information about the arrival intensity of acceptable jobs, $\mu.$ They have, at most, information about the unemployment rate for specific groups. This observation motivates the next assumption.

Assumption 5

The average expected search cost is approximately equal to $(q_{it}^{-1} - 1)\tilde{c}$ where $\tilde{c}$ is a constant.

The implication of Assumption 5 is that (2.14) is approximated by the relation

(3.1) $$\theta u_{1it} = \theta u_{2it} - \tilde{c}(q_{it}^{-1} - 1).$$

The relation in (3.1) has the plausible property that the expected search cost is zero when q_{it} = 1.

Assumption 6

The value of an arriving job offer is given by

(3.2) $$U_{i2t} = \log W_{it} + \eta_{it}$$

where W_{it} is the agent-specific wage rate, while η_{it} is a term that is supposed to account for the value of non-pecuniary attributes associated with the job offer. The wage equation is given by

(3.3) $$\log W_{it} = \beta_{0t} + X_{it}\beta + \delta_{it}$$

where the intercept β_{0t} may depend on time, X_{it} is a vector of covariates containing length of schooling, potential experience, and potential experience squared and δ_{it} is a random term with zero mean. The systematic part of the utility of being out of the labor force is given by

(3.4) $$u_{i0t} = -V_{it}\gamma$$

where V_{it} is a vector containing 1, age, age squared, real non-labor income, the number of children aged 0–3 years, the number of children aged 4–6 years, and the number of children aged 7–18 years. The probability q_{it} is a logit function depending on a vector of covariates containing 1, length of schooling, potential experience, and potential experience squared, duration of stay, real non-labor income and time dummies.

As usual, potential experience is defined as age minus length of schooling minus 7. For non-Western women we also include a second-order polynomial in duration of stay in the wage equation, while for women born in Norway we include a dummy for urbanity.

It follows from (3.2) that U_{i2t} can be interpreted as the modified wage rate, where the modification is due to other attributes of the job than salary. The wage equation in (3.3) is introduced to allow us to predict wage rates for those women who do not work. Both δ_{it} and η_{it} are supposed to capture the effects of unobservables and are therefore perceived as random variables by the researcher. It follows from (3.2) and (3.3) that we can write

$$U_{i2t} = \log W_{it} + \log \eta_{it} = \beta_{0t} + X_{it}\beta + \delta_{it} + \log \eta_{it} = \beta_{0t} + X_{it}\beta + \theta^{-1}\varepsilon_{i2t}$$

where ε_{i2t} has the interpretation as $\varepsilon_{i2t} = \theta\left(\delta_{it} + \log \eta_{it}\right).$ Recall that ε_{i2t} is assumed to follow the c.d.f. given in (2.5). Hence the above equation implies that

(3.5) $$u_{i2t} = \beta_{0t} + X_{it}\beta.$$

Since the number of observations in the respective subgroups of individuals in the labor force is rather small the logit model for q_{it} is introduced in order to obtain more reliable predictions than the corresponding observed fractions.

From Theorem 2 and Assumptions 5 and 6 it follows that

(3.8) $$\tilde{P}_{it}(Z_i) \equiv P(U_{i1t} > U_{i0t} \mid Z_i) = \frac{1}{1 + \exp(-\theta\alpha^{-1}(\beta_{0t} + X_{it}\beta - V_{it}\gamma) + \theta\alpha^{-1}\tilde{c}(1/q_{it} - 1) + \alpha^{-1}Z_i)}.$$

Furthermore, it follows from the analysis above that

(3.9) $$P_{it} \equiv E\tilde{P}_{it}(Z_i) = P(U_{i1t} > U_{i0t})$$

$$= P(\theta(\beta_{0t} + X_{it}\beta) - \tilde{c}(1/q_{it}) - 1) + \varepsilon_{i1t} > -\theta V_{it}\gamma + \varepsilon_{i0t}) = \frac{1}{1 + \exp(-\theta(\beta_{0t} + X_{it}\beta + V_{it}\gamma) + \theta\tilde{c}(1/q_{it} - 1))}.$$

Our sample has a rotating panel structure. In order to express the likelihood function, let $Y_{it} = 1$ if the woman is in the labor force in year *t* and zero otherwise. Consequently, we can write the log-likelihood function as

(3.10) $$L = \prod_i E\left(\prod_t \tilde{P}_{it}(Z_i)^{Y_{it}}(1 - \tilde{P}_{it}(Z_i))^{1-Y_{it}}\,\tilde{P}_{i,t-1}(Z_i)^{Y_{i,t-1}}(1 - \tilde{P}_{i,t-1}(Z_i))^{1-Y_{i,t-1}}\right)$$

where the expectation operator is taken with respect to Z_i. To calculate (3.10) we apply a Monte Carlo simulation approach. That is, we approximate *L* by $\tilde{L}$ given by

(3.11) $$\tilde{L}=\prod_i M^{-1}\sum_{r=1}^{M}\prod_t\left(\tilde{P}_{it}(Z_{ir})^{Y_{it}}(1-\tilde{P}_{it}(Z_{ir}))^{1-Y_{it}}\,\tilde{P}_{i,t-1}(Z_{ir})^{Y_{i,t-1}}(1-\tilde{P}_{i,t-1}(Z_{ir}))^{1-Y_{i,t-1}}\right)$$

where $Z_{ir}, r=1,2,...,M,$ are independent simulated copies of Z_i. For a detailed description of the simulation procedure, see Appendix B.

As previously mentioned, since we do not have precise estimates of q_{it}, we estimate a logit model for q_{it} based on the subsample of women who are in the labor force. An alternative specification would be to use more aggregate versions of the probabilities $\{q_{it}\}$ to represent the women's information about their chances in the labor market. For example, one could use the aggregate unemployment rate as an estimate of $1-q.$ In principle, one could estimate corresponding versions of the model and check which of them are better able to explain the data. However, in our case this seems difficult because the data do not cover a sufficiently long time period to ensure reliable identification of the discouraged worker effect without using variations in q_{it} across individuals.

4. Data

The data are obtained by linking information from the Norwegian Labor Force Surveys (LFS) 1988–2010 with information from the Norwegian Educational Database, the Norwegian Tax Return Registries 1988–1992, the Norwegian Income Registries 1993–2010, and the Population Registry with information about family composition. All registers are linked using a personal identification key.

In the selection of the sample we include only married women aged 25–60 years. In Norway many women give birth to a child around the age of 23 and most women are entitled to paid maternity leave of about one year. A relatively large proportion of women aged less than 25 years are also enrolled in education. By using a lower age limit of 25 years, most of the females in these two groups are omitted from the analysis. The reason for the upper age limit is that most women are working in the public sector and there they are entitled to early retirement schemes at age 62 years.[4] In addition to the selection based on age and marital status, we also exclude women who are disabled or claim that they are unable to work. Self-employed women and women hired in firms run by family members are also excluded.

[4] Norway has an early retirement program for workers. It was introduced for the first time in 1988, originally only for those aged 66 years working in firms that were participating in the program. Today the program covers most workers aged 62−66 years.

Using answers to a wide range of questions in the LFS, we can classify a person as being employed, unemployed, or outside the labor force. People are asked about their position in the labor market during a particular week. For a person to be defined as unemployed, she must not be employed during the survey week, she must have been actively seeking work during the preceding four weeks, and she must wish to return to work within the next two weeks.

Working time is measured as contractual hours of work on an annual basis in both the main and any possible second job. If this information is missing and the respondent is active in the labor market, information about actual working time is used. The Income Registries 1993–2010 are used to obtain information about wage income used in the calculation of hourly wages and non-labor income. In order to cover as many periods of business cycle fluctuations as possible (periods of high and low unemployment rates), we have chosen to extend the period of analysis in excess of the period covered by these registers. For this period—that is, the years 1988–1992—we use the Tax Return Registries to obtain information about wage income. Compared with the Income Registries, these registries do not include very detailed information about different types of income. To ensure time consistency, we have chosen to use a measure of non-labor income that includes salary of the husband as well as stipulated labor income for self-employed husbands even though the Income Registries allow the inclusion of capital income. Nominal hourly wages are measured as labor income divided by (formal) annual working time, as defined above. The nominal hourly wage and non-labor income variables are deflated by using the official Norwegian consumer price index, with 2010 as the base year. The number of children in each household aged 0–3 years, 4–6 years, and 7–18 years *for* the years 1993–2010 are calculated from information in the Income Registries. In addition to income information these registries include sufficient information to determine household composition with respect to adults and children and their age. For the remaining years, 1988–1992, this calculation is based on information from the Population Registry. A potential advantage of using the Income Registries for calculating the number of children is that this source gives the number of children actually living in the household. Education is measured in years of achieved level of schooling.

The Norwegian LFS are quarterly and the sample is rotating. In the estimation of the main model in this paper, we make use of the fact that it is possible to observe a person in the same quarter in two consecutive years. Thus each woman in the sample is observed twice, and by observing women in the same quarter in both years, we avoid problems related to seasonal fluctuations within the year. Note, however, that the sample includes observations from all of the four quarters during a year. The reason we exclude women who can be observed only once is that the behavior of this group of women in the labor market seems to be fundamentally different from that of other women.[5]

The empirical analysis is done separately for women born in Norway and what we refer to as non-Western immigrants. Non-Western immigrants include immigrants born in Eastern Europe, Africa, Asia, and South and Central America. Thus we have excluded immigrants born in Western and Oceanian countries (including Australia) and North America. The reason we exclude these immigrants is that we want to focus on immigrants with a substantially different cultural background compared to those born in Norway.

To predict wages we estimate a wage equation separately for immigrant women and women born in Norway. The specification includes random effects in order to account for unobserved individual heterogeneity, see Table C1 in Appendix C. The predictions of the *q*s are based on the same approach as for wages and essentially the same dataset, but now the logit model is used. By neglecting the panel data design in these estimations, we simplify and assume that the binary outcomes are independent also for observations that are from the same observational unit. As is evident from the estimation results in Table C2 in Appendix C , model specifications are also somewhat different with respect to explanatory variables. Work experience is included only in the specification for women born in Norway, while this variable is replaced by duration of stay for immigrant women. For both groups the sets of explanatory variables are expanded by including the log of the real non-labor income and the number of children aged 0–3 years and 4–6 years respectively.

In total the samples consist of 52,101 women born in Norway and 1,724 immigrant women. Table 1 gives summary statistics for the women for three selected years, while Tables D1–D4 in Appendix D give additional information about the sample: that is, the distribution of women across regions of birth and periods and their transitions in the labor market (for selected years). In addition the appendix also includes information about sample selection in the estimation of the wage- and *q*-relations and summary statistics of the predictions based on the *q*-relation. From Table 1 we notice that there is a positive trend in labor market participation over time for both groups of women. The participation rate is significantly higher for women born in Norway than for immigrant women, while the unemployment rate is significantly higher for immigrant women compared to Norwegian-born women. For both groups of women the mean unemployment rate (defined as the mean of 1- q_{it} of the women in the group in a specific period) shows

[5] One of the most frequent reasons for people not taking part in the LFS is the difficulty of getting in contact with them.

business cycle fluctuations over the years covered by the sample, but the unemployment rate among immigrants is more sensitive to fluctuations than the unemployment rate among women born in Norway.

Table 1. Summary statistics for women born in non-Western countries and women born in Norway. Selected years

	Women born in non-Western countries			Women born in Norway		
Variable	No. of obs.	Mean	Std. dev.	No. of obs.	Mean	Std. dev.
Year 1988						
Age	29	34.6	7.5	2466	40.8	9.1
Education (years)	29	11.7	3.4	2466	10.9	2.4
Experience (years)	29	15.9	8.4	2466	22.9	9.9
# children 0–3 years	29	0.4	0.6	2466	0.2	0.5
# children 4–6 years	29	0.3	0.6	2466	0.2	0.4
# children 7–18 years	29	0.8	1.0	2466	0.8	0.9
Non-labor income[a]	29	249,659	152,529	2466	328,099	153,382
Wage rate[a]	29	111.5	15.0	2466	125.8	12.4
Participation rate	29	0.586	0.50	2466	0.82	0.39
Unemployment rate	17	0.059	0.24	2014	0.022	0.15
Year 1999						
Age	134	37.1	7.3	3796	42.0	9.5
Education (years)	134	12.4	3.3	3796	12.6	2.8
Experience (years)	134	18.6	7.5	3796	23.4	10.4
# children 0–3 years	134	0.4	0.6	3796	0.3	0.5
# children 4–6 years	134	0.2	0.5	3796	0.2	0.5
# children 7–18 years	134	0.9	1.1	3796	0.7	1.0
Non-labor income[a]	134	343,531	185,439	3796	385,643	185,243
Wage rate[a]	134	120.0	16.5	3796	135.3	15.2
Participation rate	134	0.75	0.44	3796	0.91	0.29
Unemployment rate	100	0.060	0.24	3452	0.013	0.11
Year 2009						
Age	220	38.2	8.2	2566	45.1	8.9
Education (years)	220	13.2	3.7	2566	13.7	2.8
Experience (years)	220	18.9	9.2	2566	25.5	10.1
# children 0–3 years	220	0.3	0.6	2566	0.2	0.5
# children 4–6 years	220	0.2	0.4	2566	0.2	0.4
# children 7–18 years	220	0.8	1.0	2566	0.8	1.0
Non-labor income[a]	220	414,091	222,906	2566	515,718	256,768
Wage rate[a]	220	173.8	24.3	2566	207.9	23.1
Participation rate	220	0.868	0.34	2566	0.96	0.19
Unemployment rate	191	0.021	0.14	2470	0.008	0.09

[a] At constant 2010 NOK.

5. Estimation results

Estimation of the participation model requires estimates of the wage equation as well as of the model for the probability of getting an acceptable job offer for each woman. Estimations are done separately for immigrant and non-immigrant women, on samples of employed women observed either once or twice. Tables C1 and C2 in Appendix C report the estimation results for the wage equation and the job offer probability.[6]

In Table 2 we report estimates of the parameters in (3.10) for, respectively, women born in Norway and women born in non-Western countries. From the table we notice that the estimate of α, which represents the strength of serial correlation in the participation decision, is somewhat higher for the women born in non-Western countries than it is for those born in Norway, whereas the estimates of the parameter θ go in the opposite direction. A striking result in Table 2 is how different the estimates of the parameter associated with the discouraged worker effect are between women born in Norway and women born in non-Western countries. The estimate for women born in Norway is more than three times as large as the estimate for women born in non-Western countries. We interpret this finding as being due to different psychological costs. Non-Western immigrant women often come from economies where unemployment is high and accordingly it may be hard to get job offers. They are more used to demanding labor market conditions than women born in Norway, who are used to much more favorable labor market conditions. Consequently, immigrant women who are interested in entering the labor force will not be so easily discouraged as women born in Norway. Also the estimate of the parameter related to real non-labor income deviates notably. This estimate is substantially larger for women born in Norway than it is for women born in non-Western countries. Besides, the estimate for the latter group is on the border of being insignificant at the 5 per cent level. The estimates of the parameters determining the effects of children are fairly equal for the two groups. For women born in Norway the smallest effect is found for children in the oldest age group, whereas for women born in non-Western countries the smallest estimate is found for children in the middle age group.

The model parameterization adopted in this paper differs from the one used in Dagsvik et al. (2013). In order to facilitate comparison of estimates for the model of women born in Norway with the corresponding estimates obtained by Dagsvik et al. (2013), we display comparable estimates in Table E1 in Appendix E (obtained from Table 2). Apart from the estimate of the parameter representing search costs

[6] In a preliminary stage we have used Heckman's two-stage procedure for controlling for self-selection, but we found no significant selection effect.

and non-labor income, the other estimates are quite close. Recall that in this paper we use panel data that are selected in a different way than the sample used by Dagsvik et al. (2013). Also, in contrast to this paper, the analysis of Dagsvik et al. (2013) did not distinguish between women born in Norway and immigrant women. One cannot therefore expect the empirical results to be the same.

Table 2. Empirical results for immigrant women and women born in non-Western countries and women born in Norway

	Women born in non-Western countries		Women born in Norway	
Variable/parameter	Estimate	*t*-value	Estimate	*t*-value
θ	3.011	8.874	4.237	42.195
dw, $\tilde{c}$	0.753	5.103	2.307	14.434
Constant, γ_1	-4.735	-11.981	-4.194	-57.155
Age, γ_2	0.046	2.170	0.019	5.335
$(\text{Age}/10)^2$, γ_3	-0.073	-2.733	-0.040	-9.449
(real non-lab. inc)$\times 10^{-5}$, γ_4	-0.018	-1.956	-0.025	-15.903
No. of children 0-3, γ_5	-0.305	-6.760	-0.199	-28.780
No. of children 4-6, γ_6	-0.072	-2.224	-0.147	-22.804
No. of children 7-18, γ_7	-0.106	-5.236	-0.075	-18.221
α	0.450	13.568	0.344	56.524
No. of obs.	3448		104,202	
No. of obs. units observed twice	1724		52,101	
Log-likelihood	-1424.8		-25562.9	
M	150		150	

6. The discouraged worker effect and barriers against employment

In Dagsvik et al. (2013) a model-based definition of the discouraged worker effect was proposed. This definition goes as follows. For simplicity, denote by $P_{it}(q_{it})$ the probability of labor force participation of worker *i* at time (year) *t* as a function of the probability of getting a job upon search, q_{it}. The probability $P_{it}(1)$ represents the probability of labor force participation under the ideal reference case when $q_{it}=1$. Thus, under this reference case, the probability of worker *i* of being discouraged in year *t* equals $P_{it}(1)-P_{it}(q_{it})$. We define $P_{it}(1)-P_{it}(q_{it})$ as the discouraged effect for individual *i*. This effect depends crucially on the condition that the women's information about their chances of obtaining an acceptable job upon search is, on average, captured reasonably well by the specified probabilities $\{q_{it}\}$. Thus the discouraged worker effect depends on the size of the search cost parameter, $\tilde{c}$, as well as on the size of the probability of getting an acceptable job, q_{it}. In Table 3 we have displayed the overall discouraged worker effect and the employment and labor force participation rates for the two groups of women we are studying. In Tables 4 and 5 we present the corresponding figures for subgroups within immigrant women and women born in Norway, respectively.

Table 3. Observed and predicted participation rates, predicted job probability (*q*), predicted discouraged worker (DW) effect, and predicted employment rate

	Participation rate			q	DW effect	Employment rate
Period	Obs.	Std. dev.	Pred.	Pred.	Pred.	Pred.
Women born in non-Western countries						
1988–1990	0.714	0.032	0.749	0.910	0.050	0.681
1991–1993	0.665	0.024	0.643	0.781	0.163	0.517
1994–1996	0.648	0.020	0.657	0.779	0.159	0.532
1997–1999	0.725	0.023	0.779	0.942	0.035	0.734
2000–2002	0.749	0.022	0.778	0.860	0.073	0.677
2003–2005	0.776	0.018	0.759	0.838	0.095	0.640
2006–2008	0.845	0.014	0.827	0.902	0.043	0.746
2009–2010	0.865	0.019	0.852	0.906	0.036	0.772
1988–2010	0.752	0.007	0.755	0.859	0.086	0.659
Women born in Norway						
1988–1990	0.829	0.003	0.834	0.967	0.044	0.839
1991–1993	0.856	0.002	0.862	0.964	0.041	0.840
1994–1996	0.880	0.002	0.876	0.966	0.037	0.847
1997–1999	0.907	0.003	0.887	0.987	0.013	0.893
2000–2002	0.927	0.003	0.920	0.975	0.020	0.878
2003–2005	0.937	0.002	0.933	0.972	0.019	0.878
2006–2008	0.953	0.002	0.956	0.984	0.008	0.913
2009–2010	0.967	0.003	0.969	0.988	0.004	0.929
1988–2010	0.891	0.001	0.889	0.972	0.028	0.865

From Table 3 we note that the discouraged worker effect is in general much larger for immigrant women than for women born in Norway. For the period 1988–2010 the average discouraged worker effect is about three times as high for women born in non-Western countries (8.6 per cent versus 2.8 per cent) as for women born in Norway. As discussed above, the reason is that although our estimates indicate that the psychological search costs are substantially lower for immigrant women than for women born in Norway, the probability of getting an acceptable job is much lower for immigrant women.

To check the reasonableness of our discouraged worker estimates, let us compare our results with those obtained by Blundell et al. (1998), the paper closest in spirit to our work. Since the unemployment rate in their sample is rather high (between 10 per cent and 13 per cent), it only makes sense to compare their results with ours for immigrant women during years with similar levels of unemployment. The discouraged worker effect is about 6.2 per cent in their sample. In our case the unemployment rate for immigrant women is on average about 14.1 per cent and the corresponding discouraged worker effect is about 8.6 per cent. During 2006–2008 the unemployment rate among immigrant women is about 9.8 per cent and the corresponding discouraged worker effect is about 4.2 per cent. Hence the order of magnitude of the discouraged worker effect among immigrant women is similar to the findings of Blundell et al. (1998).

In Table 4 we have divided immigrant women into 12 subgroups depending on their duration of stay in Norway, their actual education, and their actual age when they participated in the LFS. The last column of the table shows the number of observations in each group in our sample. As regards barriers against employment, we note that the unemployment rate for young immigrant women with a low level of schooling and a short time since arrival (group 1) is high, about 25 per cent decreasing to about 16 per cent for group 6, where time since arrival has increased to 5–10 years and the women are aged 35+. The lowest barrier/unemployment rate among immigrant women is in group 12, which contains women with high education, aged 45+, who have been in Norway for more than 10 years. In contrast, the unemployment rate for women born in Norway is much lower for all levels of education and age. For this group the unemployment rate varies between 1 per cent and 6 per cent.

As discussed earlier, unfortunately the unemployment rate will not capture the full extent of barriers against employment due to the discouraged worker effect. Taking into account both the discouraged worker effect and the unemployment rate in Table 4, about 18 per cent of young immigrant women with a high level of schooling and a short time since arrival would like to work if they could find an acceptable job (group 3), whereas about 30 per cent of young immigrant women with a low level of schooling and a short time since arrival (group 1) would like to work if they could find an acceptable job. The corresponding effect for immigrant women aged more than 40 years with a high level of schooling and a long time since arrival (group 12) is about 5 per cent. Thus we conclude that barriers against employment are substantial for some immigrant women. For Norwegian-born women the barriers are much smaller. About 13 per cent of young women born in Norway with a low level of schooling (group 1) would like to work if they could find an acceptable job. The corresponding figure for young women born in Norway with a high level of schooling is about 3 per cent (group 2). For the two other groups the barriers are quite small.

One factor behind the variation in the difference between employment and participation rates over time is related to the rotating sample survey design underlying the data. The distribution of individual qualifications may vary substantially from one year to the next.

Table 4. Predicted participation rates, predicted job probability (*q*), predicted discouraged worker effect, and predicted employment rate for selected groups. Women born in non-Western countries

Group	Duration of stay (D)	Length of education (E)	Age (A)	Partici-pation	*q*	DW effect	Employ-ment	No. of obs.
1	D ≤ 5	E ≤ 13	A < 35	0.568	0.745	0.169	0.441	405
2	D ≤ 5	E ≤ 13	A ≥ 35	0.641	0.749	0.154	0.495	250
3	D ≤ 5	E > 13	A < 35	0.798	0.846	0.060	0.678	250
4	D ≤ 5	E > 13	A ≥ 35	0.861	0.877	0.036	0.757	108
5	5< D ≤ 10	E ≤ 13	A < 35	0.626	0.797	0.122	0.515	336
6	5< D ≤ 10	E ≤ 13	A ≥ 35	0.733	0.835	0.081	0.619	349
7	5< D ≤ 10	E > 13	A < 35	0.813	0.873	0.048	0.714	137
8	5< D ≤ 10	E > 13	A ≥ 35	0.862	0.903	0.027	0.779	188
9	D > 10	E ≤ 13	A < 40	0.758	0.899	0.045	0.687	470
10	D > 10	E ≤ 13	A ≥ 40	0.821	0.920	0.029	0.758	425
11	D > 10	E > 13	A < 40	0.874	0.948	0.014	0.829	213
12	D > 10	E > 13	A ≥ 40	0.893	0.953	0.011	0.852	317

Table 5. Predicted participation rates, predicted discourage worker effect, and predicted employment rate for selected groups. Women born in Norway

Current group	Length of education (E)	Age (A)	Participation	q	DW effect	Employment	No. of obs.
1	E ≤ 13	A < 35	0.806	0.941	0.080	0.761	17329
2	E ≤ 13	A ≥ 35	0.885	0.974	0.024	0.862	56573
3	E > 13	A < 35	0.929	0.978	0.014	0.909	8808
4	E > 13	A ≥ 35	0.952	0.990	0.005	0.942	21492

7. Elasticities and counterfactual predictions

One way of assessing counterfactual predictions is to compute marginal effects or corresponding elasticities. Following Dagsvifk et al. (2013), we have computed selected quasi-elasticities (Cramer, 2001), defined as follows:

$$E_{W_{it}}^{P_{it}} = \frac{\partial P_{it}}{\partial \log W_{it}} = \alpha\theta P_{it}(1-P_{it})$$

and

$$E_{V_{4it}}^{P_{it}} = \frac{\partial P_{it}}{\partial \log V_{4it}} = -\alpha\theta\gamma_4 V_{4it} P_{it}(1-P_{it})$$

where V_{i4t} is non-labor income (the fourth component of the vector V_{it}) and γ_4 the associated parameter. The quasi-unemployment elasticity is given by

$$E_{(1-q_{it})}^{P_{it}} = \frac{\partial P_{it}}{\partial(1-q_{it})} = \alpha\theta\tilde{c}\, P_{it}(1-P_{it})\frac{1}{q_{it}^2}.$$

In Table 6, we report the mean of the estimated elasticities for women born in Norway and women born in non-Western countries for selected years. The wage elasticity is somewhat higher for women born in non-Western countries than it is for women born in Norway. Note that $P_{it}(1-P_{it})$ attains its maximal value when $P_{it} = 0.5.$ Since labor participation is typically lower for women born in non-Western countries than it is for women born in Norway and the estimate of θ is almost the same for both groups, a lower wage elasticity is obtained for the latter group. Furthermore, since labor participation probability tends to grow over time, the absolute value of the elasticities tends to decrease over time.

The quasi-elasticity with respect to non-labor income is quite small for both groups even though the estimate of the parameters associated with non-labor income is substantially higher for women born in Norway than it is for women born in non-Western countries. The mean quasi-unemployment elasticity is higher for women born in Norway than it is for women born in non-Western countries. Note that the terms $P_{it}(1-P_{it})$ and $1/q_{it}^2$ work in the opposite direction.

Our primary concern in this paper is the discouraged worker effect. The quasi-elasticities of the discouraged worker effect with respect to wage and non-labor income are given by:

$$E_{W_{it}}^{D_{it}} = \frac{\partial P_{it}(1)}{\partial \log W_{it}} - \frac{\partial P_{it}(q)}{\partial \log W_{it}} = \alpha\theta\left[P_{it}(1)(1-P_{it}(1)) - P_{it}(q)(1-P_{it}(q_{it}))\right]$$

and

$$E_{V_{4it}}^{D_{it}} = \frac{\partial P_{it}(1)}{\partial \log V_{4it}} - \frac{\partial P_{it}(q)}{\partial \log V_{4it}} = -\alpha\theta\gamma_4 V_{4it}\left[P_{it}(1)(1-P_{it}(1)) - P_{it}(q)(1-P_{it}(q_{it}))\right].$$

Mean quasi-elasticities for the discouraged worker effects for selected years are reported in Table 7. For both groups of women an increase in the real wage rate decreases the probability of being discouraged. In some periods the effect is stronger for women born in Norway, in other periods it is stronger for women born in non-Western countries. An increase in real non-labor income leads to an increase in the probability of being discouraged. The estimated quasi-elasticities with respect to real non-labor income are quite low for both groups.

An advantage of using a structural approach to labor market participation modeling is that one might make counterfactual calculations for individuals with special characteristics in order to identify the heterogeneity in the effects. In Tables 9 and 10 we do this by reporting predicted probabilities of labor force participation and quasi-elasticities of labor market participation for different types of (hypothetical) individuals. Table 8 is for women born in non-Western countries and Table 9 is for women born in Norway. For women born in non-Western countries we consider 28 different cases, whereas for women born in Norway we consider 36 different cases. In order to reduce the number of simulations and since the quasi-elasticity with respect to non-labor income is quite small for both groups, we set the level of real labor income to 380,000 NOK (at 2010 prices) in all the calculations for immigrants and to 490,000 NOK for most of the calculations for women born in Norway. These values correspond to the median values in our samples used in the estimation of the model. Since the two groups of women also vary systematically with respect to wage rate and job probability, the assumptions being made about the level of these variables also vary systematically in the simulations. Note, then, that for a specific variable (w or q) and for a specific group of women, the lowest value used in the simulations corresponds (approximately) to the first decile in the distribution of that variable in our sample, the highest value is the ninth decile, and the value in the middle is the median value.

Looking at the results in Table 9, we see that for women born in non-Western countries the predicted probabilities of labor market participation vary from 0.267 to 0.995. The lowest probability is found for a woman aged 45 with a wage equal to 100 NOK (at 2010 prices), with five children, where four of the children are in the oldest age group and the last child is in the next oldest age group, and with a job probability (q) of 0.75. The highest predicted probability is found for a childless woman aged 30 years with a predicted wage equal to 350 NOK and with a job probability equal to 0.95. This latter group of women is also the one with the lowest quasi-wage elasticity, whereas one of the cases giving the largest quasi-wage elasticity is women aged 30 years with a wage of 100 NOK, with one child in the youngest age group and with a value of q equal to 0.75. This is tied by a woman aged 45 with a wage of 100 NOK, with two children, one in each of the two oldest child groups, and with a value of q equal to 0.75.

Although showing some variation, the real non-labor income quasi-elasticity is moderate in all cases. The quasi-unemployment elasticity, which is negative in all cases, shows considerable variation. The highest elasticity (in absolute value) is obtained for a 30-year-old woman with a wage of 100 NOK (at 2010 prices), one child in the youngest age group and with a job probability of 0.75. This position is tied by the last-mentioned woman with the largest quasi-wage elasticity. The smallest elasticity (in absolute value) is found for a childless 30-year-old woman with a wage of 350 NOK and a job probability of 0.95.

By comparing the results in Table 8 and Table 9, we notice that the predicted labor force participation probabilities for (hypothetical) women born in Norway are generally at a higher level than those for women born in non-Western countries. The smallest quasi-wage elasticity is found for a childless 30-year-old woman with a real wage equal to 305 NOK (at 2010 prices) and with a job probability of 0.99, whereas the largest quasi-wage elasticity is found for a 30-year-old woman, with an hourly wage equal to 180 NOK and non-labor income equal to 380,000 NOK, with three children, one in each of the age groups, and a job probability of 0.75. All the calculated real non-labor income elasticities are fairly small, varying from -0.001 to -0.123. The predicted quasi-unemployment elasticities vary substantially across the different types of hypothetical women born in Norway. The largest elasticity (in absolute value) is found for a 30-year-old woman with a real hourly wage equal to 180 NOK, with three children, one in each of the age groups. The lowest quasi-unemployment elasticity (in absolute value) is found for a childless woman with a real wage equal to 305 NOK and with a job probability of 0.99.

Table 6. Mean quasi-elasticities of labor market participation probabilities

Year	Women born in non-Western countries			Women born in Norway		
	E_W^P	$E_{V_4}^P$	$E_{(1-q)}^P$	E_W^P	$E_{V_4}^P$	$E_{(1-q)}^P$
1988	0.573	-0.026	-0.561	0.551	-0.045	-1.380
1992	0.563	-0.027	-0.769	0.467	-0.039	-1.175
1996	0.565	-0.029	-0.741	0.426	-0.038	-1.069
2000	0.455	-0.025	-0.501	0.297	-0.029	-0.736
2004	0.448	-0.025	-0.539	0.244	-0.027	-0.608
2007	0.357	-0.026	-0.348	0.176	-0.023	-0.424
2010	0.293	-0.024	-0.282	0.124	-0.017	-0.294

Table 7. Mean quasi-elasticities of discouraged worker effects

Year	Women born in non-Western countries		Women born in Norway	
	E_W^D	$E_{V_4}^D$	E_W^D	$E_{V_4}^D$
1988	-0.053	0.002	-0.114	0.009
1992	-0.077	0.003	-0.109	0.009
1996	-0.101	0.005	-0.099	0.008
2000	-0.086	0.004	-0.065	0.006
2004	-0.103	0.005	-0.060	0.006
2007	-0.053	0.003	-0.024	0.003
2010	-0.051	0.004	-0.014	0.002

Table 8. Participation rates and quasi-elasticities for different types of female immigrants from non-Western countries

Case	Real wage rate[a]	Non-labor income[a]	Age	Number of children aged 0–3 years	Number of children aged 4–6 years	Number of children aged 7–18 years	Probability of getting an acceptable job given search	Probability of labor force participation	Quasi-wage elasticity	Quasi-non-labor income elasticity	Quasi-unemployment elasticity
1	180	380,000	30	0	0	0	0.75	0.933	0.188	-0.013	-0.252
2	180	380,000	30	0	0	0	0.85	0.952	0.137	-0.010	-0.143
3	180	380,000	30	0	0	0	0.95	0.963	0.106	-0.007	-0.089
4	180	380,000	30	1	0	0	0.75	0.847	0.390	-0.027	-0.522
5	180	380,000	30	1	0	0	0.85	0.888	0.300	-0.021	-0.313
6	180	380,000	30	1	0	0	0.95	0.913	0.239	-0.017	-0.200
7	180	380,000	30	1	1	1	0.75	0.764	0.543	-0.038	-0.727
8	180	380,000	30	1	1	1	0.85	0.822	0.440	-0.031	-0.459
9	100	380,000	30	0	0	0	0.75	0.703	0.628	-0.044	-0.842
10	100	380,000	30	0	0	0	0.85	0.772	0.530	-0.037	-0.553
11	100	380,000	30	1	0	0	0.75	0.486	0.752	-0.052	-1.008
12	100	380,000	30	1	0	0	0.85	0.574	0.736	-0.051	-0.768
13	100	380,000	30	1	1	1	0.75	0.356	0.690	-0.048	-0.924
14	100	380,000	30	1	1	1	0.85	0.441	0.742	-0.052	-0.774
15	350	380,000	30	0	0	0	0.85	0.993	0.020	-0.001	-0.021
16	350	380,000	30	0	0	0	0.95	0.995	0.015	-0.001	-0.013
17	350	380,000	30	1	0	0	0.85	0.983	0.050	-0.003	-0.052
18	350	380,000	30	1	0	0	0.95	0.987	0.038	-0.003	-0.032
19	350	380,000	30	1	1	1	0.85	0.972	0.083	-0.006	-0.087
20	350	380,000	30	1	1	1	0.95	0.978	0.064	-0.004	-0.053
21	100	380,000	45	0	1	1	0.75	0.488	0.752	-0.052	-1.008
22	100	380,000	45	0	1	1	0.85	0.576	0.735	-0.051	-0.767
23	100	380,000	45	0	1	4	0.75	0.267	0.589	-0.041	-0.789
24	100	380,000	45	0	1	4	0.85	0.342	0.678	-0.047	-0.707
25	180	380,000	45	0	1	1	0.75	0.848	0.388	-0.027	-0.520
26	180	380,000	45	0	1	1	0.85	0.889	0.298	-0.021	-0.311
27	180	380,000	45	0	1	4	0.75	0.681	0.654	-0.045	-0.876
28	180	380,000	45	0	1	4	0.85	0.753	0.560	-0.039	-0.584

[a] At constant 2010 NOK prices.

Table 9. Participation rates and quasi-elasticities for different types of females born in Norway

Case	Real wage rate[a]	Non-labor income[a]	Age	Number of children aged 0–3 years	Number of children aged 4–6 years	Number of children aged 7–18 years	Probability of getting an acceptable job given search	Probability of labor force participation	Quasi-wage elasticity	Quasi-non-labor income elasticity	Quasi-unemploy-ment elasticity
1	205	490,000	30	0	0	0	0.95	0.990	0.040	-0.005	-0.103
2	205	490,000	30	0	0	0	0.975	0.993	0.031	-0.004	-0.075
3	205	490,000	30	0	0	0	0.99	0.994	0.027	-0.003	-0.063
4	205	490,000	30	1	0	0	0.95	0.978	0.091	-0.011	-0.232
5	205	490,000	30	1	0	0	0.975	0.983	0.070	-0.009	-0.171
6	205	490,000	30	1	0	0	0.99	0.985	0.061	-0.007	-0.143
7	205	490,000	30	1	1	1	0.95	0.946	0.217	-0.026	-0.554
8	205	490,000	30	1	1	1	0.975	0.958	0.171	-0.021	-0.414
9	140	490,000	30	0	0	0	0.95	0.954	0.187	-0.023	-0.478
10	140	490,000	30	0	0	0	0.975	0.964	0.147	-0.018	-0.357
11	140	490,000	30	1	0	0	0.95	0.899	0.385	-0.047	-0.985
12	140	490,000	30	1	0	0	0.975	0.920	0.311	-0.038	-0.753
13	140	490,000	30	1	1	1	0.95	0.777	0.735	-0.090	-1.878
14	140	490,000	30	1	1	1	0.975	0.819	0.628	-0.077	-1.523
15	305	490,000	30	0	0	0	0.975	0.999	0.006	-0.001	-0.014
16	305	490,000	30	0	0	0	0.99	0.999	0.005	-0.001	-0.012
17	305	490,000	30	1	0	0	0.975	0.997	0.013	-0.002	-0.033
18	305	490,000	30	1	0	0	0.99	0.997	0.012	-0.001	-0.027
19	305	490,000	30	1	1	1	0.975	0.992	0.034	-0.004	-0.082
20	305	490,000	30	1	1	1	0.99	0.993	0.029	-0.004	-0.069
21	140	490,000	45	0	1	1	0.95	0.802	0.673	-0.082	-1.721
22	140	490,000	45	0	1	1	0.975	0.841	0.568	-0.069	-1.379
23	140	490,000	45	0	1	4	0.95	0.611	1.007	-0.123	-2.575
24	140	490,000	45	0	1	4	0.975	0.671	0.935	-0.114	-2.269
25	205	490,000	45	0	1	1	0.95	0.953	0.189	-0.023	-0.483
26	205	490,000	45	0	1	1	0.975	0.964	0.148	-0.018	-0.360
27	205	490,000	45	0	1	4	0.95	0.888	0.423	-0.052	-1.081
28	205	490,000	45	0	1	4	0.975	0.911	0.343	-0.042	-0.831

Table 9. (Continued)

Case	Real wage rate[a]	Non-labor income[a]	Age	Number of children aged 0–3 years	Number of children aged 4–6 years	Number of children aged 7–18 years	Probability of getting an acceptable job given search	Probability of labor force participation	Quasi-wage elasticity	Quasi-non-labor income elasticity	Quasi-unemploy-ment elasticity
29	180	380,000	30	0	0	0	0.75	0.812	0.647	-0.061	-2.654
30	180	380,000	30	0	0	0	0.85	0.952	0.192	-0.018	-0.614
31	180	380,000	30	0	0	0	0.95	0.985	0.061	-0.006	-0.157
32	180	380,000	30	1	0	0	0.75	0.651	0.963	-0.091	-3.951
33	180	380,000	30	1	0	0	0.85	0.896	0.395	-0.037	-1.260
34	180	380,000	30	1	0	0	0.95	0.967	0.137	-0.013	-0.350
35	180	380,000	30	1	1	1	0.75	0.422	1.033	-0.098	-4.237
36	180	380,000	30	1	1	1	0.85	0.772	0.747	-0.071	-2.384

[a] At constant 2010 NOK prices.

8. Concluding remarks

In this paper we have analyzed labor force participation and the discouraged worker phenomenon for married immigrant women and married women born in Norway. We have demonstrated that our empirical model is consistent with a search theoretic framework based on aggregate rational expectation. The model is estimated separately for immigrant women from non-Western countries and women born in Norway. According to our estimation results, the two groups differ with respect to the estimate of the search cost per unit of time. Women born in Norway have higher probabilities of getting acceptable job offers, but they also have considerably higher estimated search cost per unit of time compared to immigrant women. A likely explanation for the latter feature is that the environments immigrant women are used to are much more demanding than the Norwegian one, and thus they may be accustomed to using more effort in order to achieve results. In total, however, the proportion of discouraged workers is significantly higher for some groups of immigrant women than for women born in Norway. The reason is that the probabilities of getting an acceptable job are substantially lower for immigrant women compared to women born in Norway.

References

Başlevent, C. and Onaran, Ö. (2003): Are Married Women in Turkey More Likely to Become Added or Discouraged Workers? *Labour*, **17**, 439–458.

Benati, L. (2001): Some Empirical Evidence on the 'Discouraged Worker' Effect. *Economics Letters*, **70**, 387–395.

Bloemen, H. G. (2005): Job Search, Search Intensity, and Labor Market Transitions. An Empirical Analysis. *Journal of Human Resources*, **40**, 231–269.

Blundell, R. and MaCurdy, T. (1999): Labor Supply: A Review of Alternative Approaches. In: Ashenfelter, O, and Card, D. (eds.) *Handbook of Labor Economics*, Vol. 3A. Amsterdam: North-Holland, pp. 1559–1695.

Blundell, R., Ham, J. and Meghir, C. (1987): Unemployment and Female Labour Supply. *Economic Journal*, **97**, 44–64.

Blundell, R., Ham, J. and Meghir, C. (1998): Unemployment, Discouraged Workers and Female Labour Supply. *Research in Economics*, **52**, 103–131.

Brown, M., C. J. Flinn and A. Schotter (2011): Real-Time Search in the Laboratory and the Market. *American Economic Review*, **101**, 948–974.

Cardell, N. S. (1997): Variance Component Structures for the Extreme-Value and Logistic Distributions with Applications to Models of Heterogeneity. *Econometric Theory*, **13**, 185–213.

Connolly, S. (1997): A Model of Female Labour Supply in which Supply is Dependent upon the Chances of Finding a Job. *Applied Economics*, **29**, 1379–1386.

Cramer, J. S. (2001): *An Introduction to the Logit Model for Economists*, 2nd edition. Timberlake Consultants Ltd., London.

Dagsvik, J. K. (2016): The Generalized Extreme Value Model as a Stable Mixture of Conditional Logit Models. Unpublished manuscript, Research Department, Statistics Norway.

Dagsvik, J. K., Kornstad, T. and Skjerpen T. (2013): Labor Force Participation and the Discouraged Worker Effect. *Empirical Economics*, **45**, 401–433.

Darby, J., Hart, R. A. and Vecchi, M. (2001): Labour Force Participation and the Business Cycle: A Comparative Analysis of France, Japan, Sweden and the United States. *Japan World Economy*, **12**, 113–133.

Ehrenberg, R. and Smith, R. (1988): *Modern Labor Economics*: *Theory and Public Policy*, 3rd edition. Scott, Foreman, and Co., London.

Emerson, J. (2011): Unemployment and Labor Force Participation in the United States. *Economic Letters*, **111**, 203–206.

Flinn, C. and Heckman, J. J. (1982): New Methods for Analyzing Structural Models of Labor Force Dynamics. *Journal of Econometrics*, **18**, 115–168.

Ham, J. (1986): On the Interpretation of Unemployment in Empirical Labor Supply Analysis. In Blundell, R., and Walker, I. (eds.) *Unemployment, Search and Labour Supply*. Cambridge University Press, Cambridge, pp. 121−142.

Hotchkiss, J. L. and Robertson, J. C. (2006): Asymmetric Labor Force Participation Decision over the Business Cycle. Federal Reserve Bank of Atlanta, Working Paper 2006-8. July 2006.

Lippman, S. A. and McCall, J. J. (1976): The Economics of Job Search: A Survey, Part I. *Economic Inquiry*, **14**, 155–189.

Luce, D. R. (1977): The Choice Axiom after Twenty Years. *Journal of Mathematical Psychology*, **15**, 215–233.

McFadden, D. (1984): Econometric Analysis of Qualitative Response Models. In: Grililches, Z. and Intriligator, M. D. (eds.) *Handbook of Econometrics*, vol. II. Elsevier Science Publishers BV, New York, pp. 1395–1457.

Österholm, P. (2010): Unemployment and Labor Force Participation in Sweden. *Economic Letters*, **106**, 205–208.

Venders, M. and Cörvers, F. (2009): Male and Female Labor Force Participation: The Role of Dynamic Adjustments to Changes in Labour Demand, Goverrnment Policies and Autonomous Trend. Maastricht University, ROA Research Memorandum 2009/13.

Yellott, J. I. (1977): The Relationship between Luce's Choice Axiom, Thurstone's Theory of Comparative Judgment, and the Double Exponential Distribution. *Journal of Mathematical Psychology*, **15**, 109–144.

Zolotarev, V. M. (1986): *One-dimensional Stable Distributions*. Translations of mathematical monographs, American Mathematical Society, **65**. Translation from the original 1983 Russian edition.

Appendix A

Proof of Theorem 1:

From (2.4) we have that

$$E_p((\Lambda(S)+R)U_1(S)) = E_p(\Lambda(S)\tilde{E}\max(U_1(S),U_2(S))) - E_pC(S) + E_p\psi(S).$$

Recall that $\tilde{E}$ is the conditional expectation operator given the information of the agent. From the law of the iterated expectation we have that $E_p\tilde{E}(\cdot) = E_p(\cdot).$ Hence, we obtain from the above equation and Assumption 1 that

(A.1) $$(\lambda + r)u_1 = \lambda E_p \max(U_1(S),U_2(S)) - c$$

where we recall that $r = E_pR,$ $c = E_pC(S)$, and $\lambda = E_p\Lambda(S).$ Under IIA, it follows from Yellott (1977) that the error terms are distributed according to the type III extreme value distribution,

(A.2) $$P(\varepsilon_j \le x) = P(\varepsilon_1(S) \le x) = \exp(-\exp(0.5772 - x)),$$

j = 0, 2. Given the distribution in (A.2) it follows readily (and it is also well-known) that

(A.3) $$E_p\tilde{E}(\max(U_1(S),U_2(S)) = E_p \max(U_1(S),U_2(S)) = \theta^{-1}\log(\exp(\theta u_1) + \exp(\theta u_2)).$$

It thus follows from (A.1) and (A.3) that

$$\left(1 + \frac{r}{\lambda}\right)\theta u_1 + \frac{c}{\lambda} = \log(\exp(\theta u_1) + \exp(\theta u_2))$$

which completes the proof.

Q.E.D.

Lemma 1

Assume that $V_j,\ j = 1,2,$ *are independent stable random variables that are distributed as* $S_\alpha(1,1,0)$ *with* $\alpha < 1,$ *and let* $Z = \alpha\log\left(V_1/V_2\right).$[7] *Then the p.d.f. of Z is given by*

$$f(z) = \frac{\sin\left(\alpha\pi\right)}{\pi\left(e^z + 2\cos(\alpha\pi) + e^{-z}\right)}.$$

[7] The notation $S_\alpha(\sigma,\beta,\mu)$ means a Stable distribution with index $\alpha,$ scale parameter $\sigma,$ skewness parameter β and location parameter $\mu.$

Proof of Lemma 1:

Since $V_j,\ j=1,2,$ are independent with c.d.f. $S_\alpha(1,1,0)$ it follows that the event $\alpha^{-1}Z \le z$ is equivalent to

(A.4) $$U(z) \equiv \frac{V_1 - e^z V_2}{\sigma(z)} \le 0,$$

where $\sigma(z)$ is the scale parameter of the Stable random variable $U(z)$. From Property 1.2.1 in Samorodnitsky and Taqqu (1994, p. 10), it follows that the scale and the skewness parameters of $U(z)$ are one and $\beta(z),$ respectively, where the latter is given by

(A.5) $$\beta(z) = \frac{1-e^{\alpha z}}{1+e^{\alpha z}}.$$

From Zolotarev (1986, equation (2.2.30), p. 79), it follows that

(A.6) $$P(\alpha^{-1}Z \le z) = P\big(U(z) \le 0\big) = \frac{1}{2} - \frac{1}{\alpha\pi}\operatorname{Arctan}\left(\frac{\left(1-e^{\alpha z}\right)\psi}{e^{\alpha z}+1}\right)$$

where $\psi = \tan(\alpha\pi/2).$ From (A.6) it follows that the probability density of the c.d.f. of $\alpha^{-1}Z$ is given by

(A.7) $$\frac{e^{\alpha z}\psi}{\pi\left(\left(1+e^{\alpha z}\right)^2 + \left(1-e^{\alpha z}\right)^2\psi^2\right)} = \frac{2\psi e^{\alpha z}}{\pi\left(1+\psi^2\right)\left(\left(e^{\alpha z} - \left(\frac{\psi^2-1}{\psi^2+1}\right)\right)^2 + \left(\frac{2\psi}{1+\psi^2}\right)^2\right)}$$
$$= \frac{\sin(\alpha\pi)e^{\alpha z}}{\pi\left(\left(e^{\alpha z}+\cos(\alpha\pi)\right)^2 + \sin^2(\alpha\pi)\right)} = \frac{\sin(\alpha\pi)}{\pi\left(e^{\alpha z} + 2\cos(\alpha\pi) + e^{-\alpha z}\right)}.$$

But (A.7) means that the p.d.f. of Z is given by

$$f(z) = \frac{\sin(\alpha\pi)}{\alpha\pi\left(e^{z} + 2\cos(\alpha\pi) + e^{-z}\right)}.$$

Q.E.D.

Proof of Theorem 2:

Assumptions 2 and 4 imply that the utility functions can be expressed as

$$U_{ijt} = \theta u_{ijt} + Z_{ij} + \tilde{\varepsilon}_{ijt}, \text{ for } j = 0, 1, 2.$$

When $\{Z_{ij}\}$ are given we obtain from Assumption 4 and Yellott (1977) that $\tilde{\varepsilon}_{ijt}$ must have the same distribution as $\alpha\varepsilon_{ijt}$ where α is a suitable constant and ε_{ijt} has c.d.f. given by (A.2). Consequently, $Z_{ij} + \alpha\varepsilon_{ijt}$ must have the same distribution as ε_{ijt}, for j = 0, 1, 2. Since $P(\varepsilon_{ijt} \le y) = \exp(-e^{0.5772-y})$ and

$$P(Z_{ij} + \alpha\varepsilon_{ijt} \le y) = EP(\alpha\varepsilon_{ijt} \le y - Z_{ij} \mid Z_{ij}) = E\exp(-e^{0.5772 + Z_{ij}\alpha^{-1} - y\alpha^{-1}})$$

we obtain that

(A.8) $$E\exp(-e^{0.5772 + Z_{ij}\alpha^{-1} - y\alpha^{-1}}) = \exp(-e^{0.5772 - y}).$$

Let $z = e^{0.5775 - y\alpha^{-1}}$ which yields that $e^{0.5772 - y} = z^{\alpha} e^{0.5772(1-\alpha)}$. When inserting for *z* in (A.8) we get

(A.9) $$E\exp(-ze^{Z_{ij}\alpha^{-1}}) = \exp(-z^{\alpha} e^{0.5772(1-\alpha)})$$

for $z \ge 0.$ We recognize the left hand side of (A.9) as the Laplace transform of the distribution of $\exp(Z_{ij}\alpha^{-1}).$ From Proposition 1.2.12 in Samorodnitsky and Taqqu (1994, p. 15), it follows that $\exp(Z_{ij}\alpha^{-1})$ must be an α stable random variable that is maximally skew to the right with location parameter equal to zero. It also follows that the scale parameter σ is given by $\sigma^{\alpha} = e^{0.5772(1-\alpha^{-1})}\cos(\alpha\pi/2).$ The latter equation implies that $\cos(\alpha\pi/2)$ is non-negative, which can only happen if $\alpha \le 1.$ From Lemma 1 we therefore obtain that $(Z_{i1} - Z_{i0})\alpha^{-1}$ must have p.d.f. given by

$$\frac{1}{\pi} \cdot \frac{\sin(\alpha\pi)}{e^{\alpha z} + e^{-\alpha z} + 2\cos(\alpha\pi)}.$$

Recall that $U_{ijt}\alpha^{-1} = \theta u_{ijt}\alpha^{-1} + Z_{ij}\alpha^{-1} + \varepsilon_{ijt}.$ Since the error terms are independent and extreme value distributed it follows from the theory of discrete choice that the maximization of the utility function $U_{ijt}\alpha^{-1}$ conditional on $\{Z_{ik}\}$ (which is equivalent to maximizing U_{ijt} conditional on $\{Z_{ik}\}$) yields (2.8). Since also $U_{ijt} = \theta u_{ijt} + \varepsilon_{ijt}$ we obtain (2.9).

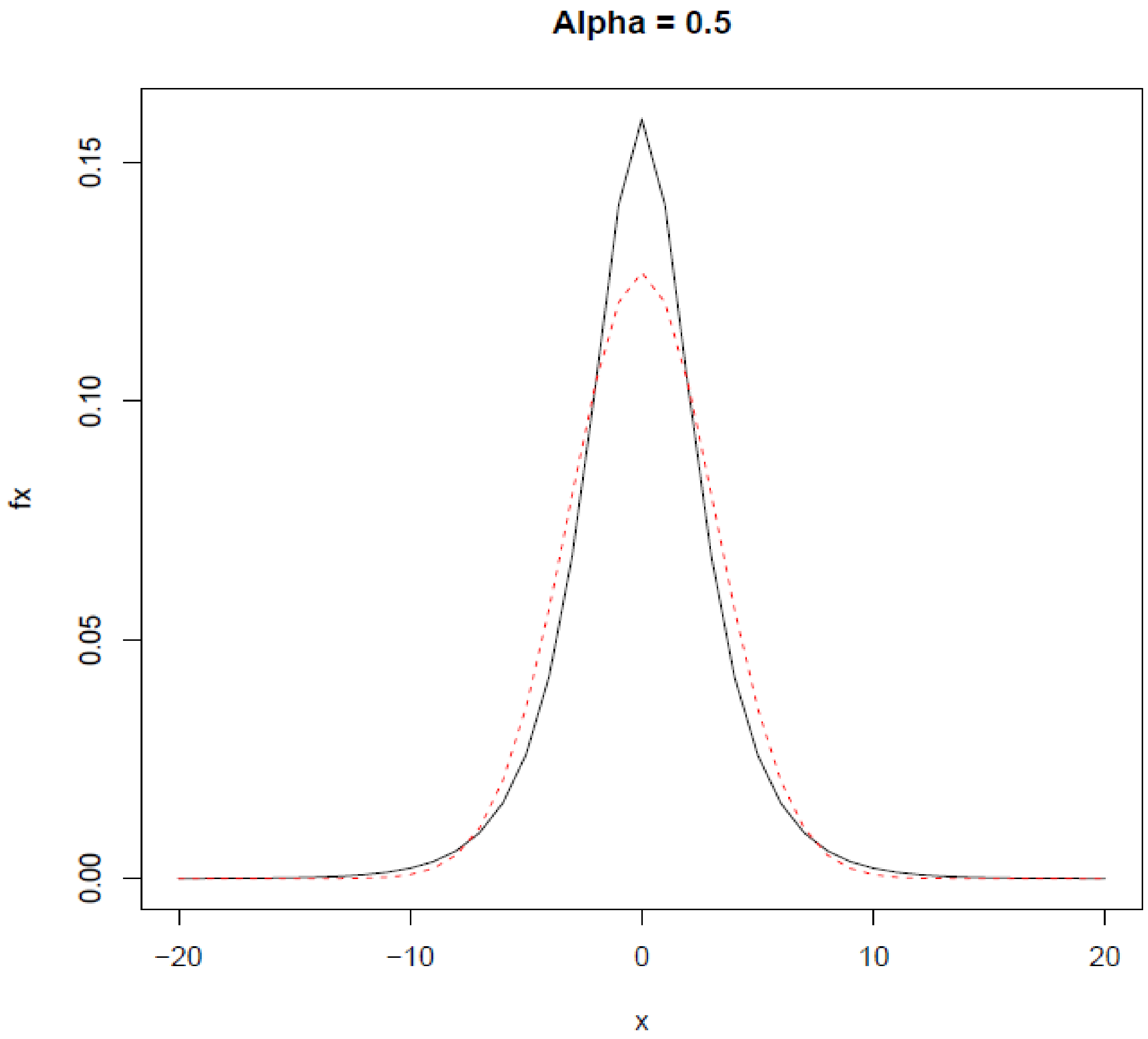
In order to prove (2.10) we use the fact that $Var(\varepsilon_{i1t} - \varepsilon_{i0t}) = 2Var\varepsilon_{i1t} = \pi^2/3.$ Since $(\varepsilon_{i1t} - \varepsilon_{i0t})\alpha + Z_i$ has the same distribution as $\varepsilon_{i1t} - \varepsilon_{i0t}$ it follows that

$$Var((\varepsilon_{i1t} - \varepsilon_{i0t})\alpha + Z_i) = \alpha^2 Var(\varepsilon_{i1t} - \varepsilon_{i0t}) + VarZ_i = Var(\varepsilon_{i1t} - \varepsilon_{i0t})$$

from which (2.10) follows.

Q.E.D.

Figure A1. Plot of the p.d.f. of $Z_i\alpha^{-1}$ and the p.d.f. of a normal distribution (dotted line)



Appendix B

Generating independent draws from the p.d.f. given in (2.11)

Let X_{ri}, r = 1, 2, …, M, be normally distributed $N(0,1)$ and let $\Phi(x)$ denote the standard normal c.d.f. Let g be the p.d.f.

(B.1) $$g_b(z) = \frac{1}{\pi b} \cdot \frac{\sin(\pi b)}{e^z + e^{-z} + 2\cos(\pi b)}$$

where b is a positive scalar. Define the random variable

(B.2) $$K_{ri}(b) = \log\left(\frac{\tan(\pi b/2) + \tan\left((2\Phi(X_{ri}) - 1)\pi b/2\right)}{\tan(\pi b/2) - \tan\left((2\Phi(X_{ri}) - 1)\pi b/2\right)} \right)$$

for r = 1, 2,…,M, for individual i. The variable $K_{ri}(b)$ will then be distributed according to (B.1). Thus, one can simulate random variables from $g(y)$ by first draw independent standard normally distributed random variables and subsequently use (B.2) to calculate these random variables. Note next that $K_{ir}(\alpha)/\alpha$ has p.d.f. $f(z)$ given in (2.11). Hence, we can write

(B.3) $$P_{it}(Z_i) = \frac{1}{1 + \exp(-(\theta\alpha^{-1}u_{i2t} - \theta\tilde{c}(1/q_{it} - 1) - \theta\alpha^{-1}u_{i0t} + K_{ir}(\alpha)/\alpha)}.$$

The simulation procedure goes as follows: Let for example $b = \alpha_0 = 0.5$ be the starting value. Given this value of b one can generate $K_{ri}(\alpha_0)$ by using (B.2). Then by plugging in the formula in (B.3) into the likelihood function with $K_{ir} = K_{ir}(\alpha_0)$ one can obtain a new estimate of α, $\alpha = \alpha_1$. Use this new value of α to generate $K_{ir}(\alpha_1)$. Then the procedure is repeated until convergence is obtained.

Appendix C

C.1. Estimation results for the wage equation

Table C1 displays the estimation results for the wage equations. Most of the variables enter the real wage equations in a significant manner. The estimated return on education is somewhat larger for women born in Norway than for women born in non-western countries. In both equations experience has a positive effect on the real wage, but it is not easy to compare the results for the two groups since experience and duration of stay, for immigrant women, to some extent pick up similar features. The dummy for urbanity, which takes the value 1 if the woman lives in a densely populated area, enters, as expected, with a positive and significant value. For both groups the estimated time effects are all positive and increasing over time, accounting for general growth of real wages over time which is not due to changes in the other explanatory variables.

Table C1. Estimates of wage equations

Variables	Women born in non-western countries[a]		Women born in Norway	
	Estimate	t-value	Estimate	t-value
Constant	4.083	53.67	4.110	445.94
Education	0.036	11.06	0.042	86.15
Experience	0.013	2.74	0.018	36.68
Experience squared/100	-0.018	-1.68	-0.028	-27.61
Dummy for urbanity			0.031	12.45
Time since arrival/10	0.107	2.89		
Time since arrival squared/100	-0.013	-1.22		
D91T93	0.051	1.16	0.063	18.71
D94T96	0.095	2.10	0.087	24.20
D97T99	0.137	2.90	0.116	28.94
D00T02	0.177	3.80	0.164	39.04
D03T05	0.201	4.51	0.218	50.70
D06T08	0.274	6.38	0.291	66.36
D09T10	0.341	7.68	0.373	69.52
Variance of random effect	0.118		0.222	
Variance of genuine error term	0.088		0.204	
# obs.	2,768		98,544	
Log-likelihood	-1,545.176		-14,439.094	

The variable D8890 is a dummy for the years 1988-1990, with a similar notation for the other time dummies.

C.2. Estimation results for the job offer probability

Table C2 shows the results from the estimation of the q-relations (probability of getting an acceptable job offer given search). As is evident from the estimation results in Table B2 model specifications are somewhat different with respect to explanatory variables. Work experience is included only in the specification for women born in Norway, while this variable is replaced by duration of stay for immigrant women. For both groups the sets of explanatory variables are expanded by including the log of the real non-labor income and the number of children aged 0-3 years and 4-6 years, respectively.

The education variable is significant in both relations, but the estimate of the coefficient attached to education in the equations for women born in non-western countries is only a third of the corresponding estimate for women born in Norway. Thus education is more important for job probability for women born in Norway than in non-western countries. For women born in Norway only the estimate of the coefficient attached to the linear term of experience is significant. As expected experience has a positive effect on the job probability. Both the linear and the quadratic terms of the duration of stay impact the job probability significantly. The estimate of the coefficient attached to the linear term is positive whereas the estimate of the coefficient of the quadratic term is negative. Log of real non-labor income enters both relations positively, but the size of the estimated coefficient attached to this variable is somewhat larger for immigrant women. Both the two variables on the number of children in two age groups enter with a negative effect on the job probability, and are mostly significant at the 5 percent level. For both groups the estimated effect of the variable indicating the number of children aged 4-6 years is somewhat larger than for the number of children aged 0-3 years. The time dummies enter significantly for both groups and show a time variation that mirrors business cycle variation.

Table C2. Estimates of the job offer probability *q*

Variables	Women born in non-western countries[a]		Women born in Norway	
	Estimate	t-value	Estimate	t-value
Education	0.081	5.494	0.243	26.175
Experience			0.060	6.344
Experience squared/100			-0.017	-0.891
Time since arrival/10	1.201	5.978		
Time since arrival squared/100	-0.179	-2.801		
log(real non-labor income)	0.260	3.691	0.154	4.906
# children aged 0-3	-0.166	-1.829	-0.140	-3.599
# children aged 4-6	-0.388	-3.978	-0.211	-5.350
D88T90	-2.349	-2.615	-2.257	-5.556
D91T93	-3.391	-3.960	-2.422	-5.955
D94T96	-3.452	-4.019	-2.412	-5.904
D97T99	-3.061	-3.481	-2.327	-5.627
D00T02	-3.097	-3.480	-2.409	-5.772
D03T05	-3.303	-3.741	-2.654	-6.316
D06T08	-2.837	-3.178	-2.179	-5.101
D09T10	-2.837	-3.157	-2.019	-5.566
# obs.	3,459		107,444	
R^2	0.075		0.015	

Appendix D

Further summary statistics

Since our sample has been subjected to a number of selection criteria it may be of interest to know more about the sample than what is contained in Table 1 in Section 4. Hence, this section provides further summary statistics.

Table D1. Distribution of women across area of birth and periods in the sample

	Area of birth[a]					
Period	Norway	Region 3	Region 4	Region 5	Region 6	Region 8
1988-1990	15267	38	19	84	38	24
1991-1993	20862	70	34	171	73	37
1994-1996	21054	133	45	219	123	39
1997-1999	12397	101	28	156	62	35
2000-2002	10956	124	30	131	69	24
2003-2005	10504	174	36	173	139	26
1996-2008	9389	185	38	224	142	64
1999-2010	3773	137	16	114	56	17

[a] Region 3 is Eastern Europe, Region 4 is Africa excluded the northern part, Region 5 is Asia excluded the western part, Region 6 is northern part of Africa and western part of Asia, Region 8 is South and Central America.

Table D2. Transitions in the labor market for women born in Norway. Selected years

	Women born in non-western countries			Women born in Norway		
Variable Year 1988/1989:	No. of obs.	Mean	Std. dev.	No. of obs.	Mean	Std. dev.
Outside to outside	29	0.310	0.47	2466	0.144	0.35
Outside to particip.	29	0.103	0.31	2466	0.040	0.20
Particip. to outside	29	0.034	0.19	2466	0.038	0.19
Particip. to particip.	29	0.552	0.51	2466	0.779	0.42
Year 1999/2000:						
Outside to outside	63	0.206	0.41	1874	0.053	0.22
Outside to particip.	63	0.063	0.25	1874	0.030	0.17
Particip. to outside	63	0.079	0.27	1874	0.021	0.14
Particip. to particip.	63	0.651	0.48	1874	0.895	0.31
Year 2009/2010:						
Outside to outside	120	0.100	0.30	1207	0.018	0.13
Outside to particip.	120	0.075	0.26	1207	0.024	0.15
Particip. to outside	120	0.042	0.20	1207	0.006	0.08
Particip. to particip.	120	0.783	0.41	1207	0.952	0.21

Table D3. Trimming of hourly wage data in current value

Year	Women born in non-western countries		Women born in Norway	
	Lower limit	Upper limit	Lower limit	Upper limit
1988	32.5	553.5	44.1	339.3
1989	32.5	553.5	42.7	359.3
1990	32.5	553.5	46.7	392.7
1991	20.0	575.0	51.9	428.0
1992	20.0	575.0	53.4	412.9
1993	20.0	575.0	57.6	439.8
1994	34.0	510.0	57.4	429.3
1995	34.0	510.0	54.5	457.0
1996	34.0	510.0	55.5	445.4
1997	25.0	535.0	55.7	494.7
1998	25.0	535.0	51.8	476.4
1999	25.0	535.0	54.1	410.7
2000	40.0	415.0	54.2	480.0
2001	40.0	415.0	54.1	439.1
2002	40.0	415.0	69.3	556.4
2003	25.0	565.0	59.2	454.2
2004	25.0	565.0	62.1	485.4
2005	25.0	565.0	69.8	544.0
2006	35.0	872.0	64.0	497.1
2007	35.0	872.0	66.6	566.1
2008	35.0	872.0	75.6	561.2
2009	34.7	695.0	86.2	507.6
2010	34.7	695.0	98.9	568.6

Table D4. Trimming of non-labor income in current value

Year	Women born in non-western countries	Women born in Norway
	Upper limit	Upper limit
1988	885788.9	1018657.3
1989	880811.7	1012933.4
1990	885385.1	1018192.8
1991	895047.8	1029304.9
1992	898789.7	1033608.1
1993	906564.4	1042549.1
1994	919655.9	1057604.3
1995	935785.2	1076153.0
1996	963600.8	1108140.9
1997	989081.2	1137443.4
1998	1029866.1	1184346.0
1999	1059603.9	1218544.5
2000	1082010.5	1244312.1
2001	1120587.0	1288675.1
2002	1173313.4	1349310.4
2003	1193343.9	1372345.5
2004	1222178.5	1405505.3
2005	1249802.0	1437272.3
2006	1292636.9	1486532.4
2007	1350496.4	1553070.8
2008	1374010.3	1580111.8
2009	1411127.5	1622796.6
2010	1418393.8	1631152.8

Table D5. Summary statistics for the predicted probability of getting an acceptable job given search (in per cent)

	Women born in non-western countries			Women born in Norway		
		Year			Year	
Statistics	1990	2000	2010	1990	2000	2010
Mean	91.1	85.7	90.7	96.8	97.4	98.9
Std. deviation	6.0	7.4	5.4	1.9	1.9	0.8
100% (Max)	98.7	97.9	98.4	99.8	99.7	99.9
90%	97.5	94.5	96.6	98.8	99.2	99.6
75%	96.2	91.0	94.6	98.2	98.6	99.4
50% (Median)	92.7	86.6	91.8	97.3	97.9	99.1
25%	88.2	81.5	87.4	95.9	96.8	98.6
10%	82.1	74.2	83.6	94.1	95.0	98.0
0% (Min)	68.6	63.0	71.3	85.3	86.7	92.9

Appendix E

Comparison with results obtained by Dagsvik et al. (2013)

In Dagsvik et al. (2013) we analyzed the discouraged effect for women living in Norway using pure cross-section data for the period 1988 to 2002. In order to compare the current estimates with those obtained by Dagsvik et al. (2013) we have transformed the parameter estimates of Table 2 so as to make them comparable. They are given in Table E1. Apart from the estimated parameter associated with the discouraged worker effect the estimated parameters do not differ much from the estimates reported in Table 2 in Dagsvik et al. (2013).

Table E1. Derived parameter estimates for women born in Norway and in non-western countries using predicted log real hourly wage with the random component set to zero

	Women born in non-western countries		Women born in Norway	
Variable/parameter	Estimate	t-value	Estimate	t-value
dw , $\theta\tilde{c}$	2.269	7.494	9.774	16.580
Constant, $\theta\gamma_1$	-14.258	-7.206	-17.770	-32.990
Age, $\theta\gamma_2$	0.140	2.287	0.080	5.486
$(\text{Age}/10)^2$, $\theta\gamma_3$	-0.220	-2.905	-0.168	-9.966
(real non-lab. inc) $\times\ 10^{-5}$, $\theta\gamma_4$	-0.055	-1.923	-0.105	-15.476
No. of children 0-3, $\theta\gamma_5$	-0.919	-9.903	-0.841	-33.504
No. of children 4-6, $\theta\gamma_6$	-0.218	-2.280	-0.621	-24.737
No. of children 7-18, $\theta\gamma_7$	-0.320	-6.540	-0.316	-20.040

Standard errors are calculated by the delta method.

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