Appendix 1

The Matching Model

A1.1. Analysis of Starting Earnings

This appendix describes the matching model of Jovanovic (1979, 1984). Let $\mu$ denote the unobservable productivity of workers. Information about productivity comes from two sources: educational qualifications and the way how the match is formed. Knowledge of recruitment channel can be treated as prior expectation about a particular applicant (because a particular recruitment channel generates applicants with a certain average quality within a certain range). Let $r$ denote the average quality of the pool of applicants generated by a particular channel. Then the prior expectation about the unknown quality of a particular applicant can be described as

(A.1.1) $\mu \sim \text{Normal}(r, \pi)$

where $\pi$ denotes precision (reciprocal of variance) and the sign $\sim$ means “follows a distribution”.

Another piece of information about quality comes from observing the education of the applicant. Let $e$ denote the educational signal. Education is an error-ridden observation of the true match quality, thus

(A.1.2) $e \sim \text{Normal}(\mu, p_e)$

where $p_e$ denotes the precision of educational signal.

Given these distributions, the expected value of $\mu$, denoted by $m$, can be calculated with the help of Bayes rule (DeGroot 1970). The expected match quality becomes

(A.1.3) $m_0 = [r\pi + p_e e] / [\pi + p_e]$

where the index 0 expresses that $m$ refers to the starting point of employment relationship.

To understand the implications of this equation, define $v$ as

$v = \pi / [\pi + p_e]$
With the help of $v$, (A.1.3) can be written as

\[(A.1.4) \quad m_0 = (1-v)e + vr\]

This simple equation has two important implications. First, as prior precision increases, returns to education decrease, while returns to prior expectations increase. A perfect return to education exists if $v=0$, thus prior information is not trusted at all. The complete distrust of prior information corresponds to a meritocratic labor market. As $v$ approaches 1, a situation where prior precision is infinitely large, education counts less, and prior expectations have larger role in determining the expected match quality. Second, $m$ increases with prior precision if $r>e$. This might seem to be a paradox. However, the condition $r>e$ means that the contact person or the current workforce is of very high quality. If $r<e$, i.e. the current workforce is of bad quality, then the similarity between newcomer and current workers would have a negative impact on estimated match quality. In the following, it is assume that $r>e$, thus the workforce has a good quality, since otherwise referrals would not be used.

A1.2. ANALYSIS OF EARNINGS GROWTH

When the worker is hired, production takes place, which also provides information about the quality of match. Employers observe cumulative output $Q$ over a period of time $t$. Again, this observation is error-ridden. Average output $q$ ($q=Q/t$) is assumed to be related to $\mu$ in the following way:

\[(A.1.5) \quad q \sim \text{Normal}(\mu, p_q)\]

The expected value of average output is the same as match quality. Given Bayes rule of updating beliefs, a sample size $t$ and sample mean $q$ ($q=Q/t$) implies that the posterior mean of $\mu$ at time $t$ becomes

\[(A.1.6) \quad m_t = E_t(\mu) = [ r\pi + p_ee + p_qtq ] / [ \pi + p_e + tp_q ]\]

Rather than analyzing (A.1.6), it is more transparent to examine the implication of this equation for changes in expectations over time. Define the wage growth parameter, $k$, as follows:

\[k = [m_t - m_0] / t\]

By substituting (A.1.6) into this definition, we obtain the following result:
(A.1.7) \[ k = \frac{pq \left[ q - m_0 \right]}{\pi + p_e + tp_q}. \]

Wage growth is positive only if \( q > m_0 \), meaning that the average production exceeds the employer’s expectation at time zero. Assume that wage growth is positive. The important implication is that prior precision decreases wage growth. First, prior precision enters the denominator. Second, prior precision is positively related to \( m_0 \) because of (A.1.4). Since referrals increase prior precision, referrals should decrease the wage growth rate.

In empirical work, (A.1.7) is difficult to use because it involves nonlinear relationships. Instead of estimating (A.1.7) directly, one might wish to estimate a linear model which summarizes the implications of the equation. Conditional on \( q > m_0 \), a linear equation can be written as

(A.1.8) \[ k \approx b_1\pi + b_2m_0 + b_3p_e + b_4p_q + b_5q + b_6t \]

The model implies that \( b_1, b_5 \), are positive, while the other parameters are negative.
Appendix 2

Estimating Marginal Effects

ESTIMATION OF MARGINAL EFFECTS

The following exposition focuses on probability models. Let \( \mathbf{b}x \) denote the value of the linear combination of parameters and covariates for the \( k \)-th observation in the estimation sample (subscripts can be omitted without causing confusion). Let \( F(\bullet) \) be the cumulative distribution function which maps the values of \( \mathbf{b}x \) onto the \([0,1]\) interval. Let \( f(\bullet) \) be the derivative of \( F(\bullet) \) with respect to the linear combination of covariates and parameter estimates.

In general, marginal effects are the means of partial changes in \( F(\mathbf{b}x) \) over the observations in the estimation sample. For dummy variables, the marginal effect for the \( i \)-th variable, \( m_i \), is the sample average of discrete changes in \( F(\bullet) \), keeping all other variables at their observed values:

\[
(A.2.1) \quad m_i = N^{-1} \sum \{ F(\mathbf{b}x \mid x_i=1) - F(\mathbf{b}x \mid x_i=0) \}
\]

For the \( i \)-th continuous variable, the marginal effect is the sample average of partial changes in \( F(\mathbf{b}x) \). Since partial changes are expressed by partial derivatives, the marginal effect for the \( i \)-th continuous variable, \( m_i \), becomes

\[
(A.2.2) \quad m_i = N^{-1} \sum f(\mathbf{b}x)b_i
\]

CONSTRUCTING THE COVARIANCE MATRIX USING THE DELTA METHOD

Let \( \mathbf{b} \) denote the vector of parameter estimates, and \( \mathbf{\beta} \) the vector of true parameters. To obtain standard errors for marginal effects, the delta method is used. Using a first-order Taylor-series expansion, the marginal effects are:

\[
(A.2.3) \quad \mathbf{m}(\mathbf{b}) \approx \mathbf{m}(\mathbf{\beta}) + \mathbf{G}(\mathbf{b}-\mathbf{\beta})
\]

where \( \mathbf{m}(\mathbf{b}) \) and \( \mathbf{m}(\mathbf{\beta}) \) are the vectors of estimated and true marginal effects, respectively, and \( \mathbf{G} \) is a matrix containing the derivatives of \( \mathbf{m}(\mathbf{\beta}) \) with respect to \( \mathbf{\beta} \). In other words, the \( ij \)-th element of \( \mathbf{G} \) is the partial derivative of the \( i \)-th marginal effect with respect to \( b_j \).
Substituting \(m(bx)-m(\hat{bx})\) into the definition of variance yields

\[
V[m(bx)] = GV(b)G^T
\]

where \(V\) denotes the variance-covariance matrix.

After estimation, the variance-covariance matrix of parameter estimates, \(V(b)\), is available. Estimation of standard errors for marginal effects requires the construction of \(G\). \(G\) can be estimated as follows. Recall that the \(ij\)-th element of \(G\) is the partial derivative of the \(i\)-th marginal effect with respect to \(b_j\). For dummies, the partial derivative is

\[
\frac{\partial m_i}{\partial b_j} = N^{-1} \sum \{ [F(bx \mid x_i=1) - (1-\delta)F(bx \mid x_i=0)] x_j \}
\]

and for continuous variables

\[
\frac{\partial m_i}{\partial b_j} = N^{-1} \sum \{ [\delta f(bx) + b_i \partial f(bx)/\partial bx] x_j \}
\]

where \(\delta=1\) if \(i=j\), and 0 otherwise.

(Note: for linear models, where \(F(bx)=bx\), \(f(bx)=1\), and \(\partial f(bx)/\partial bx=0\), \(G\) will be the identity matrix. This is easy to see in (A.2.6). In (A.2.5), note that if \(i=j\), then \(x_j=1\) for all observations.)
Appendix 3

Survey Items for Key Variables

A3.1 Search Method Choice

Did you search for a job this year?
Please, think only of jobs where weekly working time is at least 20 hours and they last for at least 3 months!

0 – no
1 – yes  SKIP NEXT QUESTION  SEARCH DUMMIES = 0

Why did you not search? If you have more reasons, please mention the 3 most important reasons!

1 – was promised to get a job  IF CATEGORY 1
2 – started an enterprise  MENTIONED,
3 – worked in family enterprise or household  INFORMAL SEARCH = 1
4 – sustained by parents
5 – no intention to became employee
6 – no job that fits vocational qualification
7 – health problems
8 – personal or family problems
9 – other (specify):

SKIP NEXT QUESTION

How did you search?

01 – visiting employers  IF ANY OF THE CATEGORIES 1-6 MENTIONED,
02 – Employment Bureau  FORMAL SEARCH = 1
03 – other employment agencies
04 – ads placed in school
05 – newspaper ads
06 – ads placed on the street
07 – teacher
08 – trainer
09 – parents
10 – siblings
11 – other relatives
12 – friends
13 – acquaintances
14 – person known by accident  INFORMAL SEARCH = 1
A3.2 Job Finding Methods and Contact Characteristics

From which source did you hear about the job?

01 – Employment Bureau IF RESPONSE = 1 OR 2, EMPLOYMENT SERVICE = 1
02 – other employment agency IF RESPONSE = 3 OR 4, ADVERTISEMENT = 1
03 – advertisement placed school
04 – newspaper advertisement
05 – ad at the street
06 – I went to this workplace
07 – parent
08 – sibling IF RESPONSE = 5 OR 6, DIRECT METHOD = 1
09 – other relative
10 – teacher in secondary school
11 – trainer
12 – person known by accident
13 – friend
14 – acquaintance

IF RESPONSE IS 01-06, SKIP NEXT QUESTIONS

Why did this person know about the job?

1 – was the employer SKIP NEXT QUESTION
2 – was an employee IF RESPONSE = 2, EMP. REFERRAL = 1;
3 – is a relative of the employer OTHERWISE, EMP. REFERRAL = 0
4 – is a friend of the employer
5 – is an acquaintance of the employer
6 – is a relative of an employee
7 – is a friend of an employee
8 – is an acquaintance of an employee
9 – learned about the job from another source

Was this person working when he or she informed you about the job?

1 – no SKIP NEXT QUESTION IF RESPONSE = 1
2 – yes, as an employer CONTACT STATUS = 0
3 – yes, as a self-employed
4 – yes, as an employee

What was the occupation of this person when he or she informed you about the job?

[CODE OCCUPATION, DEFINE CONTACT STATUS]
### A3.3 Survey Items for Family Network resources Variables

On card 11, you see four letters. These serve to identify four family members I would know some other things. Please, identify with letters A and B those persons who were raising you when you finished the secondary school. CONTINUE ONLY IF R. HAS SIBLINGS! Then identify your siblings with letters C and D. If you have more than two siblings, please select those who worked. If more than two of your siblings had a job then select the two eldest siblings.

<table>
<thead>
<tr>
<th>ASK SUBQUESTIONS BY ROW</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Please, tell me who are the persons identified with he letters.</td>
<td>1 – father</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 – mother</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3 – stepmother, partner of father</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4 – stepfather, partner of mother</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5 – brother</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6 – sister</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>7 – other male relative</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>8 – other female relative</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Was ... working when you finished secondary school?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AFTER ANSWERS 4 – 9 SKIP NEXT SUBQUESTION</td>
<td>1 – employer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 – self-employed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3 – employee</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4 – pupil, student</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5 – unemployed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6 – works in the household</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>7 – retired</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>8 – lives from social transfers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>9 – other inactive</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

IF EMPLOYER, SELF-EMPLOYED, OR EMPLOYEE:

What was the occupation of ...?

CODING OCCUPATION:
A3.4 Survey Items for the Number of Occupation Variables

I mention now some occupations. Please tell me whether you know somebody with this occupation. Please do not think now of your parents and siblings.

<table>
<thead>
<tr>
<th></th>
<th>Occupation</th>
<th>0 – does not know, 1 - knows</th>
</tr>
</thead>
<tbody>
<tr>
<td>.1</td>
<td>small-holder</td>
<td></td>
</tr>
<tr>
<td>.2</td>
<td>miner</td>
<td></td>
</tr>
<tr>
<td>.3</td>
<td>heating repairman</td>
<td></td>
</tr>
<tr>
<td>.4</td>
<td>computer technician</td>
<td></td>
</tr>
<tr>
<td>.5</td>
<td>butcher</td>
<td></td>
</tr>
<tr>
<td>.6</td>
<td>bricklayer</td>
<td></td>
</tr>
<tr>
<td>.7</td>
<td>car mechanic</td>
<td></td>
</tr>
<tr>
<td>.8</td>
<td>shop keeper</td>
<td></td>
</tr>
<tr>
<td>.9</td>
<td>waiter</td>
<td></td>
</tr>
<tr>
<td>.10</td>
<td>postman</td>
<td></td>
</tr>
<tr>
<td>.11</td>
<td>clerk</td>
<td></td>
</tr>
<tr>
<td>.12</td>
<td>security guard</td>
<td></td>
</tr>
<tr>
<td>.13</td>
<td>nurse</td>
<td></td>
</tr>
<tr>
<td>.14</td>
<td>taxi driver</td>
<td></td>
</tr>
<tr>
<td>.15</td>
<td>hairdresser</td>
<td></td>
</tr>
</tbody>
</table>
### A3.5 Survey Items for the High Status Person Outside Family Variable

**How many friends did you have when you finished secondary school?**

*Please, think of persons you felt close to.*
- 0 – no friends, does not know
- 9 – 9 or more

**Please recall the time when you finished secondary school. Imagine the following. One of your classmates looks for a job, and asks for your help.** Except your parents, siblings, and the friends you just mentioned, did you know anybody who was able to help your classmate?

**IF YES:**

**How many persons do you know?**
- 0 – no friends, does not know
- 9 – 9 or more

**IF THE ANSWER TO BOTH QUESTIONS IS "NO" OR "DO NOT KNOW", SKIP NEXT QUESTIONS**

**And how many friends and acquaintances had a workplace when you finished secondary school?**

- 0 – nobody, does not know  
  - [SKIP NEXT QUESTIONS]
- 9 – 9 or more  

**In the following, I am going to ask more questions about your friends and acquaintances who had a workplace. Please, give me the first name or nickname of those friends who worked at the time you finished the secondary school.** If you have more than 4 such a friend please give me select your 4 best friends.

| WRITE NAMES IN THE COLUMN „NICKNAME OF FRIENDS” OF THE TABLE BELOW |

Now I ask you to give me the first name or nickname of your acquaintances who were able to help your classmate and who had a job when you finished the secondary school. If you have more than 4 such an acquaintance, please select the 4 eldest person.

| WRITE NAMES IN THE COLUMN „NICKNAME OF ACQUAINTANCES” OF THE TABLE BELOW |

<table>
<thead>
<tr>
<th>ID number</th>
<th>NICKNAME of Friends</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td></td>
</tr>
</tbody>
</table>
SELECT 4 NAMES FROM THE TABLE AT E.16., AND WRITE THESE NAMES IN THE „NICKNAME” ROW OF THE TABLE BELOW. THE NAME WITH THE LOWEST ID SHOULD BE WRITTEN IN COLUMN „A”, THEN THE NAME WITH THE SECOND LOWEST ID IN THE COLUMN „B”, ETC.

ALSO FILL IN THE ID NUMBER WHICH CORRESPONDS TO THE NAME.

AFTER COMPLETING ROWS „NICKNAME”, AND „ID NUMBER”:

Now I ask some questions about the persons you just mentioned:

<table>
<thead>
<tr>
<th>NICKNAME:</th>
<th>A.</th>
<th>B.</th>
<th>C.</th>
<th>D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID NUMBER (at E.16.):</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Was ..... an employer, a self-employed, or an employee when you finished the secondary school?</td>
<td>1 – employer</td>
<td>2 – self-employed</td>
<td>3 – employee</td>
<td>8 – other (specify):</td>
</tr>
<tr>
<td>What was .....’s occupation when you finished the secondary school?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CODES FOR OCCUPATION: