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Abstract

The paper provides a theoretical foundation for the empirical regularities observed in estimations of wage consequences of overeducation and undereducation. Workers with more education than required for their jobs are observed to suffer wage penalties relative to workers with the same education in jobs that only require their educational level. Similarly, workers with less education than required for their jobs earn wage rewards. These

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departures from the Mincer human capital earnings function can be explained by Nash bargaining between workers and employers. Under fairly mild assumptions, Nash bargaining predicts a wage penalty for overeducation and a wage reward for undereducation, and further predicts that the wage penalty will exceed the wage reward. This paper reviews the established empirical regularities and then provides Nash bargaining results that explain these regularities.

Keywords: Overeducation, Undereducation, Nash bargaining, Qualitative mismatches, Mincer earnings function, Wages

JEL Codes: J31, J24, C78, C51

1 Point of Departure: Empirical Findings

Extensive and robust empirical evidence documents the earnings effects of mismatch between worker education and job requirements: a reward for bringing more education to the job than it requires, a penalty for working in a job that requires less education than actually accomplished. A convincing analytical interpretation, however, has so far not been established. In this paper, we show that the Mincer earnings function, extended to allow for over- and undereducation, can be generated by Nash bargaining over wages in a model of job search. Based on common and mild assumptions on bargaining positions, we predict a ranking of parameter values that reflects estimates in econometric research.

Extension of Jacob Mincer's earning function to divide a person's education into required education, overeducation and undereducation (or ORU specification) was initiated by Saul Duncan and Gregory Hoffman (1981), in response to "The Overeducated American" by Richard Freeman (1976). The resulting specification has generated extensive empirical work as well as discussion of econometric problems, measurement issues and interpretation. The extensive work exhibits empirical regularities in the different rewards for required education, overeducation and undereducation. Different rewards suggest a departure from the human capital earnings function to incorporate job characteristics, but no specific mechanism has been proposed that would generate these results. As mentioned, this paper proposes a simple explanation of the empirical regularities in terms of Nash bargaining between employers and workers in a frictional labor market.

To formalize ideas, consider the wages paid to workers with two levels of education at two jobs with different educational requirements:

Table 1: Wages for Workers at Different Jobs

	Job Type 1	Job Type 2
Worker Type 1	W_{11}	W_{12}
Worker Type 2	W_{21}	W_{22}

In this table, a type 1 worker has the educational level required for job type 1 and a type 2 worker has the educational level required for job type 2. Job type 2 has a higher educational requirement than job type 1, and a type 2 worker has a higher educational level than a type 1 worker. Worker 1 at job 2 is undereducated, while worker 2 at job 1 is overeducated. Comparing wages at different jobs for a given worker, define the worker undereducation reward as $W_{12} - W_{11}$ and the worker overeducation penalty as $W_{22} - W_{21}$. If the worker undereducation reward is positive, a worker gains by finding a job with an educational requirement higher than the worker's education. If the worker overeducation penalty is positive, the worker loses by taking a job with an educational requirement below the worker's level. Analogously, comparing different workers at a given job, define the overeducation pay premium as $W_{21} - W_{11}$ and the undereducation pay discount as $W_{22} - W_{12}$. The overeducation pay premium is positive when an employer pays more to a worker in a given job if the worker has more education than required for the job. The undereducation pay discount is positive if a worker with less education than required at a given job is paid less than co-workers with required education levels at the same job.

The wages for workers in Table 1 can be related to the Duncan and Hoffman extension of the earnings function. Their earnings function can be written:

$$Ln\, W = Xb + a_o S_o + a_r S_r + a_u S_u + \epsilon \tag{1}$$

where S_o is overeducation, S_r is required education, S_u is undereducation, all measured in years, X is a vector of other explanatory variables, ϵ is a random error term, and a_o, a_r, a_u and the vector b are coefficients to be estimated. The three educational measures S_o, S_r and S_u add up to the worker's actual education, the variable used in the original Mincer earnings function.

The required educational level for a worker's job can be determined from job analysis (by occupational psychologists), worker self-assessment, or realized matches (e.g., the average educational level for an occupational classification).[1] In this log-linear formulation, the coefficients a_o, a_r,and a_u can be interpreted as percentage changes in wages and as rates of return. Edwin Leuven and Hessel Oosterbeek (2011) recently surveyed the literature on overeducation and mismatch in the labor market (see also Joop Hartog, 2000; Peter Sloane, 2003; and Seamus McGuinness, 2006). Leuven and Oosterbeek are very critical about the level of econometric sophistication of the ORU literature and argue that serious attention to omitted variable bias and measurement errors is needed.

Using a weighting method from the meta-analysis literature to combine results from different studies with different data sources, measurements and estimation methods, Leuven and Oosterbeek (2011, Table 2) estimate that $a_o = 0.43$, $a_r = 0.89$, and $a_u = -.36$. Assuming the workers in Table 1 have educational levels that differ by one year and the jobs have educational requirements that differ by one year, the estimate for a_o implies that $W_{21} = 1.043W_{11}$, the estimate for a_u implies that $W_{12} = (1 - .036)W_{22}22 = .964W_{22}$, and the estimate for a_r implies that $W_{22} = 1.089W_{11}$.

Together, these results imply that the worker undereducation reward is $W_{12} - W_{11} = .964W_{22} - W_{11} = .964(1.089W_{11}) - W_{11} = .0498W_{11}$ and the worker overeducation penalty is $W_{22} - W_{21} = 1.089W_{11} - 1.043W_{11} = .046W_{11}$.

[1] Measurement issues are discussed in H. Battu, C. R. Belfield and P. J. Sloane, 1999; P. Dolton and A. Vignoles, 2000; Joop Hartog, 2000; Wim Groot and Henriette Maassen van den Brink, 2000; Seamus McGuinness, 2006; and Edwin Leuven and Hessel Oosterbeek, 2011.

Everything else the same, a given worker is paid more in a job with a higher educational requirement, and a given worker is paid less in a job that has a lower educational requirement. Furthermore, the undereducation reward is (slightly) greater than the overeducation penalty. The Leuven and Oosterbeek results also permit comparisons between workers at a given job. The overeducation pay premium is $W_{21} - W_{11} = 1.043W_{11} - W_{11} = .043W_{11}$, and the undereducation pay discount is $W_{22} - .964W_{22} = .036W_{22}$.

These results are consistent with earlier observations by Joop Hartog (2000) and with an earlier meta-analysis conducted by Wim Groot and Henriëtte Maassen van den Brink (2000, 2007). Groot and Maassen van den Brink (2000, Table 2, p. 154) estimate that $a_o = 0.078$, $a_r = 030$, and $a_u = -.15$. These estimates imply that the worker undereducation reward is $.0618W_{11}$ and the worker overeducation penalty is $.048W_{11}$. As in the Leuven and Oosterbeek estimates, the worker undereducation reward exceeds the worker overeducation penalty, and both are positive.

Using European Community Household Panel data from 1994 to 2001, Glenda Quintini (2011a, p. 33; see also OECD, 2011, pp. 210-211) provides direct evidence on the worker undereducation (underqualification) reward and the worker overeducation (overqualification) penalty.[2] On the basis of a pooled regression, Quintini finds that the worker undereducation reward is $.15W_{11}$, while the worker overeducation penalty is $.2W_{22}$. These results do not express wage consequences on a per year basis as in Leuven and Oosterbeek's meta-analysis but instead provide an average over all instances of overeducation and undereducation. As with Leuven and Oosterbeek, both the worker undereducation reward and the worker overeducation penalty are positive, but in Quintini's results the worker overeducation penalty exceeds the worker undereducation reward.

Although the wage consequences of educational mismatches are estimated regularly, there is no widely accepted theory explaining how they are generated. The results are generally regarded in the literature as being consistent with the assignment model but not with simple human capital models or Lester Thurow's job competition model (1975).[3] In simple human capital models, a worker's earnings depend only on his or her schooling or education and not on job characteristics, so the wage would be the same whether a worker was well-matched, overeducated or undereducated for the job. In Thurow's model, the wage depends only on the job, which is also inconsistent with the results. In assignment models, the wage can depend on both worker and job characteristics (see Sattinger, 1993, for a survey). However, assignment models by themselves do not explain how wages are determined in mismatches that arise through job search.

[2] The terms overqualification and underqualification are used by Quintini and others to distinguish the comparisons from skill mismatches based on competencies developed outside of formal educational preparation.

[3] See discussions in Peter Sloane, H. Battu and P. Seaman, 1999, pp. 1438-1439; Joop Hartog, 2000, p. 140; Seamus McGuinness, 2006, pp. 392-393; The European Centre for Vocational Training, 2010, p. 29; and Glenda Quintini, 2011b, p. 10.

2 An Interpretation

A first step in explaining wage consequences of mismatches is to determine the production consequences of mismatches. Stephan Kampelmann and François Rycx (2012) provide direct evidence of production consequences of educational mismatches using linked employer-employee panel data for Belgium in the period 1999-2006. They find that additional years of worker overeducation raise firm productivity, and additional years of undereducation among young workers reduces productivity. One may expect that given marginal productivity determination of factor rewards, the productivity consequences of mismatches would be sufficient to determine the wage consequences, but this is not the case. Suppose the output obtained from two workers in two jobs is given in the following table:

Table 2: Production from Two Types of Workers and Two Types of Jobs

	Job Type 1	Job Type 2
Worker Type 1	A_{11}	A_{12}
Worker Type 2	A_{21}	A_{22}

In this table, job 2 is more productive than job 1 and worker 2 is more productive than worker 1. With these outputs, comparisons of outputs would result in worker wages differing by $A_{21} - A_{11}$ in job 1, and by $A_{22} - A_{12}$ in job 2. These differences are in general not the same.[4] Nash bargaining between workers seeking jobs and employers with jobs can explain the patterns observed in the educational mismatch literature. Suppose two types of workers search randomly for two types of jobs. Suppose the outputs from combinations of workers in jobs are given by A_{ij} as in Table 2, with $A_{22} - A_{12} > A_{21} - A_{11}$. If the number of type i workers equals the number of type i jobs ($i = 1, 2$), the first-best optimal allocation would be to assign type i workers to type i jobs (as the assumption implies $A_{11} + A_{22} > A_{12} + A_{21}$), and this allocation would be realized as a competitive outcome in a frictionless world. Attained and required education would then be equal and the ORU earnings function would collapse to the Mincer specification, as under- and overeducation would not occur.

Let W_{01} and W_{02} be the reservation wages for workers of types 1 and 2, respectively, determined optimally from their job search problems. A worker's reservation wage is the same when applying to either job. The reservation wage for a worker is the lowest wage that a worker would be willing to accept at a job. It is based on a comparison between what the worker could get with the current wage offer and what the worker could get if he or she continued searching (for a recent survey of search theory and the concept of reservation wages, see Eckstein and Van den Berg, 2006) Similarly, let Z_{01} and Z_{02} be the reservation incomes for employers with jobs of types 1 and 2. A job has the same reservation income

[4] Suppose the output for entry A_{ij} is generated by a production function $f(S_i, K_j)$ that depends on worker schooling S_i and job capital K_j, and suppose $S_2 > S_1$ and $K_2 > K_1$. If $f(S_2, K_j) - f(S_1, K_j)$ increases as capital K_j increases, then $A_{22} - A_{12}$ will be greater than $A_{21} - A_{11}$. Then knowledge of the outputs could not by itself determine the wage rates for workers in mismatches. This points to the need for proper controls in the estimated earning equation.

for applications from either type of worker. Assume one worker combines with one job to generate production. Let β be the bargaining power of workers, $0 < \beta < 1$, so that workers are able to get the proportion β of the surplus of production over the reservation wage and reservation income of the worker and employer. Then the wage of a type i worker at a type j job will be:

$$W_{ij} = W_{0i} + \beta(A_{ij} - W_{0i} - Z_{0j}) \tag{2}$$

Also, the income for a job of type j employing a worker of type I will be:

$$Z_{ij} = Z_{0j} + (1 - \beta)(A_{ij} - W_{0i} - Z_{0j}) \tag{3}$$

With Nash bargaining, the worker undereducation reward is then

$$\begin{aligned} & W_{12} - W_{11} \\ = \;& W_{01} + \beta(A_{12} - W_{01} - Z_{02}) - W_{01} - \beta(A_{11} - W_{01} - Z_{01}) \\ = \;& \beta(A_{12} - A_{11} - (Z_{02} - Z_{01})) \end{aligned} \tag{4}$$

The worker undereducation reward will be positive whenever the difference in reservation incomes for the employers with two types of jobs is less than the difference in outputs of a worker type 1 at the two jobs. The reservation income for an employer with a given type of job will depend on the proportion of time the job is filled and the average income the employer will get with the two types of workers. With Nash bargaining, the employer with job 2 is generally only able to capture some of the increase in output compared to an employer with job 1. As a result, $A_{12} - A_{11} > Z_{02} - Z_{01}$, and the worker undereducation reward will be positive. Similarly, the worker overeducation penalty is:

$$\begin{aligned} & W_{22} - W_{21} \\ = \;& W_{02} + \beta(A_{22} - W_{02} - Z_{02}) - W_{02} - \beta(A_{21} - W_{02} - Z_{01}) \\ = \;& \beta(A_{22} - A_{21} - (Z_{02} - Z_{01})) \end{aligned} \tag{5}$$

The worker overeducation penalty will generally be positive for the same reasons that the worker undereducation reward is positive. Furthermore, under the assumption that $A_{22} - A_{12} > A_{21} - A_{11}$,

$$\begin{aligned} & \beta(A_{22} - A_{21} - (Z_{02} - Z_{01})) - \beta(A_{12} - A_{11} - (Z_{02} - Z_{01})) \\ = \;& \beta(A_{22} - A_{21} - (A_{12} - A_{11}) > 0 \end{aligned} \tag{6}$$

so that the worker overeducation penalty would always be greater than the worker undereducation reward. While Nash bargaining explains why a positive worker undereducation reward and a positive overeducation penalty are likely, it does not rule out extreme cases where the reward or penalty could be zero or negative.

Conditions for a positive worker undereducation reward are considered in more detail in the appendix by incorporating determinants of the reservation wage and income. In a labor market with two types of workers and two types of jobs and with both undereducation and overeducation, the worker undereducation reward will be positive whenever

$$\left(\frac{A_{22} - A_{21}}{A_{12} - A_{11}} - 1\right) < \frac{v(N_{w1} + N_{w2})}{(1-\beta)(1-v)N_{w2}} \tag{7}$$

where v is the vacancy rate and N_{wi} is the number of workers of type i. Similarly, the worker overeducation penalty is positive whenever

$$\left(\frac{A_{12} - A_{11}}{A_{22} - A_{21}} - 1\right) < \frac{v(N_{w1} + N_{w2})}{(1-\beta)(1-v)N_{w1}} \tag{8}$$

The assumption that $A_{22} - A_{12} > A_{21} - A_{11}$ is equivalent to $A_{22} - A_{21} > A_{12} - A_{11}$ and guarantees that the above condition holds, so that the worker overeducation penalty would always be positive.

Further potential information on the conditions for positive worker undereducation reward and overeducation penalty are available from the relations between the unemployment and vacancy rates, the numbers of workers and employers of each type, and the matching function relating the transition rates from unemployment to employment and from vacancies to filled jobs to the matching function. A requirement that jobs yield zero expected profit would also constrain the combinations of outcomes that could occur.

3 Conclusions

The results of this analysis demonstrate that Nash bargaining could generate the empirical regularities observed in the overeducation literature. Nash bargaining explains why workers would be paid differently depending on the job at which they are employed. Specifically, Nash bargaining explains why both the worker undereducation reward and the worker overeducation penalty are positive in the meta-analyses of Leuven and Oosterbeek and of Groot and Maassen van den Brink, and in the empirical work of Quintini. Nash bargaining also predicts that the worker overeducation penalty should exceed the worker undereducation reward, as occurs in the Quintini estimates but not in the meta-analyses of Leuven and Oosterbeek or of Groot and Maassen van den Brink. The wage consequences of educational mismatches generated by Nash bargaining provide a source of wage dispersion among identical workers and contribute to inequality (Fabian Slonimcyzk, 2012). The results of this paper provide a theoretical foundation for the Duncan and Hoffman extension of the Mincer earnings function to include overeducation, required education and undereducation.

However, this paper does not rule out alternative explanations of the wage consequences of educational mismatches. Other explanations that have been considered include regression towards the mean, Robert Shimer's model of coordination frictions (2005) and heterogeneity among workers at a given educational level and among jobs that have a given educational requirement.[5] The literature on mismatches has been extended to include differences in skills or competencies, regarded as worker productive abilities that were not generated by the formal educational process. A natural extension of this paper would be to consider the wage consequences of mismatches in both education and skill.

Appendix

Conditions for wage consequences of educational mismatches can be considered in more detail in the context of a formal model with two types of workers with different educational levels and two types of jobs with different requirements for educational levels. Suppose there are N_{wi} workers of type i and N_{kj} jobs of type j. Let A_{ij} be the output of a worker of type i at a job of type j as in Table 2. Assume both overeducation and undereducation occur, so that both types of workers take jobs at both types of employers. This imposes the constraint that $A_{ij} \geq W_{0i} + Z_{0j}$. Assume that the difference in outputs for the two types of workers, $A_{2j} - A_{1j}$, is greater for the employer with the greater educational requirement, so that $A_{22} - A_{12} > A_{21} - A_{11}$. In the labor market, unemployed workers of both types randomly seek both types of jobs. Workers move between employment and unemployment according to a Markov process, with transition rates λ from unemployment to employment and γ from employment to unemployment. The transition rate λ is determined by a matching function while the separation rate γ is assumed to be constant. With unemployment rate u and vacancy rate v, the number of matches m formed between workers and employers per period would be given by $m(u(N_{w1} + N_{w2}), v(N_{k1} + N_{k2}))$. The transition rate from unemployment to employment for workers in equilibrium is then $\lambda = m(u(N_{w1} + N_{w2}), v(N_{k1} + N_{k2}))/(u(N_{w1} + N_{w2}))$

The reservation wage for a worker moving between employment and unemployment according to a Markov process is a weighted average of the outcomes when employed and unemployed (Sattinger, 1985, p. 14):

$$W_{0i} = \frac{\lambda}{\lambda + \gamma + r} W_{ei} + \frac{\gamma + r}{\lambda + \gamma + r} B, \ i = 1, 2 \tag{9}$$

where W_{ei} is the weighted average wage while employed, r is the discount rate, and B is the benefit or loss when unemployed. The average wage will be a weighted average of the wage rates W_{i1} and W_{i2} determined in 2. Then:

$$W_{ei} = \frac{N_{w1} W_{11} + N_{w2} W_{12}}{N_{w1} + N_{w2}}, \ i = 1, 2 \tag{10}$$

In the expression for the reservation wage, the unemployment rate is $\gamma/(\lambda + \gamma)$, the same for all workers. If the discount rate is small, the expression for the reservation wage can be approximated by:

$$W_{0i} = u W_{ei} + (1 - u) B, \ i = 1, 2 \tag{11}$$

[5] See discussions of heterogeneity in Francis Green and Steven McIntosh, 2007; T. Korpi and M. Tahlin, 2009; Kostas Mavromaras and Seamus McGuinness, 2007, p. 281; McGuinness, 2006, pp. 399-401; and Quintini, 2011a, pp. 20-26.

where u is the unemployment rate.

Using an analogous approximation, the reservation income Z_{0j} can be expressed as

$$Z_{0j} = vZ_{ej} + (1 - v)C, \ j = 1, 2 \quad (12)$$

where Z_{ej} is the weighted average of incomes employing the two types of workers, v is the vacancy rate, and C is the cost to the employer while the job is vacant. Then:

$$Z_{ej} = \frac{N_{k1}Z_{1j} + N_{k2}Z_{2j}}{N_{k1} + N_{k2}} \quad (13)$$

Substituting the expression for the employer reservation incomes into the expression for the worker undereducation reward and solving yields:

$$\frac{\beta(v(N_{w1} + N_{w2}) - (A_{22} - A_{21} - A_{12} + A_{11})(1 - \beta)(1 - v)N_{w2}}{(N_{w1} + N_{w2})(1 - \beta(1 - v))} \quad (14)$$

Since the denominator in this expression is positive, the worker undereducation reward will be positive whenever 7 holds. An analogous derivation shows that the overeducation penalty will be positive whenever 8 holds.

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