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Anders Björklund
Bernt Bratsberg
Tor Eriksson
Markus Jäntti
Oddbjörn Raaum

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Forschungsinstitut
zur Zukunft der Arbeit
Institute for the Study
of Labor

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Anders Björklund
SOFI, Stockholm University and IZA Bonn

Bernt Bratsberg
Ragnar Frisch Centre for Economic Research and Kansas State University

Tor Eriksson
Aarhus School of Business

Markus Jäntti
Åbo Akademi University

Oddbjörn Raaum
Ragnar Frisch Centre for Economic Research

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IZA

P.O. Box 7240
53072 Bonn
Germany

Phone: +49-228-3894-0
Fax: +49-228-3894-180
Email: iza@iza.org

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ABSTRACT

Inter-Industry Wage Differentials and Unobserved Ability: Siblings Evidence from Five Countries*

This paper examines the role of unobserved ability in explaining inter-industry wage differentials, drawing on data on brothers. Such data allow us to account for unmeasured abilities due to common family and community factors shared by siblings. Important advantages of this approach are that we do not rely on assumptions of exogenous job mobility and that estimates reflect long-run wage differentials rather than short-run differences following switch of industry. The data sets come from four of the Nordic countries and the United States. We find that, in the Nordic countries, only a moderate proportion of the variability in industry wages is due to unobserved ability, while unmeasured factors explain as much as half of the industry wage variation observed in the United States. Accounting for such differences, we show that the U.S. inter-industry wage dispersion is similar to those of the Nordic countries.

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Corresponding author:

Anders Björklund
SOFI
Stockholm University
10691 Stockholm
Sweden
Email: anders@sofi.su.se

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1 Introduction

Following Dickens and Katz (1987) and Krueger and Summers (1988), there has been renewed interest among labor economists in analyzing inter-industry wage differentials. As a result, a growing literature presents estimates of the size and persistency of the industry wage rents that remain after controlling for human capital and job characteristics expected to give rise to compensating wage differentials.[1] The key results from estimations for a large number of countries, different time periods, and using different specifications of the empirical earnings function, are that inter-industry wage differentials do exist, are of a non-negligible magnitude, and are highly persistent over long periods of time.[2]

Such observations appear at variance with the standard model of competitive labor markets, which predicts that long-term wage differentials reflect only compensating factors (such as risks of injury or unemployment) and that short-term industry rents will dissipate over time. As a consequence, researchers have focused their attention on modified competitive models (for example, models with limited mobility between industries) and on non-competitive models, including efficiency wage and rent-sharing models, in attempts to explain the observed wage patterns.[3] Another approach has considered the role of labor market and, in particular, wage-setting institutions.[4]

As noted by Krueger and Summers, the estimated inter-industry wage differentials may reflect differences in unmeasured individual productivity (henceforth referred to as "ability") across industries. If, as seems plausible, workers with high unmeasured ability earn high wages, then industries employing disproportionately more high-ability workers pay higher average wages to observationally equivalent workers. A number of studies—four influential ones are Murphy and Topel (1990), Gibbons and Katz (1992), Blackburn and Neumark (1992), and Keane (1993)—have assessed the impact of bias from failing to account for unobserved ability using alternative

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[1] Large and persistent wage differentials have also been shown to be present across establishments within industries, even after controlling for standard covariates and individual fixed effects; see Groshen (1991).

[2] See Albæk *et al.* (1996) for evidence from the Nordic countries. Some examples of individual country studies are Vainiomäki and Laaksonen (1995) and Asplund (1993) for Finland, Longva and Strøm (1998) for Norway, and Arai (1994) for Sweden.

[3] Bell and Freeman (1991) give a comprehensive analysis of the competing explanations.

[4] See Barth and Zweimüller (1992), Edin and Zetterberg (1992), Holmlund and Zetterberg (1991), and Blau and Kahn (1998).

methodological approaches. One approach makes use of longitudinal data and the wage changes of workers who switch industry affiliation.[5] Under the assumptions that ability is time-invariant and equally valued in all industries, first-difference estimation based on industry switchers yields unbiased estimates of industry wage effects. If these assumptions do not hold, however, matching of individuals and industries becomes important and inter-industry mobility of workers is endogenous. In that event, even first-difference estimates will reflect unmeasured ability differences across industries. Presumably, many workers change jobs and thereby industry affiliation because they receive a better offer. In most cases, a better offer means a higher wage.

One way to circumvent these problems is to use data from plant closings, in which case mobility is less likely to be endogenous and industry switchers' wage changes are less likely to reflect unmeasured ability. For example, such data allow Gibbons and Katz (1992) and Kim (1998) to examine how much of the pre-displacement industry wage premium is maintained when workers are re-employed. Although data from plant closings may eliminate the endogeneity of job mobility decisions, worker selectivity with respect to change of industry remains a problem and is likely to affect estimation results.

Another potential problem of the first-difference method is related to the returns-to-tenure component of wages. Workers' post-switch wages are typically observed after a short period, *i.e.,* when they have accumulated only little tenure in their new job. If there are positive returns to tenure, the "permanent" wage in the post-switch job may be underestimated.

Finally, measurement error from misclassification of industry, which is non-trivial in most longitudinal data sets, is exacerbated using within-individual differences simply because a larger fraction of the observed variation in industry affiliation is due to measurement error.

In their seminal study, Krueger and Summers conclude that first-difference and individual fixed-effects estimators yield industry wage structures similar to that obtained in a cross-sectional study. Gibbons and Katz concur with the earlier study in finding that first-differenced and cross-section based industry wage differentials are very similar, but they also find that pre-displacement industry affiliation enters significantly in post-displacement wages, and argue that

[5] An early study using Danish data taking this approach is Albæk and Madsen (1993).

neither the true industry effects nor the pure unmeasured ability explanations fit their empirical evidence. Murphy and Topel (1989), who also employ a first-difference approach but a different data source than Krueger and Summers, conclude that unmeasured individual effects is the primary explanation of observed inter-industry wage differentials.

Blackburn and Neumark's (1992) analysis differs from the above-mentioned studies in that it includes intelligence test scores as indicators of otherwise unobserved ability. According to their results, one tenth of the variation in inter-industry wage differentials reflects differences in the test scores.

More recently, Abowd, Kramarz, and Margolis (1999), who can match workers to their employers, find that, for France, almost all of the inter-industry wage differentials can be explained by the variation in individual heterogeneity across sectors. Their findings are of considerable interest, as explanations such as efficiency wage theory suggest that in optimum some firms may pay higher than normal wages but that the resulting wage differences should depend on employer characteristics and not on the traits of the employees, as in the competitive model.[6]

This paper aims to shed further light on the importance of unobserved ability in explaining inter-industry wage differentials by making use of data on siblings. Estimating wage equations for siblings, we can account for shared unmeasured ability components that arise from common family and community factors, such as upbringing, school quality, neighborhood, as well as shared genetic traits. The literature on siblings correlations—see Solon (1999) for a survey—has demonstrated that the factors siblings have in common account for at least as much of the variation in individual earnings as do observed human capital characteristics. Moreover, there is good reason to expect industry affiliation to be influenced by family and community background, and, so, disregarding this information may lead to biased estimates. A person's industry affiliation is in part determined by her educational attainment and occupation. Several intergenerational studies have identified strong linkages between family background and length as well as type of schooling and occupation. As we show below, the probability that two persons

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[6] In a later paper, Abowd and Kramarz (2000) apply a different estimation technique to the same data set and arrive at the opposite conclusion that individual heterogeneity plays a minor role in explaining inter-industry wage differentials.

are employed in the same industry is considerably higher if they are siblings. We also provide evidence of significant inter-industry ability differentials.

There are two important methodological advantages of comparing siblings employed in different industries rather than individuals who change industry affiliation. First, we do not need to rely on the assumption of exogenous job mobility. At the same time, however, siblings do not have identical abilities and industry affiliation may correlate with unobserved ability even within families. Therefore, by studying sibling differences, we are likely to remove some of the ability bias and get a tighter upper bound on the true inter-industry wage differential. Second, estimates reflect long-run or permanent wage differentials rather than short-seniority differentials that typically are estimated in studies using data on industry switchers.

This paper utilizes large Nordic data sets and the NLSY for the United States. Previous comparative studies of industry differentials have found that wage differences across industries are small in the Nordic countries, particularly compared to those in the United States.[7] This pattern has frequently been attributed to institutional factors like centralized wage setting.

The paper is structured as follows. The next section gives a short description of the data sets. Section 3 defines the measures of inter-industry wage variation and presents the main results of the analysis. The fourth section discusses cross-country differences and some concluding remarks are offered in section 5.

2 Data description

To facilitate comparisons with prior Nordic studies, employees are classified as belonging to one of 24 industries. The exact industry classifications are reported in Appendix Table A1. (The table also lists employment shares and average log earnings in each industry in the analysis samples; see sample descriptions below.) Because our earnings records likely are poor measures of consumption opportunities of workers in agriculture and fishing/forestry, we exclude these industries from the analyses.

[7] See, *e.g.*, Blau and Kahn (1998), Edin and Zetterberg (1992), and Barth and Zweimüller (1992).

In the empirical analyses, we make use of five different data sets—one for each of the Nordic countries of Denmark, Finland, Norway, and Sweden, and one for the United States.[8] The Danish data set is constructed by merging two longitudinal databases. One is a representative 5 percent sample of the population aged 15 to 74 in the period 1980-95, and the other is the so-called fertility database, which provides detailed demographic information about all Danes born after 1942. Both data sources include information about the individuals' earnings and labor market status. Individuals in the 5 percent sample are merged with their biological siblings and parents in the fertility database. Earnings information comes from tax records and is available as from 1980. In the present paper, we use annual earnings from 1995.

The Finnish data stem from the Finnish quinquennial census panel covering the period 1970 to 1995. The data set consists of individuals aged 17 years or younger who lived in the same census household in 1970 and are therefore considered as siblings. Tax-register based measures of annual earnings for 1995 are used in the analysis below.

The source of the Norwegian data is a complete register of all residents in Norway as of January 1, 1993. Siblings are identified through links to their biological parents, so a minor sample restriction is that the mother was alive and a resident of Norway in 1993. Annual earnings information for 1995 is collected from registers of Statistics Norway. Earnings include wages and self-employment income. The sample is restricted to those working 30 hours or more per week for the same employer throughout the year.

The Swedish data emanate from several registers held by Statistics Sweden. The starting point is a random sample of persons living in Sweden in 1992 who either were born in Sweden or moved to Sweden before the age of 18. To this, we add information about siblings (biological as well as social) of the individuals and the households they were living in census years 1960 to 1980. Finally, this data set is merged with information from annual earnings registers for the year 1996.

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[8] For the Nordic countries, the data sets are subsamples of data used and described in Björklund et al. (2002). For the United States, we use in fact two data sources—the main analysis is based on the NLSY, but we also use the 1995 outgoing rotation groups from the Current Population Survey (CPS) to check whether the smaller NLSY samples are representative. To illustrate, the correlation coefficients between the NLSY-based employment shares and log wage series listed in Table A1 and those we obtain for the same age group in the 1995 CPS data are .95 and .94, respectively.

In line with prior studies, we restrict the analysis to male employees, i.e., to brothers, in order to avoid estimates that are heavily influenced by variation in working hours for female workers. Moreover, in the Nordic data sets we have employed a common age restriction of 30 to 42 years of age in the outcome year for which we observe their earnings. Because the earnings information in these data comes from tax registers, the earnings concept is that of annual earnings.[9] Thus, to reduce the impact of part-year work, we exclude individuals with earnings below a certain threshold. This threshold is defined by multiplying the 5th percentile in the hourly wage distribution for males aged 30-42 with the normal hours of work per year (37.5*52).[10]

The U.S. data set is drawn from the National Longitudinal Survey of Youth (NLSY). The NLSY is a nationally representative survey of 12,686 youths aged 14-22 when they were first surveyed in 1979. Sampling for the initial survey was based on households, and every youth in a sampled household was included in the survey. Using information on family structure recorded the initial year, we are able to identify 5,863 individuals with a biological sibling also participating in the survey. Of 6,403 males, we identify 2,013 individuals with a biological brother in the survey. To optimize the number of usable brother pairings, but also to reduce noise inherent in survey data, we base the analysis on eight recent waves of the survey (covering 1990-2000; there were no surveys in 1995, 1997, and 1999),[11] but form a cross-sectional regression sample by averaging characteristics (such as the real hourly wage) for each individual across the eight waves. Excluding observations while enrolled in school, with missing data, and with reported hourly wages less than one-half of the federal minimum wage or greater than $200, we are left with 28,267 individual-by-year observations from the eight waves. From these data, we form a cross-sectional regression sample consisting of 5,065 males, of whom 1,653 individuals also have a biological brother in the sample.

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9 The Danish data include information on both hourly wages and annual labor earnings.

10 Antelius and Björklund (2000) demonstrate using Swedish data that such a limit makes annual earnings estimates mimic hourly earnings results quite well.

11 During the relevant survey years, NLSY participants were 25 to 43 years of age, making the age profile of the U.S. sample slightly younger than those of the Nordic countries (see descriptive statistics in Appendix Table A2). When we apply the same age restriction as that used in the Nordic data to the U.S. sample, results are very similar to those reported in the paper. Unfortunately, the additional age restriction involves a substantial reduction in the number of brother pairings and loss of precision in within-family estimates, so we prefer reporting results from the broader sample.

Appendix Table A2 gives further details of the family structure in the five samples along with descriptive statistics of the variables used in the empirical analyses. The table also lists coefficient estimates of control variables in the wage equations (see the next section).

3 Analyses and results

3.1 Measuring industry wage differentials and variation

To analyze the role of industry affiliation in explaining overall wage variation, we consider two metrics measuring the weighted standard deviation of inter-industry wage differentials. These metrics are calculated from a standard wage equation, i.e., by means of the coefficient vector of a set of industry indicator variables, its variance-covariance matrix, and the distribution of wage earners across industries. The earnings equation is given by

$$(1)\ w_i = \sum_{k=1}^{K} \beta_k D_{ki} + \chi Age_i + \delta Married_i + \sum_{s=1}^{S} \phi_s EDUC_{si} + v_i \,,$$

where w_i denotes the log wage of individual i; D_{ik} equals one if individual i is employed in industry k; $EDUC_{is}$ is set to unity if the individual's educational attainment equals s; and v_i is the classical regression error.

An intuitive measure of the overall variability in industry wages is the *weighted standard deviation (WSD)* of estimated industry wage differentials. The statistic is based on the deviation of the estimated industry differential from a weighted mean, *i.e.*,

$$b_k^* = b_k - \sum_{k=1}^{K} \pi_k b_k$$

where π_k is the employment share of industry k. WSD is then given by

$$WSD = \sqrt{\sum_{k=1}^{K} \pi_k (b_k^*)^2} \ .$$

As emphasized by Krueger and Summers (1988) and further elaborated upon in Haisken-DeNew and Schmidt (1997), the WSD statistic is an upwardly biased estimate of the variability of industry wages as it ignores the least-squares sampling error arising from the fact that b_k is itself an estimate. Krueger and Summers adjust the statistic for sampling error using an approximation of the variance-covariance matrix based on the standard errors of the estimated industry coefficients and the constant term, and Haisken-DeNew and Schmidt derive an unbiased estimator based on the complete variance-covariance matrix. In the present study, the Haisken-

DeNew and Schmidt estimator is used in calculations of the *weighted adjusted standard deviation (WASD)* of industry wage differentials.[12]

3.2 Estimates Based on Ordinary Least Squares

The standard OLS estimates of industry wage differentials are set out in *Table 1,* separately for each country.[13] The table reveals some interesting parallels across the industry wage structures of the five countries. For example, workers in finance and insurance receive a considerable wage premium in all countries considered. In fact, finance and insurance ranks as the top-paying industry in four of the five countries, and ranks second (only behind the oil industry) in Norway. Within the manufacturing industries, chemical and basic metal pay above-average wages in all five countries, while wages in textiles and furniture manufacturing tend to be below average. At the bottom of the industry pay scale, those employed in the educational sector and those in social institutions receive low pay in all five countries, ranking as the two lowest paying industries in three out of five cases (the exception being education which ranks third from the bottom in the United States and fifth from the bottom in Finland). We return to further cross-country comparisons below.

Table 1 about here

Table 2 reports summary measures of the variation in inter-industry wage differentials.[14] In Panel A, we list metrics based on OLS estimates of wage differentials. Both the adjusted WASD and the unadjusted WSD statistics show that the standard deviation of industry differentials is of similar magnitude in the four Nordic countries, ranging from 0.090 log point in Finland to 0.113 log point in Denmark.[15] The table also shows that, when based on OLS estimates, the variability

[12] To save space, we omit the exact computational formulas for the WASD statistic. For details, see Haisken-DeNew and Schmidt (1997), pp. 517-18.

[13] Reflecting differences in sample size, industry differentials are more precisely determined in the Nordic samples compared to the U.S. sample. The NLSY-based estimates listed in Table 1 nonetheless appear fairly representative, as they exhibit a correlation coefficient of .91 with estimates we obtain using a larger sample drawn from 1995 CPS data.

[14] In order to preserve direct comparability of results from OLS and within-family estimations, results in Table 2 are based on the subsamples of brothers and excludes singletons. Coefficient estimates from the restricted (i.e., brothers) samples are reported in Appendix Tables A4 and A5. Estimates of wage variability, both across individuals and industries, are however quite similar when we also include singletons in the analysis samples.

[15] Because of large sample sizes and small standard errors of estimated industry wage differentials, the adjustment is of limited importance and the OLS-based WASD and WSD statistics are nearly identical for the Nordic countries;

of wages across industries is substantially higher in the United States, 0.146 and 0.157 log point according to the adjusted and unadjusted standard deviations.

Table 2 about here

The finding of greater industry wage dispersion in the United States parallels the conclusions of prior studies, such as Edin and Zetterberg (1992) and Barth and Zweimüller (1992). The U.S.-Nordic difference appears smaller in the present study, however. This is foremost due to the fact that our estimates of industry wage variability for the Nordic countries are higher than those of the prior studies, especially those of Edin and Zetterberg. (Our WASD statistic for the United States is, in fact, similar to those reported for two-digit industries in Krueger and Summers (1988) and is virtually identical to that obtained by Blackburn (1995) in his reanalysis of Keane (1992), who also uses NLSY data.) A plausible, and particularly interesting, explanation of the discrepancy relates to the time periods of the studies. The Edin and Zetterberg study is based on data from 1984, which coincides with the end of an era of centralized wage bargaining in Sweden (Edin and Holmlund, 1995). The subsequent decline in centralized wage setting is estimated to have led to significant increases in wage inequality among Swedish workers in general (Hibbs and Locking, 1995; Wallerstein, 1999). As observed by Katz and Autor (1999), a likely consequence of such developments is that our data, from 1995, exhibit greater wage dispersion across industries than that found in data that predate the move towards industry- and company- based wage setting.

3.3 Family background and industry affiliation

Our principal aim is to investigate the potential bias in the WSD and WASD statistics arising from correlation between unobserved individual productivity and industry affiliation. A study of siblings is useful for this purpose if *(i)* ability is correlated with industry affiliation, *(ii)* ability is (to a considerable extent) explained by factors shared by siblings, and *(iii)* family background is a determinant of industry affiliation.

Empirical evidence implies that all three aspects are relevant. First, using the score from the Armed Forces Qualifications Test (AFQT) as a proxy for individual ability, the NLSY data

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see also the discussion in Haisken-DeNew and Schmidt (1997).

provides an opportunity to compute the correlation between "ability" and industry affiliation.[16] We find significant industry AFQT differentials and the variability across industries as measured by AFQT-WASD remains even after controlling for age and schooling (see *Table A3*). Second, inter- as well as intra-generational studies of earnings indicate that siblings share a common human capital component; see, e.g., Solon (1999) and Björklund et al. (2002).

Third, family background does indeed affect industry affiliation. *Table 3* reports the fraction of brothers working in the same industry alongside the probability that two randomly drawn individuals are employed in the same industry. The latter probability is given by

$$P = \sum_{k=1}^{K} \Pr(individual\,1\; in\; industry\; k) * \Pr(individual\,2\; in\; industry\; k) = \sum_{k=1}^{K} \pi_k^2 \,,$$

where π_k is the employment share of industry k (K=24) listed in Table A1. As shown in Table 3, the probability that two randomly drawn individuals are employed in the same industry is about 0.07 in all five countries. The actual, observed fraction among brothers (in two brother families) is considerably higher and hovers around 0.2 in all countries.

Table 3 about here

Extending the empirical model to include family-specific components, we rewrite equation (1) as the log wage of individual i in family j:

$$(2)\;\; w_{ij} = \sum_{k=1}^{K} \beta_k D_{ijk} + \chi Age_{ij} + \delta Married_{ij} + \sum_{s=1}^{S} \phi_s EDUC_{ijs} + f_j + u_{ij} \,.$$

The unobserved component is split in two terms—a family component, f_j, which is shared by brothers, and an individual error, $u_{ij,}$ assumed normally distributed with a constant variance. The *within-family estimator* is based on the individual sibling's deviation from the family mean,

$$(3)\;\; \begin{aligned} \triangle w_{ij} &= w_{ij} - \overline{w_j} = \sum_{k=1}^{K} \beta_k (D_{ijk} - \overline{D_{jk}}) + \chi(Age_{ij} - \overline{Age}_j) \\ &+ \delta(Married_{ij} - \overline{Married}_j) + \sum_{s=1}^{S} \phi_s (EDUC_{ijs} - \overline{EDUC}_{js}) + (u_{ij} - \overline{u}_j) \end{aligned} .$$

[16] Participants of the NLSY were administered the Armed Services Vocational Aptitude Battery (ASVAB), from which the AFQT score is constructed, in 1980. The ASVAB consists of a battery of tests that measure knowledge and skill in ten different areas (such as science, arithmetic reasoning, and word knowledge) and the AFQT score is used by the armed forces as a measure of trainability and enlistment eligibility. Recent studies based on the NLSY, such as Blackburn and Neumark (1995) and Neal and Johnson (1996), use the AFQT score as a proxy for otherwise unobserved ability.

OLS and within-family estimates of WASD will differ when $var(f_j)$ is non-zero and f_j is correlated with industry affiliation. Consequently, if family background characteristics have an independent effect on adult wages beyond their influence through schooling, marital status, and industry affiliation, conventional least-squares estimates of $\beta_1, \ldots, \beta_K$ will be biased.

Of course, even within-family estimates may be biased if siblings working in different industries do not have the same ability (conditional on education, age, and marital status). If we can rule out the possibility that the OLS estimate of WASD is *downward biased*,[17] however, the within-family estimate of WASD can be considered as an *upper bound* on the true standard deviation of industry wage differentials.[18]

Panel B of Table 2 lists the estimated metrics based on the within-family variation in industry affiliation. By comparing results in Panels A and B, we assess the wage dispersion across industries and the importance of bias arising from (unmeasured) family background heterogeneity. A key pattern to emerge from the table is that within-family estimates of WASD are lower than OLS-based estimates, indicating that OLS estimates of industry wage differentials are indeed imparted by bias. This pattern holds for all five countries.

Although the within-family based estimates of the WASD metric are lower than those based on OLS, controlling for unobserved ability associated with family background turns out to have a relatively moderate impact on the measure of industry wage dispersion—at least in the Nordic countries. Following Blackburn (1995), we consider the importance of unobserved ability by squaring the ratio of within-family and OLS-based estimates of WASD. If this squared ratio is, say, 0.5, then 50 percent of the variance of industry wage differentials remains after accounting for unobserved heterogeneity. As shown in the third row of Table 2, Panel B, for the Nordic countries the squared ratio ranges from 0.74 (Sweden) to 0.89 (Denmark and Finland), meaning that a modest fraction (11 to 26 percent) of the OLS industry wage variation is due to unobserved ability. For the United States, the squared ratio is substantially lower—0.47—implying that differences in unobserved ability across industries explains more than half of the observed U.S.

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[17] The estimate would be downward biased if low-paying industries employ workers with high ability, and vice versa. This seems very unlikely to be the case.

[18] See Griliches (1977) and the corresponding argument by Bound and Solon (1999) on the value of within-family estimates of returns to schooling.

industry wage variance. According to the reanalysis of early studies in Blackburn (1995, Table 2, p. 858), our U.S. figure is in line with results based on Keane (1992), but attributes greater importance to unobserved factors than the studies of Gibbons and Katz (1992) and Blackburn and Neumark (1992).

That the WASD statistic is lower when based on within-family than OLS estimates of industry wage differentials is consistent with the story that OLS estimates in part reflect differences in unobserved ability across industries. Recall, however, that the WASD statistic deflates the measurement of industry wage variation when coefficients are imprecisely determined. Such adjustments might be more severe in small samples and for estimators (such as the within-family estimator) that typically yield large standard errors of coefficient estimates. (Inspection of Tables A4 and A5 reveals that standard errors of within-family coefficient estimates are indeed much higher than those of OLS estimates.) To ensure that our key findings are not simply the artifact of understatement of the WASD statistic when based on within-family estimates, we therefore also consider changes in the (albeit, upwardly biased) WSD statistic, which does not adjust for the precision of industry coefficient estimates. As Table 2 shows, when based on comparisons of OLS and within-family estimates of the unadjusted statistic, conclusions are largely unaffected for the Nordic countries and only slightly modified for the United States: Eight (Finland) to 26 (Sweden) percent of the industry wage variance in the Nordic countries is due to unobserved ability compared to 43 percent for the United States.[19]

Another concern is that differences in measurement error across data sources might invalidate cross-country comparisons. Because the Nordic samples are drawn from register data, industry classification is expected to be more accurate for these countries. For example, in the Norwegian data industry affiliation is the official classification of the workplace made by Statistics Norway. Moreover, to avoid any misclassification due to within-year change of industry, the sample is limited to those staying with the same employer throughout the year. In contrast, the U.S. data are based on individual reports of type of work, and are subject to considerable reporting error (Mellow and Sider, 1983). In fact, of the 14,538 continuing jobs with the same employer that we observe in the underlying U.S. longitudinal sample, 14.3 percent involve an unexplained change

[19] Note, however, that the patterns of WASD and WSD statistics in Table 2 are consistent with less precision of coefficient estimates inducing a greater upward bias in the within-family based estimate of WSD compared to that based on OLS.

of (two-digit) industry classification. Among these, 20.5 percent revert back to the original industry code after one year, and another 6.4 percent revert back after two years.[20] Such reporting errors are likely to cause severe bias towards zero in first-difference estimates, and might affect within-family estimates.

To check whether the large reduction in the U.S. within-family based estimate of the WASD statistic (compared to OLS) is influenced by reporting errors in industry affiliation, we apply three different corrections to the classification of job spells with unexplained changes of industry. Results are reported in *Table 4*. In column 1, we first override all unexplained within-job spell industry changes that revert back to the original classification within two years. Next, we recode the industry classification using the last reported code for the job spell (column 2). Finally, in column 3 we simply drop from the sample any job spell that involves an unexplained change of industry. As the table shows, these experiments produce estimates of OLS and within-family based WASD statistics that are very close to those reported in Table 2. Importantly, the conclusion that unobserved heterogeneity explains approximately 50 percent of observed U.S. industry wage variation appears not to be the result of individual reporting errors in industry classification.

Table 4 about here

Figure 1 plots within-family against OLS estimates of industry wage differentials separately for each of the five countries of the study, and gives a visual illustration of several of the key findings of this section. First, the plots show the greater general variability of OLS estimates in the United States compared to those of the Nordic countries. For example, the range between the highest and lowest paying industries is 0.758 log point in the United States and varies from 0.501 (Sweden) to 0.572 (Finland) log point in the Nordic countries. Such differences bring about the larger U.S. OLS-based WASD and WSD statistics reported in Table 2.

Second, the plots illustrate a tendency of high-pay scatter points to fall below, and of low-pay

[20] A couple examples illustrate how difficult it can be for individuals to classify ones workplace (however easy a task for a trained labor economist). One survey participant lists the same job under “Vending machine operators” (i.e., retail trade) for three years running, and then under “Eating and drinking places” (restaurants) the following two years. Another lists his job as “Scientific and controlling instruments” one year, “Business services, n.e.c.” in year two, “Engineering services” in year three, and “Aircraft parts” in years four and five.

scatter points to lie above, the 45-degree line, suggesting upward bias in high, and downward bias in low, OLS estimates of industry wage differentials. To illustrate, the within-family estimate of the wage premium in finance and insurance (industry 17) falls below the OLS estimate in each of the countries considered. Conversely, the industry wage penalties faced by workers in social institutions (industry 23) and education (industry 21) are lower when based on within-family than OLS estimates.[21] Such modifications to high and low estimates result in less variability of industry wages when measured along the vertical axis, giving rise to lower within-family measures of WASD and WSD compared to those based on OLS. As the figure shows, this pattern is particularly strong for the United States and Sweden, the countries with the greatest reductions in the WASD and WSD statistics in Table 2.[22]

Figure 1 about here

In summary, the exercise of comparing OLS and within-family estimates of industry wage dispersion suggests moderate ability bias in estimates of industry wage differentials in the Nordic countries but a greater role for unobserved factors in U.S. estimates. Such differences between the United States and the Nordic countries may reflect a stronger pattern of sorting of workers by ability across industries in the U.S. labor market (perhaps related to the greater overall dispersion of basic skills among U.S. workers discussed in the next section), but also that U.S. returns to unobserved skills exceed those of the Nordic countries. Importantly, when we account for unobserved ability, the larger reduction of the U.S. WASD measure brings the estimate of industry wage dispersion in the United States close to those of the Nordic countries (see Table 2, Panel B). The implication is that at a significant portion of the greater industry wage variation observed in the United States is the result of ability bias in OLS estimates of industry wage differentials.

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[21] Again, the exception is the educational sector in Finland, for which the within-family estimate suggests a larger wage penalty than the OLS estimate. Note, however, that both sets of estimates indicate smaller wage penalties in the educational sector in Finland compared to the other four countries considered.

[22] The U.S. plot is also suggestive of greater general variability of scatter points that might be related to the smaller U.S. sample size. In particular, some of the smaller industries in the U.S. data (1. Oil, mining; 6. Other non-metal; and 8. Furniture) appear to be outliers in the figure. Because the WASD and WSD statistics are weighted by the industry employment share, small industries have little influence on these statistics. Indeed, excluding these industries from the analyses turns out to have only minor impact on results and do not alter any of the conclusions drawn in the paper.

4 Further cross-country comparisons

In this section, we briefly discuss similarities and differences of results within the Nordic countries and how they differ from those of the United States. As shown in *Table 5*, the patterns of industry wage differentials are highly correlated across countries, with the same industries paying high or low wages in each the five countries considered. Not surprisingly, correlation coefficients are generally higher within the Nordic countries than in comparisons with the United States.[23]

Table 5 about here

Previous comparative studies of industry wage differentials have focused exclusively on the WASD (or WSD) statistic as the relevant metric for cross-country comparisons. Such studies typically attribute the lower metrics obtained for the Nordic (and other European) countries compared to the United States to institutional factors like centralized wage setting and union coverage; see, e.g., Barth and Zweimüller (1992) and Kahn (1998). It is rarely acknowledged that the distribution of skills, beyond that measured by formal education, differs across countries. This of course reflects the fact that data on comparable measures of "productivity" or "skills" are very thin. The International Adult Literacy Survey (IALS) is one of the few exceptions; cf. OECD (2000). The survey provides a "Quantitative literacy" index that has been used by, *e.g.*, Freeman and Schettkat (2000) and Blau and Kahn (2001) in their comparative studies of wage inequality.[24]

Table 6 lists figures showing how the level, and more importantly, the distribution of literacy skills differ across the countries of the present study. We note that mean scores are only slightly higher in the Nordic countries than in the United States. The major difference lies instead in the dispersion of skills, measured by the 95/5 percentiles ratio, which is about 50 percent higher in

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[23] When reporting correlation coefficients based on within-family estimates, we exclude industry 1. Oil, mining, because of a small cell count in the U.S. brother sample. In fact, the U.S. sample of brothers includes only seven observations in that industry. Importantly, apart from the within-family correlations reported in Table 4, Panel B, no other results or conclusions drawn in the paper are sensitive to whether or not we include this industry.

[24] The index measures the individual's "knowledge and skills required to apply arithmetic operations, either alone or sequentially, to numbers embedded in printed materials, such as balancing a chequebook, figuring out a tip, completing an order form or determining the amount of interest on a loan from an advertisement" (OECD, 2000).

the United States than in the Nordic countries. These numbers provide strong indication that productive skills are distributed more equally across workers in the Nordic countries. Hence, if all workers were paid according to their individual productivity, the lower dispersion of skills would lead us to expect less wage inequality in the Nordic countries than in the United States.

Table 6 about here

In light of such cross-country differences in the distribution of skills, it is reasonable to question the use of WSD or WASD as the sole metric for cross-country comparisons of industry wage variation. If the purpose of the exercise is to assess the importance of industry wage dispersion in a country, one might ask the following question: "What share of the total variation in wages in a society can be attributed to the distribution of workers by industry?" To answer that question, variability in industry wages must be considered relative to the total variation of wages and a candidate metric for cross-country comparisons is the ratio

$$WASD^2 / \mathrm{var}(w) .$$

If relevant skills are determined by pre-labor market qualifications, perhaps due to such factors as family background, neighborhoods, and schools, rather than by labor market institutions, a natural solution to preserve comparability across countries is to "scale" the WASD metric dividing by the overall variance of log wages.

In *Table 7*, we report the sample variances of log wages along with the rescaled measures of industry wage dispersion. The first row highlights the greater overall dispersion of wages in the United States compared to the Nordic countries, with the sample variance of log wages being about twice as large in the U.S. data (0.23 vs. 0.09 to 0.13 in the Nordic countries). Once we account for cross-country differences in overall wage variation, even OLS-based estimates of industry wage dispersion in the United States appear in line with those of the Nordic countries (Panel A). When we in addition account for the greater role of ability bias in U.S. estimates, results show that the relative variation in industry wages actually is *lower* in the United States than in the Nordic countries. Based on the within-family estimate of WASD listed in Panel B, the fraction of overall wage variation that is attributable to the industry wage structure and the distribution of workers across industries is only 4.4 percent in the United States, and falls below the range found in the Nordic countries (6.5 percent in Finland to 10.1 percent in Norway). Notwithstanding the importance of labor market institutions, underlying differences in the distribution of skills, beyond what is accounted for by formal education controls, ought to be taken into account in cross-country comparisons of labor market features like wage differentials between industries. When we standardize for differences in the overall distribution of wages, results in this section question the apparently well-established conclusion that the wage-setting institutions of the Nordic countries have lead to smaller wage differences across industries compared to those observed in the more competitive U.S. labor market.

Table 7 about here

5 Concluding remarks

The novelty of this paper has been to examine the importance of unobserved ability in understanding the existence and persistence of inter-industry wage differentials using data on siblings (brothers) from five countries. In contrast to the earlier literature, which has predominantly made use of longitudinal data of industry switchers, the approach of our study does not rely on difficult-to-defend assumptions regarding exogeneity of worker mobility between industries. Moreover, our approach is based on estimates of long-run wage differentials, not on short-term differences of industry switchers. We also argue that cross-country comparisons should pay attention to an alternative metric where the variance of industry wage differentials is measured relative to the overall variance in wages.

Our key findings are: (i) Within-family estimates of inter-industry wage differentials are lower than OLS estimates. (ii) Family background accounts for different proportions of the observed variation in wages across industries in the Nordic countries and in the United States. For the Nordic countries, we find that 11-24 percent of the industry wage dispersion can be attributed to unobserved factors common to brothers, while the U.S. figure is approximately 50 percent. Accounting for differences in ability bias brings U.S. estimates of industry wage dispersion in the same range as those of the Nordic countries. (iii) Our cross-country comparisons, which unlike the bulk of the previous studies recognize that the overall variance of wages is considerably higher in the U.S. than in the Nordic countries, show that the contribution of inter-industry wage differentials to total wage variation is larger in the Nordic countries than in the United States.

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Table 1. Inter-industry wage differentials. OLS estimates.

Industry	Denmark	Finland	Norway	Sweden	USA
1 Oil, mining	0.149	-0.023	0.328	0.087	0.060
	(0.036)	(0.035)	(0.005)	(0.015)	(0.071)
2 Food, beverage,	0.069	0.056	0.007	0.032	-0.034
tobacco	(0.009)	(0.016)	(0.004)	(0.008)	(0.040)
3 Textiles	0.000	-0.154	-0.081	-0.060	-0.162
	(0.023)	(0.034)	(0.014)	(0.018)	(0.061)
4 Wood, printing	0.087	0.076	0.023	0.076	-0.001
	(0.011)	(0.008)	(0.003)	(0.004)	(0.033)
5 Chemicals,	0.106	0.089	0.064	0.071	0.073
plastics	(0.012)	(0.015)	(0.005)	(0.007)	(0.046)
6 Other non-metal	0.037	0.008	-0.008	0.000	-0.013
	(0.017)	(0.023)	(0.007)	(0.012)	(0.065)
7 Basic metal	0.013	0.040	0.038	0.027	0.135
	(0.005)	(0.006)	(0.002)	(0.002)	(0.019)
8 Furniture	-0.051	-0.164	-0.106	-0.057	-0.183
	(0.014)	(0.022)	(0.007)	(0.011)	(0.074)
9 Utilities	-0.085	0.056	-0.071	0.056	0.141
	(0.015)	(0.015)	(0.005)	(0.008)	(0.046)
10 Construction,	0.021	-0.066	-0.050	-0.023	0.149
building	(0.006)	(0.010)	(0.002)	(0.003)	(0.016)
11 Sales, repair	-0.056	-0.106	-0.066	-0.053	0.000
	(0.012)	(0.015)	(0.004)	(0.007)	(0.031)
12 Wholesale trade	0.124	0.145	0.108	0.113	-0.078
	(0.007)	(0.010)	(0.002)	(0.004)	(0.036)
13 Retail trade	-0.007	-0.165	-0.077	-0.072	-0.196
	(0.012)	(0.014)	(0.004)	(0.006)	(0.025)
14 Hotels,	0.024	-0.071	-0.051	-0.090	-0.297
restaurants	(0.018)	(0.026)	(0.007)	(0.012)	(0.028)
15 Transportation	0.058	-0.014	0.025	-0.005	0.071
	(0.007)	(0.010)	(0.002)	(0.004)	(0.026)
16 Post,	-0.070	-0.039	-0.053	0.031	0.211
communication	(0.012)	(0.014)	(0.004)	(0.007)	(0.045)
17 Finance,	0.214	0.307	0.122	0.282	0.272
insurance	(0.011)	(0.020)	(0.004)	(0.007)	(0.038)
18 Real estate	-0.055	-0.074	0.093	-0.050	0.037
	(0.016)	(0.018)	(0.007)	(0.007)	(0.054)
19 Business	0.118	-0.029	0.103	0.076	-0.038
services	(0.008)	(0.009)	(0.003)	(0.004)	(0.022)
20 Public admin,	-0.131	-0.048	-0.114	-0.107	0.067
defense	(0.007)	(0.009)	(0.003)	(0.005)	(0.027)
21 Education	-0.222	-0.116	-0.220	-0.281	-0.270
	(0.009)	(0.014)	(0.004)	(0.006)	(0.035)
22 Health services	-0.101	-0.043	-0.107	-0.096	-0.065
	(0.014)	(0.016)	(0.005)	(0.006)	(0.034)
23 Social	-0.354	-0.217	-0.217	-0.234	-0.359
institutions	(0.011)	(0.029)	(0.005)	(0.008)	(0.093)
24 Org. recreation,	-0.078	-0.016	-0.092	-0.134	-0.160
cultural services	(0.011)	(0.015)	(0.005)	(0.006)	(0.032)
#significant differentials (5%)	22	20	22	22	15
Observations	28111	11765	117269	53715	5065

Note: Differentials are expressed as the deviation from the (employment-share weighted) mean differential. Standard errors are reported in parentheses and are calculated as described in DeNew and Schmidt (1997). Samples consist of all families (including singletons).

Table 2. Wage dispersion across industries. Metrics based on OLS and within-family estimates. Brothers samples.

	Denmark	Finland	Norway	Sweden	USA
A. OLS estimates					
***Adjusted** (WASD)*	0.113	0.090	0.104	0.097	0.146
	(0.002)	(0.005)	(0.001)	(0.002)	(0.013)
***Unadjusted** (WSD)*	0.113	0.092	0.104	0.097	0.157
	(0.002)	(0.005)	(0.001)	(0.002)	(0.012)
B. Within-family estimates					
***Adjusted** (WASD)*	0.106	0.085	0.094	0.083	0.100
	(0.006)	(0.006)	(0.002)	(0.002)	(0.015)
Ratio (WASD_within/WASD_OLS)	*0.941*	*0.943*	*0.906*	*0.857*	*0.685*
Ratio squared (Blackburn, 1995)	*0.885*	*0.890*	*0.820*	*0.735*	*0.470*
***Unadjusted** (WSD)*	0.108	0.088	0.095	0.084	0.118
	(0.006)	(0.005)	(0.002)	(0.002)	(0.013)
Ratio (WSD_within/ WSD_OLS)	*0.956*	*0.961*	*0.907*	*0.862*	*0.754*
Ratio squared (Blackburn, 1995)	*0.913*	*0.924*	*0.823*	*0.743*	*0.570*
Observations	14592	4678	42509	22832	1653
Families	6529	2124	19816	10503	755

Note: Standard errors are reported in parentheses and are estimated with the bootstrapping procedure *bstrap* in STATA 7.0 using 200 replications and family as clustering unit.

Table 3. Probability of two brothers in the same industry, by chance and actual.

	Denmark	Finland	Norway	Sweden	USA
Two randomly drawn men (by chance)	0.07	0.08	0.07	0.08	0.07
Two brothers (actual)	0.16	0.16	0.19	0.22	0.19

Table 4. Measurement error sensitivity analyses. U.S. brothers sample.

	(1)	(2)	(3)
WASD_OLS	0.144	0.136	0.143
	(0.013)	(0.012)	(0.014)
WASD_within	0.099	0.095	0.102
	(0.014)	(0.014)	(0.016)
Ratio (WASD_within/ WASD_OLS)	*0.689*	*0.699*	*0.715*
Ratio squared (Blackburn, 1995)	*0.474*	*0.489*	*0.511*
Observations	1653	1653	1445
Families	755	755	666
Comment	Recode errant one- or two-year within-job spell industry changes	Use last reported industry code for entire job spell	Drop all job spells with unexplained change of industry

Note: Bootstrapped standard errors are reported in parentheses.

Table 5. Correlation of industry wage differentials between countries.

A. OLS estimates

	Denmark	**Finland**	**Norway**	**Sweden**
Finland	0.683			
Norway	0.824	0.563		
Sweden	0.865	0.816	0.774	
USA	0.504	0.643	0.519	0.726

Note: Correlation coefficients are based on the industry differentials listed in Table 1.

B. Within-family estimates

	Denmark	**Finland**	**Norway**	**Sweden**
Finland	0.618			
Norway	0.828	0.648		
Sweden	0.811	0.798	0.776	
USA	0.396	0.559	0.392	0.724

Note: Correlation coefficients are based on the industry differentials listed in Table A4. Last row (USA) excludes industry 1. Oil, mining.

Table 6. Distribution of Quantitative Literacy Skills, International Adult Literacy Survey.

	Mean score	**5th percentile (p05)**	**95th percentile (p95)**	**p95/p05**
Denmark	298.4	219.0	329.5	1.5
Finland	286.1	197.1	318.4	1.6
Norway	296.8	208.9	328.8	1.6
Sweden	305.9	215.9	342.0	1.6
USA	275.2	138.3	376.3	2.7

Source: OECD (2000), Table 2.1, part C, Annex D.

Table 7. Industry wage dispersion relative to overall wage variation.

	Denmark	**Finland**	**Norway**	**Sweden**	**USA**
Var(ln wage)	0.134	0.111	0.088	0.099	0.227
	(0.006)	(0.005)	(0.002)	(0.002)	(0.010)
A. OLS estimates					
$WASD^2$/var(ln wage)	0.096	0.073	0.124	0.096	0.094
	(0.004)	(0.007)	(0.003)	(0.004)	(0.017)
WSD^2/var(ln wage)	0.096	0.077	0.124	0.096	0.109
	(0.004)	(0.007)	(0.003)	(0.003)	(0.017)
B. Within-family estimates					
$WASD^2$/var(ln wage)	0.087	0.065	0.101	0.070	0.044
	(0.009)	(0.009)	(0.004)	(0.004)	(0.015)
WSD^2/var(ln wage)	0.067	0.071	0.102	0.071	0.062
	(0.006)	(0.009)	(0.004)	(0.004)	(0.015)

Note: Bootstrapped standard errors are reported in parentheses.

Table A1. Industries; Classification, employment shares, and mean earnings.

A. Industry classification and employment shares

Industry	**Industry classification**		**Employment shares**				
	NACE codes (Nordic countries)	**1970 Census codes (USA)**	**Denmark**	**Finland**	**Norway**	**Sweden**	**USA**
1 Oil, mining	1009-	47-58	.003	.006	.024	.005	.009
2 Food, beverage, tobacco	1509-	268-299	.044	.028	.039	.022	.027
3 Textiles	1709-	307-327,388-397	.007	.006	.003	.004	.012
4 Wood, printing	2009-	107-109,328-339	.033	.093	.046	.059	.037
5 Chemicals, plastics	2309-	347-387	.028	.030	.022	.024	.022
6 Other non-metal	2600-	119-138,398-399	.015	.013	.010	.008	.013
7 Basic metal	2709-	139-267	.133	.174	.127	.177	.110
8 Furniture	3600-	118	.020	.014	.010	.011	.008
9 Utilities	4009-4499, 9000	467-499	.028	.029	.024	.018	.020
10 Construction, building	4500-	67-78	.108	.066	.100	.108	.143
11 Sales, repair	5000-	639-649,757	.029	.030	.043	.025	.043
12 Wholesale trade	5100-	507-599	.085	.064	.095	.077	.041
13 Retail trade	5200-	607-638,657-668,677-699	.027	.033	.039	.032	.069
14 Hotels, restaurants	5500-	669,777-778	.012	.010	.011	.011	.052
15 Transportation	6009-	407-429	.082	.065	.084	.072	.061
16 Post, communication	6400-	448-449,907	.023	.035	.031	.027	.020
17 Finance, insurance	6500-	707-717,719	.035	.018	.033	.022	.028
18 Real estate	7009-	718	.014	.022	.010	.023	.015
19 Business services	7209-	727-751,758-767,849,888-899	.069	.087	.079	.093	.100
20 Public admin, defense	7500-	908-947	.069	.078	.071	.058	.052
21 Education	8000-	857-858,867-868	.053	.037	.038	.039	.033
22 Health services	8500-8529	828-848	.022	.026	.024	.032	.036
23 Social institutions	8530-8999	878-879	.032	.008	.018	.021	.006
24 Org. recreation, cultural services	9100-9600	447,769,779-817,859,869-877,887	.029	.028	.019	.031	.043

B. Sample mean log earnings (wages)

Industry	Denmark	Finland	Norway	Sweden	USA
1 Oil, mining	5.21	11.87	12.85	12.41	2.10
2 Food, beverage, tobacco	5.08	11.85	12.41	12.35	1.96
3 Textiles	4.99	11.68	12.32	12.26	1.86
4 Wood, printing	5.11	11.91	12.46	12.41	2.04
5 Chemicals, plastics	5.14	11.96	12.52	12.45	2.12
6 Other non-metal	5.01	11.83	12.40	12.33	1.96
7 Basic metal	5.04	11.93	12.48	12.39	2.16
8 Furniture	4.93	11.63	12.30	12.25	1.80
9 Utilities	4.92	11.92	12.40	12.44	2.22
10 Construction, building	5.02	11.79	12.38	12.30	2.06
11 Sales, repair	4.93	11.69	12.35	12.26	1.91
12 Wholesale trade	5.14	12.04	12.57	12.50	2.00
13 Retail trade	4.99	11.65	12.35	12.27	1.87
14 Hotels, restaurants	4.95	11.67	12.36	12.24	1.68
15 Transportation	5.05	11.76	12.45	12.32	2.07
16 Post, communication	4.92	11.78	12.40	12.41	2.34
17 Finance, insurance	5.28	12.31	12.65	12.77	2.48
18 Real estate	4.96	11.75	12.56	12.31	2.09
19 Business services	5.27	11.98	12.67	12.59	2.09
20 Public admin, defense	4.95	11.88	12.43	12.41	2.23
21 Education	4.99	11.99	12.40	12.29	2.03
22 Health services	5.01	11.96	12.46	12.43	2.06
23 Social institutions	4.72	11.64	12.28	12.17	1.90
24 Org. recreation, cultural services	5.03	11.90	12.43	12.30	1.96

Note: National currencies. Hourly wages for Denmark and USA, annual earnings for other countries.

Table A2. Family structure, sample means, and coefficients of control variables.

	Denmark	Finland	Norway	Sweden	USA
Family structure					
Individual observations	28111	11765	117269	53715	5065
Families	20048	9211	94576	41386	4167
Singletons	13519	7087	74760	30883	3412
Two brothers families	5232	1753	17227	8904	631
Three+ brothers families	1297	371	2589	1599	124
Means					
Age	35.7	37.0	34.8	36.4	32.7
Married	0.745	0.645	0.518	0.488	0.526
Education level 2	0.263	NA	0.271	0.180	0.090
Education level 3	0.353	NA	0.352	0.404	0.444
Education level 4	0.145	0.520	0.116	0.107	0.158
Education level 5	0.092	0.111	0.090	0.153	0.150
Education level 6	0.069	0.172	0.067	0.140	0.049
Education level 7	0.010	0.018	0.004	0.010	0.028
OLS estimates					
Constant	4.557	11.230	11.847	11.815	1.264
	(0.019)	(0.032)	(0.010)	(0.019)	(0.064)
Age	0.009	0.013	0.011	0.010	0.010
	(0.001)	(0.001)	(0.000)	(0.000)	(0.002)
Married	0.081	0.061	0.055	0.058	0.242
	(0.004)	(0.006)	(0.002)	(0.002)	(0.013)
Education level 2	-0.038	NA	0.028	0.063	0.078
	(0.012)		(0.003)	(0.014)	(0.027)
Education level 3	0.167	NA	0.119	0.101	0.198
	(0.011)		(0.003)	(0.013)	(0.022)
Education level 4	0.083	0.077	0.262	0.213	0.369
	(0.005)	(0.007)	(0.003)	(0.014)	(0.025)
Education level 5	0.202	0.200	0.295	0.299	0.597
	(0.009)	(0.010)	(0.003)	(0.014)	(0.025)
Education level 6	0.336	0.447	0.381	0.495	0.731
	(0.008)	(0.010)	(0.004)	(0.014)	(0.033)
Education level 7	0.413	0.596	0.465	0.560	0.863
	(0.009)	(0.022)	(0.012)	(0.018)	(0.041)
Within-family estimates					
Constant	4.615	11.783	11.959	11.812	1.397
	(0.039)	(0.245)	(0.018)	(0.036)	(0.137)
Age	0.008	0.011	0.011	0.012	0.010
	(0.001)	(0.002)	(0.001)	(0.001)	(0.005)
Married	0.061	0.051	0.042	0.052	0.250
	(0.008)	(0.011)	(0.003)	(0.005)	(0.025)
Education level 2	-0.064	NA	0.013	0.041	0.026
	(0.032)		(0.006)	(0.025)	(0.051)
Education level 3	0.103	NA	0.067	0.060	0.073
	(0.022)		(0.006)	(0.025)	(0.047)
Education level 4	0.045	0.053	0.191	0.130	0.190
	(0.010)	(0.015)	(0.008)	(0.026)	(0.055)
Education level 5	0.153	0.153	0.219	0.204	0.320
	(0.016)	(0.022)	(0.008)	(0.026)	(0.060)
Education level 6	0.269	0.329	0.298	0.360	0.379
	(0.016)	(0.022)	(0.009)	(0.027)	(0.074)
Education level 7	0.351	0.419	0.382	0.393	0.436
	(0.018)	(0.044)	(0.027)	(0.034)	(0.088)

Note: Educational levels 1-7 denote: Denmark and Sweden, -8, 9, 10-11, 12-13, 14, 15-16 and 17+; Finland, -9, 11-12, 13, 15 and 17+; Norway and USA, -9, 10-11, 12, 13-14, 15-16, 17-18 and 19+.

Table A3. AFQT industry differentials. NLSY. With and without educational controls.

	Controls	
	Age	**Age and education**
1 Oil, mining	1.999	3.783
	(5.191)	(4.130)
2 Food, beverage, tobacco	-12.056	-6.735
	(2.999)	(2.389)
3 Textiles	-17.268	-5.912
	(4.555)	(3.629)
4 Wood, printing	-2.023	0.915
	(2.502)	(1.992)
5 Chemicals, plastics	7.846	2.011
	(3.436)	(2.736)
6 Other non-metal	-3.783	5.935
	(4.794)	(3.818)
7 Basic metal	4.185	5.365
	(1.386)	(1.104)
8 Furniture	-16.666	1.079
	(5.494)	(4.391)
9 Utilities	-4.394	-2.002
	(3.441)	(2.739)
10 Construction, building	-12.470	-0.482
	(1.174)	(0.961)
11 Sales, repair	-14.781	-2.065
	(2.310)	(1.854)
12 Wholesale trade	-4.366	2.473
	(2.687)	(2.142)
13 Retail trade	2.539	2.897
	(1.885)	(1.504)
14 Hotels, restaurants	-10.193	-5.991
	(2.078)	(1.657)
15 Transportation	-7.920	-2.074
	(1.922)	(1.535)
16 Post, communication	8.919	-1.452
	(3.315)	(2.645)
17 Finance, insurance	32.442	8.985
	(2.733)	(2.229)
18 Real estate	-1.676	-5.307
	(3.982)	(3.171)
19 Business services	12.73	2.762
	(1.584)	(1.278)
20 Public admin, defense	8.631	-0.859
	(1.982)	(1.589)
21 Education	14.632	-5.817
	(2.475)	(2.022)
22 Health services	7.142	-5.970
	(2.414)	(1.963)
23 Social institutions	-4.429	-14.783
	(7.021)	(5.596)
24 Org. recreation, cultural services	4.363	-1.700
	(2.356)	(1.878)
#significant differentials (5%)	15	8
Mean AFQT	40.31	40.31
Var (AFQT)	892.24	892.24
WASD of AFQT	10.53	3.54
WSD of AFQT	10.80	4.02

Table A4. Inter-industry wage differentials. Within-family estimates.

Industry	Denmark	Finland	Norway	Sweden	USA
1 Oil, mining	0.213	0.116	0.316	0.116	-0.350
	(0.063)	(0.068)	(0.010)	(0.031)	(0.242)
2 Food, beverage,	0.097	0.016	0.026	0.052	-0.014
tobacco	(0.016)	(0.030)	(0.008)	(0.015)	(0.072)
3 Textiles	-0.014	-0.068	-0.111	-0.028	0.000
	(0.040)	(0.066)	(0.028)	(0.033)	(0.122)
4 Wood, printing	0.110	0.084	0.016	0.075	0.082
	(0.018)	(0.017)	(0.008)	(0.009)	(0.061)
5 Chemicals,	0.071	0.123	0.080	0.068	0.134
plastics	(0.021)	(0.030)	(0.011)	(0.014)	(0.087)
6 Other non-metal	0.011	-0.018	0.024	0.040	0.093
	(0.027)	(0.045)	(0.016)	(0.025)	(0.131)
7 Basic metal	0.035	0.055	0.047	0.033	0.101
	(0.009)	(0.012)	(0.004)	(0.005)	(0.033)
8 Furniture	-0.007	-0.171	-0.091	-0.023	-0.038
	(0.024)	(0.041)	(0.015)	(0.020)	(0.199)
9 Utilities	-0.051	0.084	-0.037	0.057	0.082
	(0.021)	(0.030)	(0.010)	(0.016)	(0.080)
10 Construction,	0.010	-0.011	-0.042	-0.020	0.087
building	(0.010)	(0.020)	(0.005)	(0.007)	(0.035)
11 Sales, repair	-0.064	-0.082	-0.057	-0.064	0.034
	(0.020)	(0.029)	(0.008)	(0.014)	(0.060)
12 Wholesale trade	0.091	0.103	0.088	0.075	-0.107
	(0.012)	(0.021)	(0.005)	(0.008)	(0.062)
13 Retail trade	0.015	-0.191	-0.096	-0.089	-0.090
	(0.021)	(0.028)	(0.008)	(0.013)	(0.051)
14 Hotels,	-0.046	-0.183	-0.052	-0.119	-0.221
restaurants	(0.033)	(0.050)	(0.015)	(0.023)	(0.054)
15 Transportation	0.067	-0.066	0.016	-0.019	-0.003
	(0.012)	(0.021)	(0.006)	(0.009)	(0.052)
16 Post,	-0.123	-0.078	-0.043	0.053	0.336
communication	(0.024)	(0.030)	(0.009)	(0.013)	(0.093)
17 Finance,	0.134	0.293	0.083	0.204	0.195
insurance	(0.020)	(0.041)	(0.009)	(0.015)	(0.078)
18 Real estate	-0.063	-0.050	0.080	-0.059	-0.179
	(0.029)	(0.032)	(0.016)	(0.014)	(0.108)
19 Business	0.097	-0.041	0.089	0.060	-0.053
services	(0.014)	(0.017)	(0.006)	(0.007)	(0.041)
20 Public admin,	-0.144	-0.037	-0.105	-0.093	0.063
defense	(0.013)	(0.019)	(0.006)	(0.009)	(0.050)
21 Education	-0.212	-0.095	-0.202	-0.237	-0.221
	(0.016)	(0.029)	(0.008)	(0.012)	(0.066)
22 Health services	-0.154	-0.013	-0.114	-0.084	-0.044
	(0.024)	(0.033)	(0.010)	(0.013)	(0.057)
23 Social	-0.303	-0.218	-0.188	-0.189	-0.278
institutions	(0.021)	(0.051)	(0.012)	(0.017)	(0.158)
24 Org. recreation,	-0.065	-0.057	-0.095	-0.117	-0.137
cultural services	(0.021)	(0.030)	(0.011)	(0.013)	(0.057)
#significant differentials (5%)	19	15	23	21	7

Table A5. Inter-industry wage differentials. OLS estimates. Brothers samples.

Industry	Denmark	Finland	Norway	Sweden	USA
1 Oil, mining	0.141 (0.045)	0.050 (0.052)	0.344 (0.007)	0.094 (0.021)	-0.379 (0.203)
2 Food, beverage, tobacco	0.095 (0.012)	0.023 (0.023)	0.007 (0.006)	0.027 (0.011)	-0.004 (0.061)
3 Textiles	0.001 (0.029)	-0.153 (0.052)	-0.078 (0.021)	-0.067 (0.026)	-0.076 (0.117)
4 Wood, printing	0.088 (0.013)	0.078 (0.012)	0.003 (0.005)	0.072 (0.007)	0.123 (0.054)
5 Chemicals, plastics	0.088 (0.016)	0.095 (0.023)	0.070 (0.008)	0.080 (0.010)	-0.014 (0.078)
6 Other non-metal	0.029 (0.020)	0.009 (0.034)	-0.005 (0.012)	-0.001 (0.018)	-0.170 (0.118)
7 Basic metal	0.018 (0.007)	0.048 (0.009)	0.038 (0.003)	0.026 (0.004)	0.097 (0.031)
8 Furniture	-0.069 (0.018)	-0.182 (0.032)	-0.114 (0.011)	-0.061 (0.015)	-0.238 (0.194)
9 Utilities	-0.077 (0.015)	0.075 (0.024)	-0.072 (0.008)	0.061 (0.013)	0.126 (0.073)
10 Construction, building	0.019 (0.007)	-0.056 (0.015)	-0.048 (0.004)	-0.024 (0.005)	0.180 (0.027)
11 Sales, repair	-0.067 (0.015)	-0.139 (0.023)	-0.060 (0.006)	-0.057 (0.011)	0.009 (0.054)
12 Wholesale trade	0.109 (0.009)	0.140 (0.016)	0.108 (0.004)	0.105 (0.006)	-0.081 (0.060)
13 Retail trade	-0.020 (0.016)	-0.170 (0.022)	-0.072 (0.006)	-0.077 (0.010)	-0.170 (0.045)
14 Hotels, restaurants	-0.007 (0.025)	-0.126 (0.041)	-0.027 (0.012)	-0.113 (0.017)	-0.274 (0.049)
15 Transportation	0.060 (0.009)	-0.052 (0.016)	0.026 (0.004)	-0.006 (0.006)	0.042 (0.046)
16 Post, communication	-0.116 (0.018)	-0.043 (0.023)	-0.057 (0.007)	0.045 (0.010)	0.209 (0.089)
17 Finance, insurance	0.195 (0.014)	0.348 (0.033)	0.109 (0.007)	0.264 (0.012)	0.379 (0.070)
18 Real estate	-0.068 (0.022)	-0.085 (0.025)	0.110 (0.012)	-0.048 (0.011)	-0.221 (0.099)
19 Business services	0.128 (0.104)	-0.006 (0.014)	0.109 (0.004)	0.081 (0.005)	-0.044 (0.038)
20 Public admin, defense	-0.132 (0.010)	-0.049 (0.014)	-0.116 (0.004)	-0.106 (0.007)	0.065 (0.046)
21 Education	-0.225 (0.012)	-0.076 (0.024)	-0.220 (0.006)	-0.272 (0.009)	-0.288 (0.061)
22 Health services	-0.164 (0.018)	-0.052 (0.027)	-0.116 (0.008)	-0.093 (0.010)	-0.035 (0.055)
23 Social institutions	-0.335 (0.015)	-0.224 (0.042)	-0.212 (0.009)	-0.237 (0.013)	-0.374 (0.153)
24 Org. recreation, cultural services	-0.06 (0.016)	-0.017 (0.024)	-0.103 (0.009)	-0.141 (0.010)	-0.180 (0.053)
#significant differentials (5%)	20	17	21	21	11

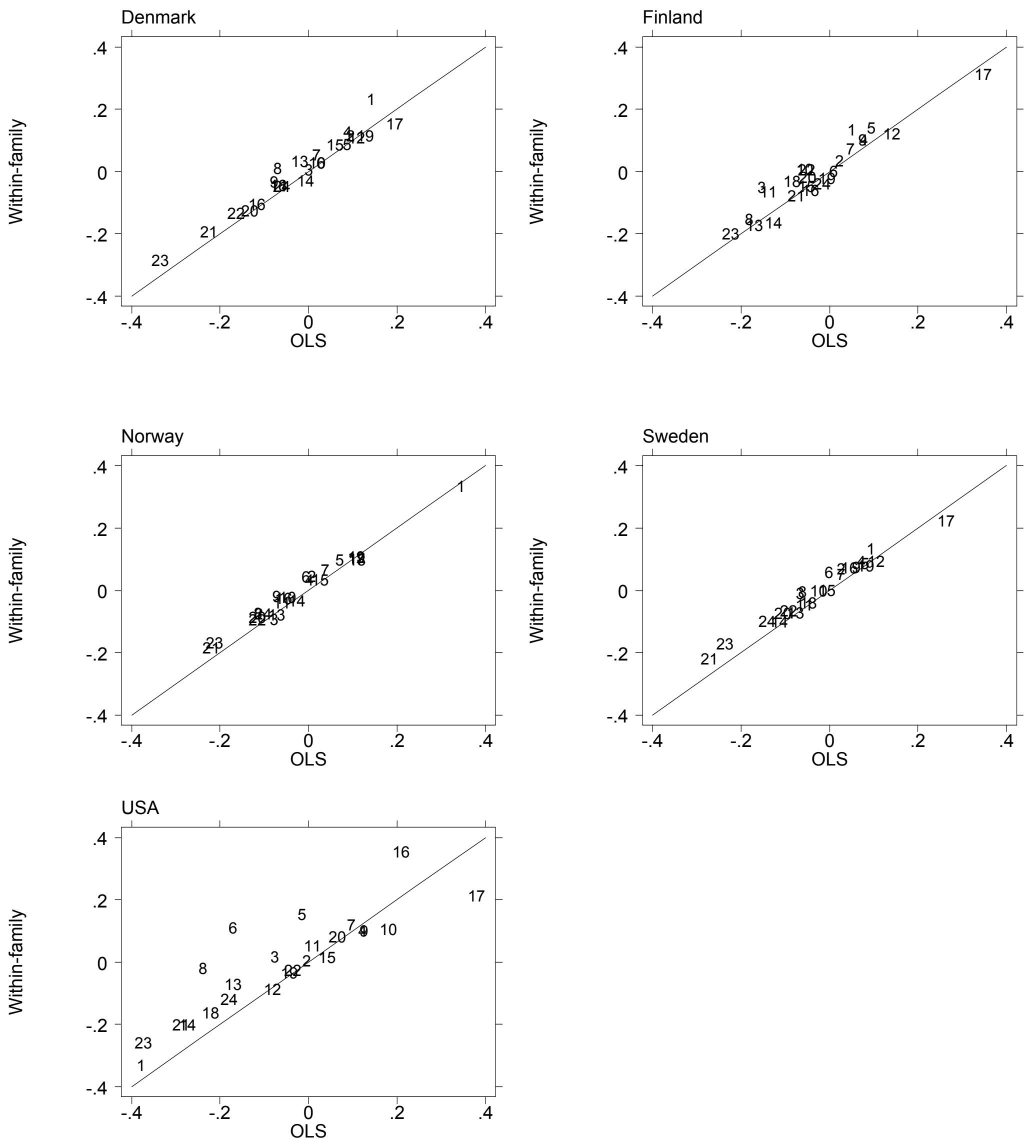

Figure 1. OLS and within-family estimates of inter-industry wage differentials.

Note: Estimates are based on brothers samples (Tables A4 and A5). Plot symbol refers to the industry identifier used in tables.