Labour Economics 31 (2014) 162–173

Contents lists available at ScienceDirect

Labour Economics

journal homepage: www.elsevier.com/locate/labeco

# The significance of firm and occupation specific human capital for hiring and promotions ☆

Illoong Kwon [a,*], Eva M. Meyersson Milgrom [b,1]

[a] Graduate School of Public Administration (GSPA), Seoul National University, 1 Gwanak-ro, Gwanak-gu, Seoul, Republic of Korea
[b] Stanford Institute for Economic Policy Research (SIEPR) and Department of Sociology, 366 Galvez St., Stanford University, Stanford, CA 94305, United States

## HIGHLIGHTS

- We analyze firms' hiring and promotion patterns using the Swedish data.
- Firms are less likely to hire from outside the firm for higher job ranks.
- Firms are less likely to hire/promote outside the occupation for higher job ranks.
- Both firm- and occupation-specific human capital are equally valuable.
- The value of firm- and occupation-specific human capital varies across occupations.

## ARTICLE INFO

*Article history:*
Received 24 March 2013
Received in revised form 9 July 2014
Accepted 15 July 2014
Available online 15 August 2014

*JEL classification:*
J24
J62
M51

*Keywords:*
Firm-specific human capital
Occupation-specific human capital
Promotions

## ABSTRACT

This paper analyzes firms' hiring and promotion patterns, and infers the relative significance of the firm- and occupation-specific human capital required for each job rank. The results suggest that firm-specific skills are just as valuable as occupation-specific skills, and that the value of these specific skills increases in job rank. However, there is great heterogeneity across occupations. This paper also shows that the lengths of firm- and occupation-tenure are noisy measures of firm- and occupation-specific human capital, and contrasts our results with those of other recent studies on the returns to firm- and occupation-tenure for wages.



## 1. Introduction

In order to fill a vacancy for top manager of a marketing department in a firm, would the firm promote someone who knows more about the specifics of the firm? Or would it hire someone who is good at marketing in general? The answer to these questions can provide direct implications for the relative importance of firm vs. occupation specific human capital required for a job, and consequently for a firms' personnel strategies and workers' promotion paths. For example, if firm-specific human capital is relatively more important, especially for high ranked jobs, firms would focus on training and internal promotions (as opposed to external search and recruiting), which in turn would allow long-term contracts with workers.

☆ The paper is based on individual-level wage data made available by the former Swedish Employers' Federation (SAF). We are grateful to Ari Hietasalo, Svenskt Näringsliv and Åke Kempe of the Svenska Medlingsinstitutet, for their extensive and exceptionally expert cooperation in preparing these data for analysis. We thank Robert Gibbons, Tor Ericsson, Guido Imbens, Edward Lazear, Paul Oyer, Katherine Shaw, Gary Solon, Michael Waldman, and participants of seminars at Cornell University, the University of Michigan, and the NBER Personnel Economics Meeting for helpful comments and suggestions. The first author gratefully acknowledges the financial support from the National Research Foundation of Korea Grant funded by the Korean Government (NRF-2012S1A5A8024619).

* Corresponding author. Tel.: +82 2 880 8551.
*E-mail addresses:* ilkwon@snu.ac.kr (I. Kwon), emilgrom@stanford.edu (E.M. Meyersson Milgrom).
[1] Tel.: +1 650 723 0188.

http://dx.doi.org/10.1016/j.labeco.2014.07.003
0927-5371/

Despite the importance of job hierarchies and promotions for organizational design and for workers' career paths,[2] there exist few studies that analyze how the importance of firm vs. occupation-specific human capital for hiring and promotions changes with *job rank*. Instead, the previous literature on firm- and occupation-specific human capital has largely focused on estimating the returns to firm and occupation tenure for individual workers' *wages* without controlling for job rank (see, e.g., Altonji and Shakotko, 1987; Topel, 1991; Parent, 2000; Kambourov and Manovskii, 2009b). Also the previous literature on job hierarchies and promotions has focused on the firm-specific aspects such as firm-specific human capital, firm–worker specific contracts, or firm–worker specific matching, and has largely ignored the occupation-specific aspects.[3]

Therefore, in this paper we analyze the significance of firm- and occupation-specific human capital for each job rank within the job hierarchies of firms. Using the Swedish employer–employee matched data, which include detailed job ranks and occupation codes comparable across firms, this paper shows that for a given job rank, the tendency to promote within the same firm is similar to the tendency to hire/promote within the same occupation, on average. Moreover, both tendencies increase in job rank. These results suggest that as one moves up the job ladders within a firm, both firm- and occupation-specific human capital become equally more valuable for firms' hiring and workers' promotions.

This paper also shows that the relative importance of firm- and occupation-specific human capital varies significantly across occupations. In sales, for instance, firm specific human capital is relatively more important for hiring and promotion at all ranks, whereas in medicine, occupation-specific human capital is much more important. Therefore, the results for one occupation do not generalize to other occupations.

In modern labor economic theories, firm-specific human capital is one of the key building blocks (e.g. Becker, 1962), but occupation-specific human capital has been largely ignored until recently.[4] In stark contrast to earlier studies, though, newer studies have emphasized occupation- (or industry-) specific human capital, even suggesting that firm-specific human capital may not be significant at all, because the returns to firm tenure are not significant for workers' wages after controlling for occupation (or industry) tenure (see e.g. Neal, 1995; Parent, 2000; Kambourov and Manovskii, 2009b; Zangelidis, 2008).

We can replicate these newer wage and tenure studies with the Swedish data (see Appendix C). In contrast to the previous studies on wages, however, when we look at the promotion and hiring patterns with job ranks, we find that both firm- and occupation-specific human capital are equally important for hiring and promotions, especially for higher ranked jobs.

These findings imply that future research on firms' personnel policy and workers' careers must address both firm- and occupation-specific human capital, not ignoring either type, and must consider the types of occupations that are concentrated in a given firm. Lazear (2009) provides an important starting point in this direction of research, defining firm-specific human capital as a firm-specific combination of various occupation-specific skills.

Our approach builds upon the literature of *internal labor markets* (ILMs). An ILM is typically structured as a hierarchy of job ranks, where a single wage is attached to each rank; workers are hired only through the bottom ranks (called ports of entry); and top-ranked jobs are filled only by internal promotions (see, e.g., Doeringer and Piore, 1985). Therefore, job ranks and promotions are key building blocks for an ILM.

A main difference between our analysis and most of the ILM literature in economics is that we analyze promoting from within versus hiring from outside an *occupation* as well as from within or outside *a firm*. Surprisingly, most empirical research on ILMs has ignored the former, focusing on the firm aspect only (see, e.g. Baker et al., 1994a,b). We suspect that one major reason is the lack of data on workers' occupations and job ranks (especially for those who switch employers), and that another is the current abundance of firm-based theories (e.g. contract theory, firm-specific human capital theory, and firm-specific matching/search theory).[5]

Given the aforementioned wage studies that suggest the significance of occupation-specific human capital but the insignificance of firm-specific human capital, the lack of consideration of occupations in the ILM literature leaves a serious gap. This paper fills that gap by showing that for promotion to higher ranked jobs, both firm- and occupation-specific human capital are (equally) important.

## 2. Data

Our analysis is based on the Swedish employer–employee matched data on all white-collar workers in the entire private sector of Sweden (except for financial sectors) during the period 1970–1990. For each worker, the data contain annual information on wage, age, education, gender, geographic region, work–time status, firm ID, plant ID, industry ID, and occupation and rank IDs (called BNT codes). Because each ID is unique, we can track each individual worker within and across firms throughout his/her career during 1970–1990.

To reduce the computational burden, in this study, we focus mostly on full-time, male, white-collar workers between 1986 and 1989. This sample contains 337,908 workers and 1,013,757 worker–year observations.[6]

A unique feature of this Swedish data is the occupation–rank code (or BNT code), consisting of four digits where the first three (called the occupation code) describe types of tasks and the fourth (called the rank code) describes the degrees of skill the tasks require.[7] We define occupations by the three-digit level BNT code. There exist 51 different occupations such as construction, personnel work, and marketing. Within each occupation, the rank code runs from 1 (lowest) to 7 (highest).[8] Rank reflects skills needed to make decisions at that level and the number of employees.[9] See appendices A and B for more details.

These data are ideal for our analysis in several ways. First, occupation and rank codes are precise, detailed, unbiased, and carefully checked: because these data served as the input to the centralized wage negotiations, they were gathered and monitored by both the Swedish Federation of Employers and the labor unions. In contrast, most previous studies have used occupation classifications based on noisy self-reported survey responses.

Second, though job titles and their skill requirements are typically not comparable across firms, BNT codes were created precisely to facilitate such cross-firm comparison, allowing the analysis of promotions and hiring in a given rank across firms. It is also worth emphasizing that Swedish firms had full discretion in promotions and hiring, while wages were constrained, but not dictated, by the centralized wage bargaining system.

[2] For example, see Valsecchi (2000) and Gibbs and Ierulli (2002).

[3] See Gibbons and Waldman (1999) for a nice survey.

[4] For early exceptions, see Shaw (1984, 1987). For example, Shaw (1987) analyzes workers' mobility across both firms and occupations, but, like the aforementioned wage analyses, still focuses mostly on the effect of workers' firm- and occupation-tenure, not on job ranks.

[5] For example, see Baker and Holmström (1995) which is titled "Internal Labor Markets: Too Many Theories, Too Few Facts".

[6] We have also repeated the analyses for different time periods and for full-time female workers as well, but the qualitative results do not change.

[7] Rank also reflects the number of employees beneath an employee at that level and types of skills needed to make decisions at that level.

[8] To make cross-occupation comparison feasible, not all occupations span the entire 7 ranks; some lack the highest rank, and some lack the lowest one.

[9] For details on the rank and the Swedish wage bargaining system, see Calmfors and Forslund (1990), and Kwon et al. (2010).

**Table 1**
Summary statistics.

| Variables | Description | # of obs. | Mean | Std.dev. |
|---|---|---|---|---|
| Age | Age | 1,013,757 | 41.95 | 10.66 |
| Experience | Numbers of years since the first data entry | 716,126 | 7.58 | 5.06 |
| Firm tenure | Number of years in the same firm | 716,126 | 5.35 | 4.53 |
| Occup. tenure | Number of years in the same occupation | 716,126 | 6.02 | 4.59 |
| Wage | Monthly wage in 1970 Kronor | 1,013,757 | 3384.23 | 1103.53 |
| Rank | 7 = highest, 1 = lowest | 1,013,757 | 3.93 | 1.07 |
| Firm turnover | " = 1 if change firms, =0 otherwise" | 1,013,757 | 13.8 (%) | |
| Occup. turnover | " = 1 if change occupations, =0 otherwise" | 1,013,757 | 13.6 (%) | |
| Promotion | " = 1 if get promoted, =0 otherwise" | 1,013,757 | 5.2 (%) | |
| Education | 0 = compulsory | | 59.39 (%) | |
| | 1 = secondary | | 29.32 (%) | |
| | 2 = post-secondary | | 11.28 (%) | |
| Firm size | Firm size (by # of white collar workers) | 45,325 | 34.42 | 183.01 |
| Occup. Size | Occupation size (by # of white collar workers) | 204 | 7732.98 | 11,240.2 |

Note: The unit of observation is the individual male workers who were working full-time between 1986 and 1989. For those who entered the data before 1971, we cannot measure their experience, firm tenure, and occupation tenure. As a result, these tenure variables are missing for them.

Third, the large size of the sample enables us to estimate the model separately by occupations, allowing us to investigate heterogeneity in the relative importance of firm- and occupation-specific skills across occupations.

Table 1 shows the summary statistics of selected variables for all full-time male workers between 1986 and 1989. On average, workers are 41 years old, have a monthly wage of 3384 Kronor in 1970, and have a rank of 3.93 (where 1 is the lowest and 7 the highest). About 11% of workers have post-secondary education. On average, 13.8% of workers change firms each year, 13.6% change occupations, and about 5% of workers get promoted to a higher rank. Firm size and occupation size are measured by the number of white-collar workers, and their averages are 34.42 and 7732, respectively.

For those who have entered the data after 1970 (71% of the sample), we can compute labor market experience, firm tenure, and occupation tenure. These workers average 7.58 years of labor market experience, 5.35 years of firm tenure, and 6.02 years of occupation tenure.[10]

As we discuss later, our analysis focuses on job changes, that is, on the choice of hiring/promotion options conditional on the vacancy filled in a particular job. Thus, we will focus on workers who were hired or promoted into new jobs from 1986 to 1989. This subsample contains 190,832 workers, and 234,061 worker–year observations.[11]

Table 2 shows the details of firms' hiring/promotion patterns by rank. Note that 43% of entrants to a job at rank 7 (the highest) are from the same firm and the same occupation, but that at rank 2, only 6.4% are.[12] In particular, observe that the likelihood of hiring workers from outside the firm but within the same occupation *increases* in rank.[13]

Previous studies have emphasized that the likelihood of hiring outside a firm decreases in rank, suggesting the significance of firm-specific human capital or promotion-based incentive schemes. However, the likelihood of hiring workers from outside a firm within the same occupation increases in rank, suggesting the significance of occupation-specific human capital. In the next section, we will formalize this idea to distinguish the values of firm- and occupation-specific human capital from one another by analyzing their effects on firms' hiring and promotion patterns.

**Table 2**
Origins of newly hired or promoted workers.

| Rank | # of obs. | Within firm | Within firm | Outside firm | Outside firm |
|---|---|---|---|---|---|
| | | Within occup | Outside occup | Within occup | Outside occup |
| 7 | 2278 | 0.433 | 0.169 | 0.229 | 0.169 |
| 6 | 12840 | 0.422 | 0.196 | 0.210 | 0.171 |
| 5 | 43457 | 0.379 | 0.205 | 0.202 | 0.215 |
| 4 | 83630 | 0.260 | 0.185 | 0.178 | 0.377 |
| 3 | 67065 | 0.124 | 0.132 | 0.123 | 0.621 |
| 2 | 22072 | 0.064 | 0.108 | 0.065 | 0.763 |
| 1 | 2719 | 0.028 | 0.066 | 0.036 | 0.869 |

Note: The unit of observation is the individual male, full-time workers who were newly hired or promoted to each job rank between 1986 and 1989. The table shows the ratio of these workers' origin, i.e. whether they come from the same firm and/or the same occupation.

Fig. 1 shows that wages are closely, but not perfectly, related to job rank: some workers in rank 7, for example, are paid less than some workers in rank 6. However, focusing on the 25%–75% range of the wage distribution reveals little wage overlap between ranks, suggesting that these ranks represent distinct productivity differences. These patterns of wage distribution are similar to those found in US personnel records (e.g. Baker et al., 1994a,b; Kwon, 2006).[14]

Fig. 2 shows the distribution of firm tenure in each rank: even though the median increases with rank, firm tenure varies widely within each rank, and the ranges of firm tenure (e.g. 25%–75%) significantly overlap across ranks. For example, workers with 4 years of firm tenure can be found in every rank. Certainly, a long firm tenure is not required at the top ranks. Assuming that higher productivity is required at higher-ranked jobs, this finding suggests that firm tenure alone is an inaccurate measure of workers' productivity. Likewise, occupation tenure also varies widely within each job rank, suggesting that it cannot accurately measure workers' productivity either.[15]

In the next section, therefore, we develop a simple framework to estimate the significance of firm- and occupation-specific human capital by focusing on workers' job ranks (instead of tenure) and their mobility across firms and occupations (instead of wages).

[10] Firm (occupation) tenure is measured by the number of years observed in the same firm (occupation). Alternatively, we also used the number of years since the first entry, and there was little change in the results.

[11] The summary statistics for this subsample are not reported, as they are similar to those in Table 1, except that average age and tenures are lower for this subsample.

[12] Even at rank 1, some workers come from the same firm and same occupation. Most of these workers are those who used to work in the same job and quit in the past.

[13] It should be noted that the distinction between hiring within occupation vs. outside occupation depends on the definition of occupations. Because occupation can be defined in several ways (e.g. broad vs. narrow or task vs. function), it remains an open question whether our results are robust to alternative definitions of occupation. We will control for occupation size throughout our analyses.

[14] These patterns remain constant even when we focus on a single occupation in a single firm. For a more detailed comparison of wage structure between the US and Sweden, see Edin and Zetterberg (1992).

[15] Not shown due to the space constraint.

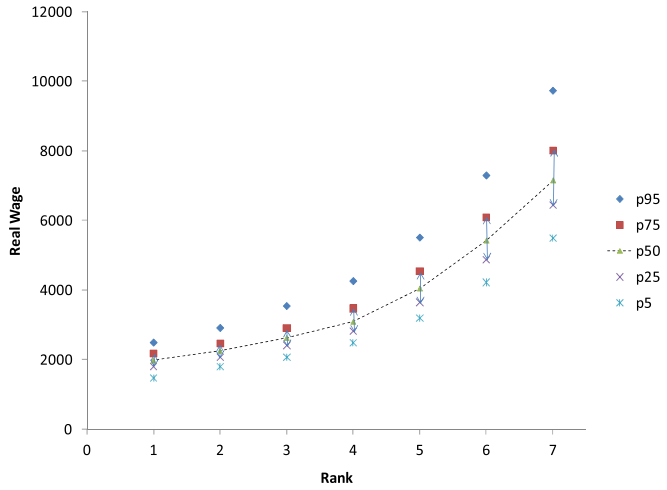


**Fig. 1.** Wage distribution and rank.

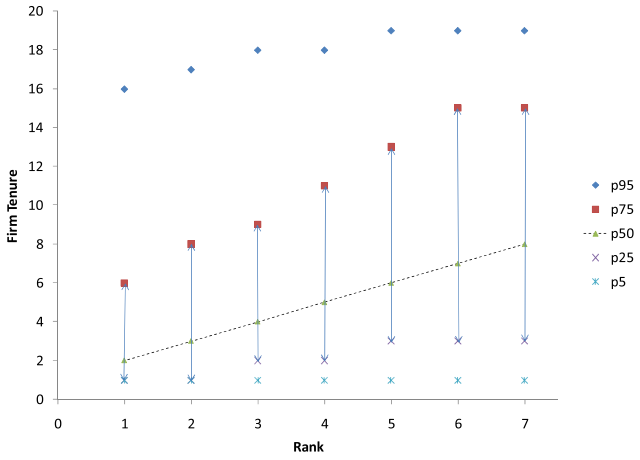


**Fig. 2.** Firm tenure distributions and rank.

## 3. Empirical framework

### 3.1. Hiring and promotion: firm vs. occupation

We define a *job* as a particular rank ($r$) of an occupation ($j$) in a firm ($i$). The firm has the following four options to fill a job vacancy: (a) promoting someone from within the same firm and within the same occupation,[16] (b) hiring from outside the firm within the same occupation,[17] (c) promoting/transferring someone from within the same firm and outside the occupation, and (d) hiring from outside the firm and outside the occupation.[18]

In order to motivate our empirical specifications, let us assume that if firm $i$ chooses option (a) (promotion from within firm and within occupation), then the expected revenue, including wage payments, is given as follows:

$$R^a_{ij}(r) = H_g(r) + H_f(r) + H_o(r) + \delta^a_i + \varepsilon^a_{ijr}, \tag{1}$$

where $H_g(r)$, $H_f(r)$, and $H_o(r)$ represent the expected value of workers' general human capital, firm-specific human capital, and occupation-specific human capital, respectively, at rank $r$. $\delta^a_i$ captures unobserved firm characteristics for option (a) such as preference for promoting within firm within occupation for the purpose of incentives. $\varepsilon^a_{ijr}$ is a random matching quality with a potential candidate within firm and within occupation.

If firm $i$ chooses option (b), hiring outside a firm within an occupation, then, by definition, there will be no gains from workers' firm-specific human capital, so the expected revenue is given as follows:

$$R^b_{ij}(r) = H_g(r) + 0 + H_0(r) + \delta^b_i + \varepsilon^b_{ijr}. \tag{2}$$

Likewise, the expected revenues of options (c) and (d), respectively, can be specified as follows:

$$R^c_{ij}(r) = H_g(r) + H_f(r) + 0 + \delta^c_i + \varepsilon^c_{ijr} \tag{3}$$

$$R^d_{ij}(r) = H_g(r) + 0 + 0 + \delta^d_i + \varepsilon^d_{ijr}. \tag{4}$$

If, for example,

$$R^b_{ij}(r) = \max_{k\in\{a,b,c,d\}} R^j_{ij}(r), \tag{5}$$

then firm $i$ would choose option (b) to fill a vacancy at rank $r$ in occupation $j$. In other words, despite the loss of firm-specific human capital, $H_f(r)$, if firm $i$ has strong preference for hiring from outside the firm within occupation (i.e. $\delta^b_i$ is large enough) or if firm $i$ has found a particularly suitable candidate from outside the firm within the same occupation $j$ for rank $r$ (i.e. $\varepsilon^b_{ijr}$ is large enough), then firm $i$ would hire someone from outside the firm within the same occupation.[19]

Moreover, if we assume that each variable $\varepsilon^k_{ijr}$ is IID (independent and identically distributed) and follows a type I extreme distribution, then our framework is a well-known multinomial logit model (see, e.g., Maddala, 1983). For example, the relative probability of the firm's choosing option (b) (hiring outside firm within occupation) to option (a) (promoting from within firm and within occupation) becomes

$$\frac{\Pr(\textit{outside}\text{ firm within occupation})_{ijr}}{\Pr(\textit{within}\text{ firm within occupation})_{ijr}} = \exp\left\{-H_f(r) + \delta^{ba}_i\right\}, \tag{6}$$

where $\delta^{ba}_i \equiv \delta^b_i - \delta^a_i$. Note that assuming $\delta^{ba}_i$ is independent of $H_f(r)$, we can identify the expected value of workers' firm-specific human capital at rank $r$, $H_f(r)$, by using a random effects multinomial logit model. In contrast, the previous studies have focused on the probability of hiring within firm regardless of occupation, an approach that cannot isolate the effects of firm-specific human capital, $H_f(r)$.

Similarly, we can isolate the expected value of workers' occupation-specific human capital at rank $r$, $H_o(r)$, by analyzing the relative probability of option (c) (promoting within firm outside occupation) to option (a) (promoting within firm and within occupation).

Note that our approach differs from the previous studies on workers' returns to experience. First, because hiring and promotion are joint decisions by a firm and a worker, these decisions, if efficient, do not depend on the relative bargaining power of firms and workers. In contrast, if firms have all the bargaining power, for example, workers

[16] We ignore the possibility of demotions as they are extremely rare in our data, as well as in other studies such as Baker et al. (1994a).

[17] These workers may come from the same or lower ranks.

[18] 'Hiring from outside firm outside occupation' includes hiring workers who were previously unemployed or who just entered the labor market, as they would not possess occupation- or firm-specific human capital. While some workers who were previously unemployed may have worked in the same occupation or in the same firm in the past, the number of such workers is quite small, and excluding them makes little difference to our results.

[19] When firms face some constraints on their sizes (e.g. due to regulations), they may have to promote from within firm rather than hire from outside. However, it is not clear why such constraints would be more binding at higher ranks. Moreover, it does not explain why firms would promote more from within firm within occupation for top ranks while hiring more from outside firm within occupation, as shown in Table 2.

may not receive any returns to firm-specific skills, but may still receive the returns to occupation-specific skills, which are transferable to other firms. Then, even when firm- and occupation-specific skills are equally significant parts of workers' productivity, the wage returns to firm-specific skills (often proxied by firm tenure) would be insignificant compared with the wage returns to occupation-specific skills (often proxied by occupation tenure). That is, the relative returns to firm- and occupation-tenure in wages can be a biased measure of the relative importance of firm- and occupation-specific skills, perhaps explaining why recent wage analyses (e.g. Parent, 2000; Kambourov and Manovskii, 2009b) found insignificant returns to workers' firm tenure.

Second, because we focus on turnover (instead of wages) and use job ranks (instead of tenure), we may reduce the potential endogeneity problems associated with previous studies on wages and tenure. More specifically, note that even in a simple static setting it is optimal for workers to change firms or occupations only when their productivity and wages increase. Thus, when turnover occurs, workers' firm (or occupation) tenure resets to zero, and their wages increase. Then, if we do not observe the change in productivity/matching quality, it would look as if firm (or occupation) tenure and wages are negatively correlated. Therefore unobserved matching quality and firm (or occupation) tenure are the main sources of the endogeneity problem in wage regressions. However, this endogeneity problem can be addressed by proper instrumental variables. The choice of instrumental variables has often been debated. (Altonji and Shakotko, 1987; Topel, 1991)

In our paper, we assume a specific functional form for the distribution of matching quality, that is, an extreme distribution for $\varepsilon_{ijr}^{k}$ in Eqs. (1)–(4). We also assume that workers make optimal turnover decisions as in Eq. (5). Then, we can predict workers' (optimal) turnover probabilities by *integrating out* the unobserved changes in matching quality as in Eq. (6). That is, in Eq. (6), the (optimal) turnover probabilities no longer depend on unobserved matching quality $\varepsilon_{ijr}^{k}$ which is the main source of the endogeneity problem in wage regressions. Also, we use workers' job rank rather than tenure to measure their human capital. Unlike tenure, workers' job ranks do not automatically reset to zero during turnover. Thus, we can also reduce endogeneity problems such as reverse causality where workers' propensity for turnover affects their firm (or occupation) tenure (Farber, 1999).

### 3.2. Caveats

There are several important caveats to our approach. Our approach assumes that workers' expected job ranks are determined by their productivity only. That is, firms' unobserved preference for hiring or promotion, $\delta_i^k$ $(k = a, b, c, d)$ in Eqs. (1)–(4), is independent of workers' job ranks $(r)$.

If, however, firms use promotion tournaments as an incentive scheme, they would not prefer to hire someone from outside firm, especially for the top job ranks, because it would reduce the incentives for existing workers at lower ranks (see, e.g., Chan, 1996). Consequently, new hires may have to start at the lower ranks (called ports of entry) despite high productivity when they move to another firm. Then turnover would affect workers' job ranks directly, and in Eq. (6), $\delta_i^{ba}$ would be negatively correlated with rank $(r)$ and consequently with $H_f(r)$, which can lead to an overestimation of the importance of firm-specific human capital.

However, we find that for 63.5% of those who change firms, job rank does not change. While 10.7% of turnover is associated with a loss of one job rank, 22.1% of turnover is associated with a gain of one job rank. Therefore, it does not appear that turnover is systematically associated with a decrease in job rank. Later we will also restrict our analysis to those in higher job ranks only, excluding potential ports of entry.

Moreover, suppose that promotion tournaments for top job ranks are more feasible and effective as an incentive device for those who have higher levels of education or a higher chance of promotion. Then, we can possibly control for the effect of a promotion tournament by controlling for the share of educated workers employed in the firm within a given occupation and rank.[20]

There are other mechanisms that can affect workers' turnover probabilities and job ranks, independent of workers' human capital. For example, asymmetric information on workers' productivity between the current employer and other potential employers can affect workers' promotions and hiring (Waldman, 1984; Bernhardt, 1995). If this asymmetric information problem diminishes in rank $(r)$, there can be a correlation between $\delta_i^{ba}$ and $r$ in Eq. (6). Also, at higher ranks, firms may get better at finding well-matched workers outside an occupation or firm, which can violate the IID assumption of $\varepsilon_{ijr}^{k}$ $(k = a, b, c, d)$ in Eqs. (1)–(4).

Also, in a dynamic setting with uncertainty, firms may hire workers at rank $n-1$ in order to have an option to promote them to rank $n$ in the future. Then, workers' ranks would not necessarily reflect their human capital. Moreover, if such an option value becomes more important at higher ranks, there can be correlation between $\delta_i^{ba}$ and $r$ in Eq. (6) again.

Later we will allow for correlated random effects in our estimations to partially address these problems, and show that the results do not change. However, we should still keep in mind these caveats.[21]

## 4. Empirical results

As discussed in Section 3, we estimate the significance of firm and occupation specific human capital, denoted by $H_f(r)$ and $H_o(r)$ respectively, based on a multinomial logit model of hiring/promotion strategies with four choices: within or outside firm and occupation.

### 4.1. Firm-specific human capital vs. occupation-specific human capital

For ease of comparison, begin by assuming that the values of both types of human capital are linear in job rank $r$. That is,

$$H_f(r) = \beta_f r \text{ and } \mathrm{H}_o(r) = \beta_o r. \tag{7}$$

Later we will relax this linearity assumption. Then, column [1] of Table 3 estimates the probability of 'hiring from outside firm, but within occupation' relative to 'promotion from within firm within occupation,' that is, the probability of hiring outside firm conditional on hiring within the same occupation.

In the regression, we control for rank, firm size, firm size annual growth rate, occupation size, occupation size annual growth rate, age, age squared, and a set of dummy variables for education, industry, time, and region.

Note that the coefficient of rank is negative, as expected. That is, at higher ranks, firms are much less likely to hire from outside the firm, which implies, by Eq. (6), that the value of firm-specific human capital is significant and increases with rank, with a coefficient, from Eqs. (6) and (7), of $\hat{\beta}_f = 0.3942$. [22]

[20] We would like to thank an anonymous referee for making this suggestion.

[21] Note that the studies on wages and the returns to tenure share the same caveats. For example, if longer labor market experience or occupation tenure allows for better firm–worker matching or if long-term wage contracts such as tournaments or back-loaded compensations are available, the returns to tenure in wage regressions would not reflect the level of workers' human capital (Farber, 1999; Kambourov and Manovskii, 2009b).

[22] Alternatively, for top-ranked positions firms may simply announce their job openings less frequently than for lower-ranked positions. However, as Table 2 shows, this explanation is not consistent with the finding that firms are more likely to hire outside firm within occupation for higher ranks. Also, the reason that firms may not announce top-ranked jobs frequently could be that firm-specific human capital is important at top-ranked jobs.

**Table 3**
Hiring and promotion: firm vs. occupation
(Multinomial logit, dependent variable = choice of hiring/promotion strategy).
(Relative to 'promotion from within firm and within occupation').

| | Hiring 'outside firm within occupation' | | Promotion 'within firm outside occupation' | | Hiring 'outside firm outside occupation' | |
|---|---|---|---|---|---|---|
| | [1] | [2] | [3] | [4] | [5] | [6] |
| Rank | −0.3942[a] | | −0.4742[a] | | −0.9384[a] | |
| | (0.0085) | | (0.0081) | | (0.0075) | |
| Rank (=7) | | −2.0904[a] | | −2.6158[a] | | −4.2176[a] |
| | | (0.1724) | | (0.1565) | | (0.1377) |
| Rank (=6) | | −2.1090[a] | | −2.3772[a] | | −4.2144[a] |
| | | (0.1640) | | (0.1456) | | (0.1244) |
| Rank (=5) | | −1.8889[a] | | −2.0905[a] | | −3.9258[a] |
| | | (0.1623) | | (0.1437) | | (0.1218) |
| Rank (=4) | | −1.4246[a] | | −1.6165[a] | | −2.9921[a] |
| | | (0.1616) | | (0.1430) | | (0.1208) |
| Rank (=3) | | −0.8734[a] | | −1.0069[a] | | −1.7305[a] |
| | | (0.1616) | | (0.1430) | | (0.1207) |
| Rank (=2) | | −0.5635[a] | | −0.3436[b] | | −0.8483[a] |
| | | (0.1654) | | (0.1460) | | (0.1231) |
| # of obs. | 212,143 | | | | | |

Note: The unit of observation is the individual male, full-time workers who were newly hired or promoted to each job rank between 1986 and 1989. Each regression includes firm size, firm size growth rate, occupation size, occupation size growth rate, age, age squared, and dummy variables for education, industry, year, and region.
[a] Significant at 1%.
[b] Significant at 5%.
[c] Significant at 10%.

**Table 4**
Hiring and promotion: correlated random effect.
(Multinomial logit, dependent variable = choice of hiring/promotion strategy).
(Relative to 'promotion from within firm and within occupation').

| | Hiring 'outside firm within occupation' | | Promotion 'within firm outside occupation' | | Hiring 'outside firm outside occupation' | |
|---|---|---|---|---|---|---|
| | [1] | [2] | [3] | [4] | [5] | [6] |
| Rank | −0.3263[a] | −0.4374[a] | −0.4146[a] | −0.5362[a] | −0.8806[a] | −1.0731[a] |
| | (0.0246) | (0.0324) | (0.0241) | (0.0301) | (0.0218) | (0.0285) |
| Firm size | −0.2485[a] | −0.1177 | −0.0041 | −0.0358 | −0.1075[a] | −0.0062 |
| | (0.0160) | (0.1035) | (0.0093) | (0.0924) | (0.0088) | (0.0793) |
| Occup size | 0.0165[a] | 0.0155[a] | −0.0080[a] | −0.0099[a] | −0.0002 | −0.0010 |
| | (0.0011) | (0.0014) | (0.0011) | (0.0014) | (0.0009) | (0.0012) |
| Occup size growth | 1.2350[b] | 0.9908 | −4.0561[a] | −1.6082[a] | −1.6000[a] | −0.7342 |
| | (0.6192) | (0.8064) | (0.5788) | (0.7199) | (0.4834) | (0.6205) |
| Age | 0.1910[a] | 0.2153[a] | 0.1232[a] | 0.1359[a] | 0.0036 | −0.0063 |
| | (0.0176) | (0.0216) | (0.0163) | (0.0189) | (0.0139) | (0.0168) |
| Age-sq. | −0.0021[a] | −0.0024[a] | −0.0011[a] | −0.0012[a] | −0.0005[a] | −0.0004[b] |
| | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) | (0.0002) |
| Firm R.E. | No | Yes | No | Yes | No | Yes |
| # of obs. | 23,497 | | | | | |

Note: The estimation is based on a 10% random sample. All regressions include education dummies. Columns [2], [4], and [6] also control for the (firm-level) time average of each independent variable.
[a] Significant at 1%.
[b] Significant at 5%.
[c] Significant at 10%.

Though the past literature on internal labor markets has shown similar patterns of "promotion from within the firm", it has not controlled for occupation (e.g. Baker et al., 1994a; Lazear and Oyer, 2004), and has thus not isolated the effect of firm-specific human capital.

Table 3, column [3] estimates the probability of promotion from outside occupation conditional on promotion from within firm and shows that again, at higher ranks, firms are much less likely to promote from outside the occupation. For example, firms are unlikely to promote someone from a finance department to a high-ranked job in a marketing department. This result suggests that the value of occupation-specific human capital is also significant, and also increases with rank. In particular, from Eq. (7), the result implies that the coefficient $\hat{\beta}_o = 0.4742$.

While the occupation coefficient $\hat{\beta}_o$ is slightly larger than the firm coefficient $\hat{\beta}_f$, both are significant, suggesting that firm- and occupation-specific human capital are about equally valuable in generating revenue at each job rank. For example, when measured in standard deviations, 45.3% (=0.3942 / (0.3942 + 0.4742)) of the variation in specific-human capital would be due to firm-specific human capital.

In columns [2], [4], and [6], we relax the linear restriction on $H_f(r)$ and $H_o(r)$, and use the rank dummy variables. Note that the coefficients of each rank variable in columns [2] and [4] are similar (except, perhaps, for the highest rank), again implying that firm- and occupation-specific human capital are about equally valuable for the task at each job rank.[23]

[23] At the highest rank, however, columns [2] and [4] show that firms are more (less) likely to hire/promote someone within (outside) the same occupation than within (outside) the same firm, suggesting that occupation-specific skills are relatively more important than firm-specific skills at the highest rank.

**Table 5**
Robustness.
(Multinomial logit, dependent variable = choice of hiring/promotion strategy).
(Relative to 'promotion from within firm and within occupation').

| | Hiring 'outside firm within occupation' | Promotion 'within firm outside occupation' | Hiring 'outside firm outside occupation' |
|---|---|---|---|
| | [1] | [2] | [3] |
| *(a) Controlling for share of highly educated* | | | |
| Rank | −0.3983[a] | −0.4731[a] | −0.9462[a] |
| | (0.0088) | (0.0084) | (0.0078) |
| Share of college graduates | 0.0567[c] | −0.0109 | 0.1043[a] |
| | (0.0324) | (0.0310) | (0.0271) |
| # of obs. | 212,143 | | |
| *(b) Excluding ranks below 4* | | | |
| Rank | −0.3708[a] | −0.4207[a] | −0.7359[a] |
| | (0.0123) | (0.0121) | (0.0124) |
| # of obs. | 129,056 | | |
| *(c) Occupations with all 7 ranks only* | | | |
| Rank | −0.4112[a] | −0.6132[a] | −0.9453[a] |
| | (0.0111) | (0.0119) | (0.0108) |
| # of obs. | 112,881 | | |

Note: Each regression includes firm size, firm size growth rate, occupation size, occupation size growth rate, age, age squared, and dummy variables for education, industry, year, and region. Table 5(a) controls for share of college graduates in each rank and occupation within a firm. Table 5(b) excludes those workers below rank 4. Table 5(c) excludes those occupations that have strictly less than seven ranks.
[a] Significant at 1%.
[b] Significant at 5%.
[c] Significant at 10%.

Overall, our results indicate that firm-specific human capital is as valuable as occupation-specific human capital. Firm-specific human capital is among the key building blocks of modern labor economic theories (e.g. Becker, 1962), but recent wage analyses have downplayed its significance (see e.g. Neal, 1995; Parent, 2000; Kambourov and Manovskii, 2009b). Our results restore the empirical significance of firm-specific human capital.

At the same time, our results confirm the significance of occupation-specific human capital, which has received far less attention until recently, except for early studies by Shaw (1984, 1987). One justification for disregarding occupation-specific capital argues that, if workers choose an occupation first and then choose firms within an occupation, we can analyze workers' firm turnover conditional on an occupation (Neal, 1995). But our analyses show that significant occupation mobility within firms still exists even at the highest rank and thus that both firm and occupation mobility, or firm- and occupation-specific human capital, must be considered simultaneously.

For simplicity, we have assumed that firm-specific human capital and occupation-specific human capital are additive and separable, as in Eq. (1). Since firms would lose both firm and occupation-specific human capital when they hire from outside a firm and outside an occupation, if our specification and the estimates are correct, the estimates in columns [5] and [6] in Table 3 should reflect the sum of firm and occupation specific human capital, and be equal to the sum of the corresponding estimates in columns [1]–[4]. Note, for example, that the estimate in column [5] (=0.9348) is roughly equal to the sum of the estimates in columns [1] and [3] (=0.3942 + 0.4742). These results are consistent with our empirical framework in Section 3.

### 4.2. Robustness

#### 4.2.1. Correlated random effects

Hiring/promotion patterns can vary widely across firms: Some may have stronger labor unions that reduce external hiring, some may have only a few occupations, limiting internal promotion from outside occupation, and some may practice a job rotation policy, increasing occupation mobility within the firm. Such unobserved firm characteristics can lead to non-independence of the residuals across observations for a given firm. Moreover, as discussed earlier, they can be correlated with the main independent variables such as rank, which would bias our results.

To address these problems, in Table 4, we allow for firm random effects, $\delta_i^k$ ($k = a, b, c, d$), in each hiring or promotion option as in Eqs. (1)–(4). And to account for possible correlation between unobserved (time-invariant) firm characteristics and independent variables, we follow the standard Mundlak–Chamberlain approach, and control for the firm-level time average of each independent variable.

It is well known, however, that allowing for random effects in a multinomial logit model presents a very heavy computational burden (see, e.g., Malchow-Moller and Svarer, 2003), especially on a large dataset like ours. So we simplify our empirical model as follows. First, we focus on a 10% random sample, resulting in 23,497 observations. Second, we use fewer controls: For rank, firm size, occupation size, occupation size growth rate, age, age squared, and education dummies.

In order to measure the effects of this simplification, we first estimate the simplified model without correlated random effects. Table 4, columns [1], [3], and [5] show that the results are very similar to those from the full sample in Table 3 columns [1], [3], and [5], indicating that these simplifications should not be responsible for any changes in the results.

In columns [2], [4], and [6], we allow for correlated random effects as in Mundlak (1978) by controlling for the time average of each independent variable and firm random effects in the simplified model. Even though the coefficients of rank become slightly larger in absolute value, the qualitative results do not change. For example, when measured in standard deviations, 44.9% (=0.4374 / (0.4374 + 0.5362)) of the variation in specific human capital is due to firm-specific human capital. Therefore, both firm- and occupation-specific human capital are equally valuable within each job rank.

#### 4.2.2. Share of educated workers

As discussed earlier, if firms provide incentives based on promotion tournaments, they would be less likely to hire from outside a firm for higher job ranks. To the extent that promotion tournaments are firm

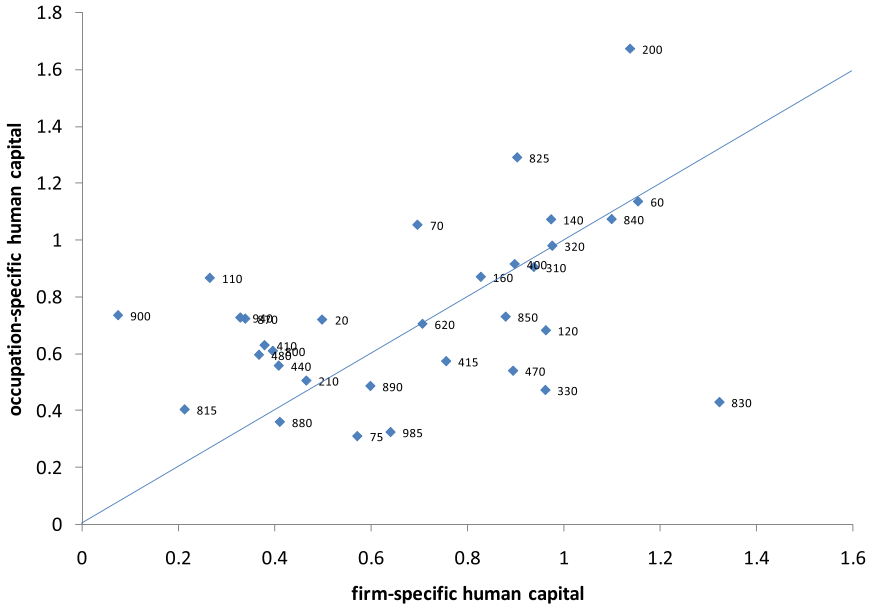


**Fig. 3.** Heterogeneity: Occupation (3-digit BNT codes). Note: Firm- and occupation-specific human capital are measured by $\hat{\beta}_f$ and $\hat{\beta}_o$ as in Eq. (7), and estimated by running a multinomial regression as in Table 3 columns [1], [3], and [5] for each occupation. See appendix A for the description of 3-digit BNT occupation codes.

specific and independent of the level of human capital, a firm random effects model can control for such incentive effects.

However, promotion tournaments would not provide incentives for those who have very little prospect of promotions. Then, promotion tournaments would not be independent of the level of human capital, and firm random effects may not account for such firm heterogeneity. For example, promotion tournaments will be more feasible and more effective for those with higher levels of education.

Therefore, in Table 5(a), we control for the share of college graduates in a firm within occupation and within job rank.[24] However, the qualitative results do not change.

#### 4.2.3. Excluding lower job ranks

At lower job ranks, firms may have no choice but to hire from outside the firm. Also, as discussed earlier, when firms use promotion tournaments as a main incentive device, firms may have internal labor markets where new workers are hired only from the lower job ranks. Then, it would not be appropriate to compare ranks 7 and 2, for example, in order to argue in favor of the relevance of firm-specific human capital. Thus, in Table 5(b), we exclude those at rank 3 and below. However, the results remain robust.

#### 4.2.4. Occupations with all 7 ranks only

Recall that ranks are constructed so that the skill requirements are comparable across firms and occupations. Therefore, some low-skilled occupations do not have high ranks. For example, occupation 775 ("restaurant work") has only three ranks, from 2 to 4. Then, occupations that have all seven ranks, where there is more room for promotion, would not be comparable to those that have only 2 or 3 ranks. Therefore, in Table 5(c), we include only those occupations that have all seven ranks. Then, while firm-specific human capital remains significant, the significance of occupation-specific human capital increases. These results also suggest heterogeneity among occupations.

[24] Due to space constraints, we only show the results from the linear specification for the rank. Including rank dummies, however, does not change the results.

### 4.3. Heterogeneity among occupations

In this section, we analyze whether the (relative) importance of firm- and occupation-specific human capital varies significantly across occupations. Previous studies have documented large variations in the returns to firm- and occupation-tenure across different firms and occupations (see, e.g. Topel, 1991; Shaw, 1984; Abowd et al., 2006, and Zangelidis, 2008) but, as discussed earlier, the returns to workers' experience in wages can be difficult to identify and interpret, and the heterogeneity in the patterns of promotions remains largely unexplored.

We thus repeat the rank-based hiring/promotion analysis of Table 3, but separately for each occupation (three digit BNT code), assuming, for ease of comparison, that the values of firm- and occupation-specific human capital are linear in rank, as in Eq. (7). Fig. 3 reports $\hat{\beta}_o$ and $\hat{\beta}_f$ for each occupation.

Fig. 3 shows that large variations exist in both the absolute and relative values of firm- and occupation-specific human capital. For example, in occupation 830 (=sales at exhibitions), firm-specific human capital is much more valuable than occupation-specific human capital, while in occupation 900 (=financial administration), occupation-specific human capital is more valuable.

These results recommend caution when interpreting empirical research based on a particular occupation, and indicate that no theoretical model based on a general assumption about the absolute and relative importance of firm- and occupation-specific human capital can be expected to apply to all occupations.

To further understand what determines this pattern of heterogeneity, we conjecture that workers with higher levels of education would be more specialized and likely to pursue occupations with higher demands for occupation-specific human capital. For example, Lamo et al. (2011) show that over-specialization of the labor force can lead to lower mobility and higher and persistent unemployment. Therefore, in Fig. 4(a), we compare the estimated value of occupation-specific human capital with the average level of education by each occupation. As conjectured, there is a positive and significant relationship between the value of occupation-specific human capital and the average level of education within occupation.

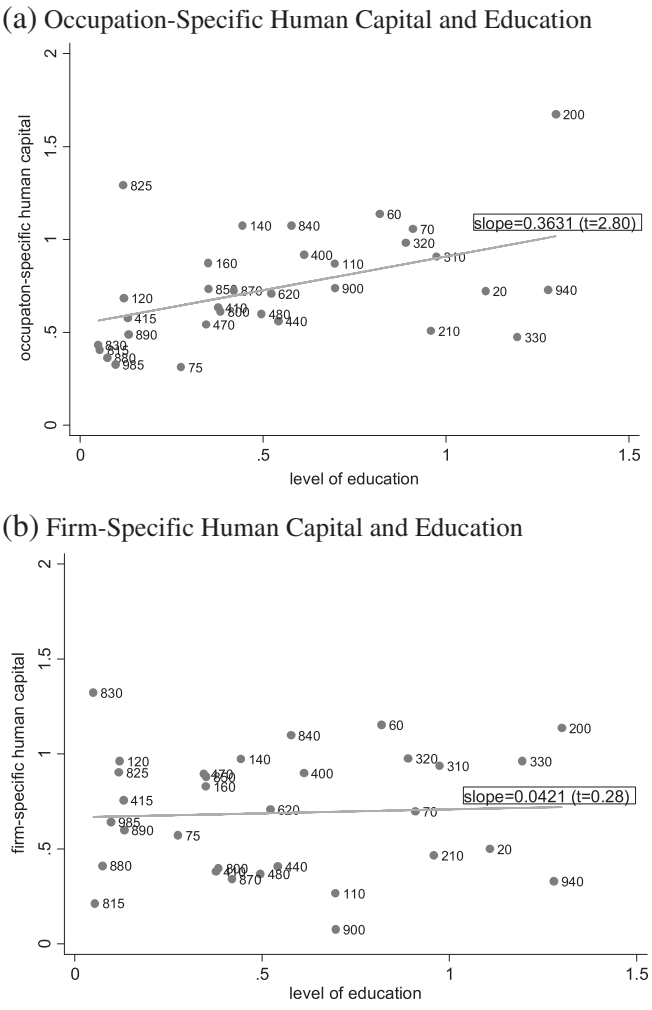


**Fig. 4.** Heterogeneity and Education. Note: Education = 0 if elementary; = 1 if secondary; = 2 if college and above. Firm- and occupation-specific human capital are measured by $\hat{\beta}_f$ and $\hat{\beta}_o$ as in Eq. (7), and are estimated by running a multinomial regression as in Table 3 column [1], [3], and [5] for each occupation. See appendix A for the description of 3-digit BNT occupation codes. The solid line is the predicted specific human capital from regressing specific human capital on average level of education. The coefficient on education and the corresponding t-statistics are displayed in the graph.

In Fig. 4(b), we compare the estimated value of firm-specific human capital with the average level of education by each occupation. Interestingly, the value of firm-specific human capital in an occupation is not related to the average level of education in the same occupation. These results are consistent with the concept of firm-specific human capital as a set of skills that can be acquired only through employment in a firm, and thus cannot be acquired through general education or training.

These patterns of the heterogeneity among occupations can provide important policy implications. For example, occupational training/education for unemployed or young workers would be most effective for those occupations that require occupation-specific human capital (e.g. BNT = 200 "mathematical work"; = 825 "travel agency"; = 70 "applied data processing"). However, for occupations that require firm-specific human capital, not occupation-specific human capital, occupational training/education would be less effective (e.g. BNT = 830 "sales"; = 330 "architectural work"; = 470 "technical service"). Thus, the patterns of heterogeneity can guide us in deciding what types of occupational training would be most effective.

The heterogeneity among occupations can also provide rich theoretical implications, especially in the literature of search and matching models. For example, in a standard search and matching model, wage dispersion is only partially explained by worker heterogeneity and on-the-job search (see, Rogerson et al., 2005; Hornstein et al., 2006). However, Kambourov and Manovskii (2009a) incorporate occupation-specific human capital into a search model, and show that the importance of occupation-specific human capital can lock workers into unproductive occupations and generate wage dispersion.

Our results suggest that firm-specific human capital will also lock in workers to unproductive firms and generate further wage dispersion among workers (see also Wasmer, 2006). More importantly, our analysis shows that the value of occupation- and firm-specific human capital varies across occupations and ranks. Therefore, the extent of wage dispersion and the patterns of wage dispersion (e.g. across firms vs. across occupations) should systematically vary across occupations and ranks depending on the value of firm- and occupation-specific human capital. Furthermore, if the variance of productive shocks is larger for skilled workers at higher job ranks where both firm- and occupation-specific human capital are more significant, it should generate much larger wage dispersion(s) among workers at higher job ranks.

Also, a directed search model typically assumes that workers direct their search based on the posted wages only. However, the importance of firm- and occupation-specific human capital and its heterogeneity implies that the costs of job transition (i.e. loss of specific human capital) differ systematically across occupations. Thus, the intensity of search should differ systematically across occupations. Moreover, to the extent that wages are outcomes of bargaining between firms and workers, the relative bargaining power would have a much larger effect when firm-specific human capital is more significant than when occupation-specific human capital is more significant. Therefore, incorporating the heterogeneity of firm- and occupation-specific human capital across occupations should generate a much richer set of results.

## 5. Conclusion

Though hiring and promotions are arguably the two most important aspects of firms' personnel policy and workers' careers, the literature has largely ignored what types of skills workers need to be hired or promoted, especially to top-ranked jobs. Firm-specific human capital and occupation-specific human capital are among the most important and contested of these skills, and this study shows that the two are about equally valuable, even at top-ranked jobs. For example, our measure for the significance of firm-specific human capital, $\hat{\beta}_f$, ranges from 0.3263 to 0.4112 depending on specifications, while the significance of occupation-specific human capital, $\hat{\beta}_o$, ranges from 0.4146 to 0.6232. Moreover, this study observes a large heterogeneity across occupations in both the absolute and relative values of the two, and shows that education is an important determinant of this heterogeneity.

In contrast, the previous theoretical and empirical literature has largely focused on the *firm*-aspect of personnel policy and workers' careers, including workers' firm turnover, returns to firm tenure, the firm–worker contract, and firm–worker matching. Our results suggest that it would be useful for future research to incorporate both firm *and* occupation aspects, while taking cognizance of the heterogeneity among occupations. Also, while we show that education is an important determinant for the significance of occupation-specific human capital, the determinants for the significance of firm-specific human capital as well as other determinants for the significance of occupation-specific human capital remain topics for future research.

## Appendix A. Three-digit occupation (BNT) codes

| BNT family | BNT code | No. of ranks | |
|---|---|---|---|
| 0 | | | Administrative work |
| | 020 | 7 | General analytical work |
| | 025 | 6 | Secretarial work, typing and translation |
| | 060 | 6 | Administrative efficiency improvement and development |
| | 070 | 6 | Applied data processing, systems analysis and programming |
| | 075 | 7 | Applied data processing operations |
| | 076 | 4 | Key punching |
| 1 | | | Production management |
| | 100 | 4 | Administration of local plants and branches |
| | 110 | 5 | Management of production, transportation and maintenance work |
| | 120 | 5 | Work supervision in production, repairs, transportation and maintenance work |
| | 140 | 5 | Work supervision in building and construction |
| | 160 | 4 | Administration, production and work supervision in forestry, log floating and timber scaling |
| 2 | | | Research and development |
| | 200 | 6 | Mathematical work and calculation methodology |
| | 210 | 7 | Laboratory work |
| 3 | | | Construction and design |
| | 310 | 7 | Mechanical and electrical design engineering |
| | 320 | 6 | Construction and construction programming |
| | 330 | 6 | Architectural work |
| | 350 | 7 | Design, drawing and decoration |
| | 380 | 4 | Photography |
| | 381 | 2 | Sound technology |
| 4 | | | Technical methodology, planning, control, service and industrial preventive health care |
| | 400 | 6 | Production engineering |
| | 410 | 7 | Production planning |
| | 415 | 6 | Traffic and transportation planning |
| | 440 | 7 | Quality control |
| | 470 | 6 | Technical service |
| | 480 | 5 | Industrial, preventive health care, fire protection, security and industrial civil defense |
| 5 | | | Communications, library and archival work |
| | 550 | 5 | Information work |
| | 560 | 5 | Editorial work — publishing |
| | 570 | 4 | Editorial work — technical information |
| | 590 | 6 | Library, archives and documentation |
| 6 | | | Personnel work |
| | 600 | 7 | Personnel service |
| | 620 | 6 | Planning of education, training and teaching |
| | 640 | 4 | Medical care within industries |
| 7 | | | General services |
| | 775 | 3 | Restaurant work |
| 8 | | | Business and trade |
| | 800 | 7 | Marketing and sales |
| | 815 | 4 | Sales within stores and department stores |
| | 825 | 4 | Travel agency work |
| | 830 | 4 | Sales at exhibitions, spare part depots, etc. |
| | 835 | 3 | Customer service |
| | 840 | 5 | Tender calculation |
| | 850 | 5 | Order processing |
| | 855 | 4 | Internal processing of customer requests |
| | 860 | 5 | Advertising |
| | 870 | 7 | Buying |
| | 880 | 6 | Management of inventory and sales |
| | 890 | 6 | Shipping and freight services |
| 9 | | | Financial work and office services |
| | 900 | 7 | Financial administration |
| | 920 | 6 | Management of housing and real estate |
| | 940 | 6 | Auditing |
| | 970 | 4 | Telephone work |
| | 985 | 6 | Office services |
| | 986 | 1 | Chauffeuring |

## Appendix B. Sample description of four-digit occupation codes

*Occupation family* 1: Occupation #120 — Manufacturing, repair, maintenance, and transportation.

11% of 1988 sample.

There is no rank 1 in this occupation.

Rank 2 (4% of occupation # 120 employees) — Assistant for unit; insures instructions are followed; monitors processes.

Rank 3 (46%) — In charge of a unit of 15–35 people.

Rank 4 (45%) — In charge of 30–90 people; does investigations of disruptions and injuries.

Rank 5 (4%) — In charge of 90–180 people; manages more complicated tasks.

Rank 6 (0.3%) — Manages 180 or more people.

There is no rank 7 in this occupation.

*Occupation family* 2: Occupation #310 — Construction.

10% of 1988 sample.

Rank l (0.1%) — Cleans sketches; writes descriptions.

Rank 2 (1%) — Does more advanced sketches.

Rank 3 (12%) — Does simple calculations regarding dimensions, materials, etc.

Rank 4 (45%) — Chooses components; does more detailed sketches and descriptions; estimates costs.

Rank 5 (32%) — Designs mechanical products and technical products; does investigations; has 3 or more subordinates at lower ranks.

Rank 6 (8%) — Executes complex calculations; checks materials; leads construction work; has 3 or more subordinates at rank 5.

Rank 7 (1%) — Same as rank 6 plus has 2–5 rank 6 subordinates.

*Occupation family* 3: Occupation #800 — Marketing and sales.

19% of 1988 sample.

Rank l (0.2%) — Telesales; expedites invoices; files.

Rank 2 (6%) — Puts together orders; distributes price and product information.

Rank 3 (29%) — Seeks new clients for 1–3 products; can sign orders; does market surveys.

Rank 4 (38%) — Sells more and more complex products; negotiates bigger orders; manages 3 or more subordinates.

Rank 5 (20%) — Manages budgets; develops products; manages 3 or more rank 4 workers.

Rank 6 (7%) — Organizes, plans, and evaluates sales force; does more advanced budgeting; manages 3 or more rank 5 workers.

Rank 7 (1%) — Same as rank 6 plus 2–5 rank 6 subordinates.

*Occupation family* 4: Occupation #900 — Financial administration.

5% of 1988 sample.

Rank 1 (1%) — Office work; bookkeeping; invoices; bank verification.

Rank 2 (7%) — Manages petty cash; calculates salaries.

Rank 3 (18%) — More advanced accounting; 4–10 subordinates.

Rank 4 (31%) — Places liquid assets; manages lenders; evaluates credit of buyers; manages 3 or more rank 3 employees.

Rank 5 (28%) — Financial planning; analyzes markets; manages portfolios; currency transfers; manages 3 or more rank 4 employees.

Rank 6 (12%) — Manages credits; plans routines within the organization; forward-looking budgeting; manages 3 or more rank 5 employees.

Rank 7 (2%) — Same as rank 6 plus 2–5 rank 6 subordinates.

## Appendix C. Wage returns to firm- and occupation-tenure

For comparison with previous studies, we estimate the returns to firm- and occupation-tenure in workers' wages. In particular, following Kambourov and Manovskii (2009b), we estimate the following wage regression:

$$\ln\left(wage_{ijkt}\right) = \beta_{f1}\left(firm\ \text{tenure}_{ijt}\right) + \beta_{f2}\left(firm\ \text{tenure}_{ijt}\right)^2 + \beta_{o1}\left(occup.\ \text{tenure}_{ijt}\right) + \beta_{o2}\left(occup.\ \text{tenure}_{ijt}\right)^2 + \beta_{g1}\left(age_{ijt}\right) + \beta_{g2}\left(age_{ijt}\right)^2 + OJ_{ijt} + X_{ijkt}\cdot\gamma, \quad \text{(A.1)}$$

where $wage_{ijkt}$ is the real monthly wage of person $i$ working in period $t$ with firm $j$ in occupation $k$. Firm- and occupation-tenure measure the number of years observed within a single firm and a single occupation, respectively. $OJ_{ijt}$ is a dummy variable that equals one if the individual is not in the first year with the current firm. $X_{ijt}$ is a vector of various individual, firm, and occupation characteristics including education, firm size, firm size growth rate, occupation size, occupation size growth rate, and dummy variables for industry, year, and region. Since we cannot measure the labor-market experience of workers who entered our data before 1970, who represent about 30% of the sample from 1986–1989, we use age, with education, as a proxy for labor market experience.[25]

[25] Using labor market experience, i.e. the number of years observed in the data, instead of age, does not change the qualitative results.

Firm- and occupation-tenure are endogenous variables since they are determined by workers' firm and occupation turnover decisions, which in turn depend on wages. This endogeneity problem may be particularly serious for the case of Sweden, where it is generally difficult for firms to fire workers and workers thus change firms only when their wages increase (see, e.g., Gibbs and Ierulli, 2002). As workers change firms, their firm tenures will reset to zero while their wages increase, generating a negative bias on the returns to firm tenure.

To control for this bias, following Altonji and Shakotko (1987) and Kambourov and Manovskii (2009b), we first compute individual-sample means of firm tenure for each period of working in a firm. Then, we use the deviations of firm tenure from those means as instrumental variables, following the same procedure to construct instrumental variables for occupation tenure, *OJ*, and tenure-squared variables (see, e.g., Kambourov and Manovskii (2009b) for more details).

Table A.1 shows both OLS- and IV-regression outcomes. From column [2], IV-regression estimates the returns to ten years of firm tenure at an essentially negligible −1.7%. The returns to ten years of occupation tenure are, however, relatively large at 9.5%. These results are robust even when we allow for possible serial correlation within individual workers, as shown in column [3]. Note that to reduce the computational burden, we use a 10% random sample of workers for IV-GLS estimation.

These findings replicate the previous studies that find that the returns to occupation tenure are significant but the returns to firm tenure are economically insignificant. However, these findings contrast with our results based on promotion and hiring analyses where we find that firm- and occupation-specific human capital are equally important for workers' productivity in a given job.

In addition to the endogeneity problem discussed before, the insignificance of the returns to firm tenure in the wage analysis may be due to aspects of wage-bargaining power between firms and workers, or to the inaccuracy of firm- and occupation-tenure as measures of firm- and occupation-specific human capital, since, as Figs. 2 shows, workers with only one year of firm tenure are easily found even in the highest-ranked jobs.

**Table A.1**
Wage: Firm tenure vs. occupation tenure. (Dependent variable = log(real wage)).

| | OLS | IV | IV-GLS |
|---|---|---|---|
| | [1] | [2] | [3] |
| Age | 0.0622[a] | 0.0613[a] | 0.0632[a] |
| | (0.0002) | (0.0002) | (0.0009) |
| Age sq. | −0.0006[a] | −0.0006[a] | −0.0007[a] |
| | (0.0000) | (0.0000) | (0.0000) |
| Firm tenure | −0.0039[a] | −0.0027[a] | −0.0031[a] |
| | (0.0002) | (0.0005) | (0.0007) |
| Firm tenure sq. | 0.0002[a] | 0.0001[a] | 0.0001[b] |
| | (0.0000) | (0.0000) | (0.0000) |
| Occup. tenure | 0.0108[a] | 0.0145[a] | 0.0139[a] |
| | (0.0002) | (0.0004) | (0.0008) |
| Occup. tenure sq. | −0.0003[a] | −0.0005[a] | −0.0005[a] |
| | (0.0000) | (0.0000) | (0.0000) |
| OJ | 0.0063[a] | −0.0026[b] | −0.0034[b] |
| | (0.0008) | (0.0011) | (0.0019) |
| # of obs. | 962,890 | 962,890 | 96,009 |
| R-sq. | 0.48 | 0.48 | 0.49 |

Note: Each regression includes dummy variables for firm size, firm size growth rate, occupation size, occupation size growth rate, education, industry, year, and region. IV-GLS estimation in column [3] is based on 10% random samples. OJ is a dummy variable that equals one if the individual is not in the first year with the current firm.

[a] Significant at 1%.

[b] Significant at 5%.

[c] Significant at 10%.

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