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COGNITIVE ABILITY AND EMPLOYEE MOBILITY: EVIDENCE FROM SWEDISH MICRODATA

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Abstract

Cognitive ability and intelligence have been highlighted as the primary personnel measures used for hiring decisions, and gurus and popular business outlets consistently recommend that managers hire people smarter than themselves. However, the sustainability of such hiring strategies with respect to employee retention has not been fully investigated, largely due to data constraints. In this research note, we examine the relationship between cognitive ability and employee mobility, taking advantage of unique microdata from Sweden. Our empirical results show that higher cognitive ability is negatively associated with turnover, implying that cognitively-gifted employees settle with better employment options internally, compared to the external labor market. Nevertheless, when the employee has a significantly higher cognitive ability than their manager , employees are more likely to the firm. The results shed light on the relationship between cognitive ability and mobility, and highlight the role of managers for the success of hiring strategies based on cognitive ability.

JEL Classification: N/A

Keywords: cognitive ability, employee mobility, cognitive distance, Managers, retention

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Cognitive Ability and Employee Mobility: Evidence from Swedish Microdata[1]

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ABSTRACT

Cognitive ability is often highlighted as key measure used for hiring decisions, and popular business outlets consistently recommend that managers hire people smarter than themselves. However, the sustainability of such hiring strategies with respect to employee retention has not been fully investigated. We examine the relationship between cognitive ability and employee mobility using microdata from Sweden. We find that higher cognitive ability is negatively associated with turnover, implying that cognitively-gifted employees settle with better employment options internally, compared to external opportunities. Nevertheless, when the employee has a higher cognitive ability than their manager, employees are more likely to exit the firm. This sheds light on the relationship between cognitive ability and mobility, and highlights the role of managers for the success of intelligence-based hiring strategies.

Keywords: Cognitive ability, employee mobility, cognitive distance, managers, retention

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Introduction

"My philosophy is to always find the smartest people you can. Hire people smarter than you."

– Donny Deutsch

Firms frequently rely on human assets to create value and build competitive advantage (Campbell, Coff, and Kryscynski, 2012a; Coff and Kryscynski, 2011; Starr, Ganco, and Campbell, 2018). Thus, selecting and retaining employees and the strategic management of human capital is crucial for competitive organizations (Agarwal, Gambardella, and Olson, 2016b; Campbell *et al.*, 2012b). While human capital encompasses knowledge, skills, and other abilities (Becker, 1964), personnel selection scholars have consistently stressed that firms should focus on recruiting the "smartest" individuals available and that general cognitive ability should be "the primary personnel measure for hiring decisions" (Schmidt and Hunter, 1998: 266). In fact, the mantra to select on intelligence has become omnipresent in the popular business press and propagated by strategy gurus who, as the introductory quote highlights, actively advise managers to hire people smarter than themselves.

That said, a firm can only create value and build competitive advantages by hiring cognitively gifted employees if it can *retain* these employees. Indeed, employee mobility often depletes firm knowledge and transfers it to competitors (Arrow, 1972), which in turn can undermine a firm's competitive position (Agarwal *et al.*, 2016b). As Agarwal, Ganco, and Ziedonis (2009: 1349-1350) concisely capture, "departures of key talent can deliver a double blow — the firms lose valuable human capital and rivals stand to gain technological know-how at their expense". These adverse effects of employee mobility may be particularly strong when exiting employees have high cognitive ability, as these employees have the capacity to both absorb knowledge within a firm and to transfer such knowledge to rival firms if they decide to leave. Therefore, understanding the relationship between cognitive ability and employee mobility in more detail may be critical for the strategic management of human assets.

To date, however, there has been surprisingly little research exploring if, when, or under what conditions cognitively gifted employees tend to remain within (or sort out of) their firms (Maltarich, Nyberg, and Reilly, 2010). Data availability has long restricted more comprehensive and generalizable study of these relationships: estimates of individual cognitive ability are not readily observable, especially in large-scale longitudinal datasets.[2] Our understanding of the relationship between cognitive ability and mobility has therefore remained limited.

We address this gap by exploiting an employee-employer linked database constructed from Swedish administrative records for which we can observe quantitative cognitive ability scores for the *population* of adult Swedish males.[3] Conceptually, intelligent employees are likely to have greater labor market options both internally and externally, thereby rendering the general relationship between cognitive ability and mobility ex-ante ambiguous. Accordingly, we let the data speak and take full advantage of the novelty of our data to report some stylized facts, examine the general link between cognitive ability and mobility, and then explore the role of managers' cognitive ability on the aforementioned relationship (Bettis *et al.*, 2014).

Our analysis yield two key results. First, there is a robust negative relationship between an employee's cognitive ability and mobility, suggesting that, on average, an individual's cognitive ability generates more exchange value at their employer compared to the external labor market. The data suggest that this may be explained by the relative unobservability of cognitive ability in labor markets, compared to other more easily observable signals such as education, which are positively associated with mobility in our analysis. Second, the likelihood of mobility also depends on the cognitive ability of the *employees' manager*: Employees are more likely to exit the firm as the relative cognitive ability of the employee

[2] The few studies which have explored the relationship between cognitive ability and employee mobility decisions rely on small idiosyncratic samples, self-reported surveys, and other crude proxies and have yielded inconsistent and heterogeneous findings (Cotton and Tuttle, 1986; Griffeth, Hom, and Gaertner, 2000). Also, none of these studies have incorporated the role of managers' cognitive ability.

[3] The data also offers a unique opportunity to control for social and non-cognitive ability of individuals, which allows us to isolate the effect of interest.

compared to their manager increases— i.e. for a given manager, the smarter an employee, the greater is their exit likelihood. Our reading of these results is that, in equilibrium, cognitively gifted employees tend to end up in satisfactory job matches and hence are less likely to exit, but that the quality of match and therefore the probability of exit also depends critically on the cognitive ability of their manager.

Our findings contribute to the strategic human capital and employee mobility literatures by starting to unpack the nuanced relationship between cognitive ability and mobility. While selection scholars ubiquitously argue that intelligence should be prioritized in hiring decisions (Schmidt, Oh, and Shaffer, 2016), our results suggest that retaining cognitively gifted employees will be challenging without having "smart" managers in place. In doing so, our study connects and contributes to the growing literature examining the effects of managerial ability on employee outcomes (e.g., Lazear, Shaw, and Stanton, 2015). While conventional wisdom suggests that employees leave bosses who lack interpersonal skills (e.g., Hoffman and Tadelis, 2018), our results suggest that employees are likely to leave bosses who are cognitively inferior, even when controlling for the manager's social ability. These results have implications for the selection of personnel across firm levels (Ployhart, 2006), the structure of human assets within firm hierarchies (e.g., Garicano and Wu, 2012), and ultimately the strategic management of human capital (Campbell *et al.*, 2012a; Campbell *et al.*, 2012b).

Cognitive Ability and Employee Mobility

The Data

To explore the relationship between cognitive ability and mobility we link multiple datasets. We begin with the Longitudinal Integrated Database for Health and Labor Market Studies (LISA) provided by Statistics Sweden (SCB). LISA contains registry data on employment, education, and demographic characteristics for all individuals residing in Sweden who are at least 16 years old. Coverage for LISA begins in 1990. We obtain financial information about employer firms by linking LISA with the Serrano database. The data included in Serrano uses financial statements provided by Swedish Companies Registration Office and

company history provided by SCB. Coverage of Serrano includes most legal forms of business in Sweden and begins in 1998. Together, LISA and Serrano provide a longitudinal employee-employer linked database containing detailed (objective) information on the characteristics of individuals and firms across time.

We supplement this database with military enlistment data extracted from the Swedish Defense Recruitment Agency (SDRA) (for individuals enlisted in the military between 1983 and 2010) and the Military Archives (MA) (for individuals enlisted between 1969 and 1983). These data sources provide quantitative cognitive ability and non-cognitive (social) ability scores for the population of Swedish men, collected at the ages of 18-19, as part of the mandatory military enlistment process. A detailed description of the data collection process is provided in Lindqvist and Vestman (2011).[4]

Sample Construction

We have a panel covering 14 years (between 2001 and 2014, inclusive), and our unit of analysis is the individual-year. Because cognitive ability scores are only available for men, our sample is limited to male employees. We restrict our sample to the years of 2001-2014 because occupational codes are not available prior to 2000 and our data coverage ends in 2015, meaning 2014 is the final year we can examine mobility. We use occupational codes, in conjunction with data on boards of directors (available from 1998 onward) to differentiate individual employees from CEOs. Our sample includes all male employees working in private companies across all sectors of the Swedish economy, excluding "Agriculture and fishing" and "non-profit organizations".

We restrict the employers included in our primary sample to firms with at least 5 employees but no more than 50.[5] We implement a minimum size threshold to exclude extremely small firms which may lack any form of organizational structure and where turnover dynamics may be highly idiosyncratic. We

[4] These data have recently been exploited in several studies on CEOs (Adams, Keloharju, and Knüpfer, 2018), politicians (Dal Bó *et al.*, 2017), and finance professionals (Böhm, Metzger, and Strömberg, 2018).
[5] Results, both in terms of effect size and statistical significance, are similar with firm size thresholds of 70 and 100.

implement a maximum size threshold of 50 for several reasons.[6] First, approximately 99 percent of all businesses in the Swedish economy have less than 50 employees (European Commission, 2018). Second, limiting our sample to smaller firms reduces the potential effects of unobserved heterogeneity due to variation across business unit and plant locations (e.g., Bloom, Kretschmer, and Van Reenen, 2011). Finally, although our data is quite detailed, we cannot observe direct managers within work units. Smaller firms tend to have simpler hierarchical structures (Benz and Frey, 2008) where top managers and CEOs will, on average, have more direct interactions and influence on individual employees. Thus, by focusing on small and medium sized firms, it lets us explore how the relationship between cognitive ability and exit decisions may be contingent on factors, specifically the cognitive ability of the employee's manager. Our final sample comprises 996,733 individual-year observations from 288,487 individuals and 22,640 firms.

Empirical Strategy

Since we are interested in the relationship between cognitive ability and mobility, our primary dependent variable is a binary indicator (*Departure*) equal to one if an individual's employer changes in the following year. This is in line with existing research on mobility using Swedish data (Bonhomme, Lamadon, and Manresa, 2019; Kacperczyk and Balachandran, 2018; Skans, Edin, and Holmlund, 2009).[7] Although we cannot observe the cause of mobility, involuntary mobility or employee dismissals are relatively rare in the Swedish context given various forms of legal protections.[8] Also, it reasons that dismissals are likely to result in unemployment rather than employment in the next period. Therefore, and following prior work (Baghai *et al.*, 2020; Bonhomm *et al.*, 2019; Kacperczyk and Balachandran, 2018; Skans *et al.*, 2009) ,we

[6] Excluding firms with less than five employees is common practice in studies utilizing employer-employee linked administrative data to study issues pertaining to employee mobility (e.g., Agarwal *et al.*, 2016a; Campbell *et al.*, 2012b).
[7] We exclude changes in employee due to mergers, acquisitions, or firm bankruptcies. We identify these events by ensuring the current employer exist in the following year, and that the firm status does not indicate merger, or bankruptcy.
[8] Job termination by employer is less common in Sweden compared to many western countries– e.g. unlike the US, the Swedish labor law does not allow for *at-will employment*.

identify voluntary departures by excluding transitions into unemployment and build our dependent variable based on the workers who leave to work for *another* employer.[9]

We begin by estimating the following baseline equation:

$$Pr(Departure_{i\,t+1}) = \beta_1\, Cognitive\ Ability_i + \beta_2\, Zijt + \pounds_o + \theta_c + \mu_k + a_t + \varepsilon_{it}, \qquad (1)$$

where *i* indicates the individual, *j* indicates the firm, *o* indicates ownership category, *c* indicates region, *k* indicates industry, and *t* indicates time. $Cognitive\ Ability_i$ is a numeric variable ranging from 1 to 9, with higher values indicating greater cognitive ability. These scores are derived from four written tests assessing logic, verbal, spatial, and technical comprehension (Ståhlberg-Carlstedt and Sköld, 1981). The results of these tests, which scholars have argued are valid proxies for intelligence (Lindqvist and Vestman, 2011), are then transformed to a discrete variable of general cognitive ability. This variable has a stanine scale such that a 5 is reserved for the middle 20 percentile of the test population, while 4, 3, and 2, are given to the next 17, 12, and 7 percentiles, and the score of 1 to the lowermost 4 percentiles (scoring above 5 is symmetric). Since the majority of men start their military service upon high school graduation, the measure is not affected by educational attainment. The average (median) cognitive ability score for employees in our sample is 5.15 (5), consistent with population averages reported in Dal Bó *et al.* (2017) and Böhm *et al.* (2018).

Given the time-invariant nature of the cognitive ability score, we cannot use individual fixed effects, but we exploit the richness of the data to control for a host of factors which may influence mobility to come as close as possible to a fully saturated model. Accordingly, *Zijt* represents a vector of time-variant and time-invariant control variables at the employee and firm level, designed to capture sources of individual and firm heterogeneity. This includes factors related to employee skill and ability (non-cognitive ability, wage, education, industry experience, and tenure), demographics (age, age squared,

[9] In addition to using a conservative definition of departure, we estimate our model on the subsample of high earning individuals (4th quantile within each industry) as a robustness test. These cases are more likely to be high-performing employees and therefore, less likely to be fired. Our results stay robust and are available upon request.

marital status, foreign born, and number of children), and firm characteristics (CEO non-cognitive ability, share of employees with reported cognitive score[10], number of employees, total assets, operating margin, and employment growth). Table 1 gives detailed descriptions of our control variables.

[Insert Table 1]

In addition to the covariates outlined in Table 1, we include a number of fixed effects in our baseline model. Specifically, $\pounds_o$ are ownership fixed effects (3 dummy variables for Swedish parent company (12.4%), subsidiary belonging to a Swedish group (43.3%), belonging to a foreign multinational (12.9%), and independent firm (31.5%) as the baseline), θ_c are region fixed effects (25 provinces), μ_k are industry fixed effects (classified in Swedish Standard Industrial Classification (SNI) 2002 at the level of section[11]), and a_t are time (year) fixed effects. We subsequently include additional and more stringent fixed effect structures in our analysis, as we detail below.

Results

We begin by presenting descriptive statistics and basic sanity checks designed to demonstrate the validity of our cognitive ability measure. As noted, the mean cognitive ability for employees in our sample is 5.15. In figure 1a, we show that this score monotonically increases with educational attainment, indicating that those with greater innate cognitive ability tend to become more educated (Lynn and Mikk, 2007). In particular, the mean cognitive ability score for employees who graduate from university is 2.92 points (73.12 percent) higher than employees who did not complete high school. Figure 1b shows that cognitive ability is systematically linked with wages, consistent with age-old expectations in labor economics (Woodbury, 1917). The average cognitive ability score for employees in the top wage quartile (across industries and year) is about 21% higher than the average score for those in the bottom wage quartile.

[10] Alternatively, we used share of female employees within the firm. The variables are correlated at 60%.
[11] The exact details are provided by SCB (see https://www.scb.se/en/documentation/classifications-and-standards/swedish-standard-industrial-classification-sni/). The SNI 2002 is based NACE Rev 2. Alternatively, we used two-digit and three-digit SNI 2002 codes. Result are very similar to the main findings and available upon request.

[Insert Figures 1a and 1b]

In Figure 2a, we plot the distribution of cognitive ability scores (1-9) of employees and CEOs separately. As Figure 2a demonstrates, the distribution of CEO cognitive ability scores tends to be more right-skewed (mean is equal to 6.03) than that of employees (mean is equal to 5.15). Hence, CEOs tend to have greater cognitive ability on average than employees, consistent with Adams *et al.* (2018). In Figure 2b, we show that this pattern holds across sectors (reported at the 1-digit level for brevity), although the average cognitive ability varies across sectors (Dal Bó *et al.*, 2017).

[Insert Figures 2a and 2b]

We now shift our attention toward the relationship between cognitive ability and employee mobility. To do so, we estimate equation 1 to examine the relationship between cognitive ability and mobility while controlling for an extensive set of other factors outlined in Table 1. Most models are estimated via linear probability models to ease interpretation. We cluster standard errors by employer because employees are nested within firms, although results remain very similar when we cluster errors at the employee level. Results are presented in Table 2. To conserve space, our regression tables only include point estimates for the key variables of interest. Appendix 1 reports the point estimates for all variables, including controls relevant to Table 2.

[Insert Table 2 about here]

The estimate in Model 1 demonstrates that cognitive ability is negatively correlated with employee departure (p-value=0.000). In terms of effect size, the coefficient estimate in Model 1 implies that one standard deviation increase in an employee's cognitive ability is associated with a 1.7 percent reduction in the baseline probability that the employee exits the firm. Note this effect is estimated from an already saturated model including controls for factors such as wage, non-cognitive ability, and education, all of which are significantly correlated with cognitive ability and likely to partly absorb its effect. As an example, estimating model 1 without controlling for wage yields a point estimate for cognitive ability

approximately threefold in magnitude. The interpretation is that cognitive ability appears to be negatively related to employee mobility even when controlling for host of factors cognitive ability may theoretically associate, as demonstrated in Figures 1a and 1b.

In Model 2, we replicate the estimation in Model 1 using a logistic regression. The point estimate for cognitive ability remains negative and statistically significant negative (p-value=0.000). In Model 3, we probe the extent to which our results may be influenced by sample selection, increasing the maximum size threshold of employers from firms employing 50 employees to firms employing up to 100. As demonstrated in Model 3, the point estimate remains negative with a low p-value (p-value=0.000) and an effect size similar to the estimate from Model 1.

Although we include a host of time-varying controls in all estimations, we ask if our results are robust to the inclusion of additional fixed effects designed to more conservatively account for sources of time-varying heterogeneity in Models 4 and 5. In Model 4, we include industry-year fixed effects, thereby forcing the comparison to employees working within an industry in a given year – effectively holding constant all temporal industry effects. In Model 5 we include firm-year fixed effects. This extremely restrictive model compares employees within a firm to other employees within that same firm, year by year, thereby absorbing all time-varying firm controls and implicitly controlling for time-varying unobserved heterogeneity at the firm level. The negative association between cognitive ability and mobility is robust to these additional fixed effects (Model 4: p-value=0.000; Model 5: p-value=0.015).

The robust pattern of results presented in Table 2 indicating a negative relationship between cognitive ability and mobility is interesting because, as we briefly outlined above, the ex-ante theoretical expectation is ambiguous. Cognitive ability is a valued attribute in the labor market (Schmidt *et al.*, 2016) which leads to competing forces: firms want to retain cognitively gifted employees and other employers want to recruit these employees. One explanation as to why employees with high cognitive ability may be less likely to leave is that, unlike labor market signals such as education, cognitive ability is not fully

observable in the market, and the employer learns about it during employment (Spence, 1973). As a result, the external labor market options for employees with high cognitive ability may be lower than what we would expect in a world of complete information (Byun, Raffiee, and Ganco, 2019). This conjecture is supported in our data as we observe positive mobility effects for signals which are arguably more easily *observable*, such as a college degree or non-cognitive (social) ability – both of which are positively correlated with cognitive ability, which is more *unobservable* and negatively linked to exit.[12]

The robust negative relationship between cognitive ability and mobility suggests that, in equilibrium, employees with higher cognitive ability are less likely to exit. Hence, all else equal, employees with high cognitive ability tend to be at least content with their employment. One interpretation is that firms recognize when employees are cognitively gifted and offer them merit-based job packages and incentives to stay – consistent with an equilibrium in which better quality employees match to better firms (Oyer and Schaefer, 2010).

Based on the findings above, one may wonder if higher cognitive ability is unconditionally a factor relevant for employee retention. To examine this, we turn to a growing literature highlighting the importance of top managers for employee careers (Hoffman and Tadelis, 2018; Lazear *et al.*, 2015). We do so by leveraging the fact that we have cognitive ability scores not only for employees, but also for top executives. Our guiding logic here is that the cognitive ability of the CEO will be important in determining match quality for employees. Simply put, CEOs and other top executives are crucial for organizations (Hambrick and Mason, 1984), and when CEOs have low cognitive ability it could limit the potential an employee may expect within the firm – especially cognitively gifted employees who may have outside employment options. To examine this, we enhance equation (1) by adding a measure of the relative cognitive ability of the employee compared to his manager, as follows:

[12] Common job interviews are more effective in providing information on an individual's social skills and non-cognitive ability. Employers may observe cognitive ability through job screening tests, but only a handful of companies implement tests of cognitive ability during the selection process (Menkes, 2005).

$Pr(Departure_{i\,t+1}) = \beta_1\ Cognitive\ Ability_i + \beta_2\ Relative\ Cognitive\ Ability + \beta_3\ Zijt + \pounds_o + \theta_c + \mu_k + a_t + \varepsilon_{it}$, (2)

where the notation is the same as equation 1. Our variable *Relative Cognitive Ability* is calculated as the cognitive ability score of the employee minus the cognitive ability score of her manager. A positive Relative Cognitive Ability value implies that the employee has scored higher in the cognitive ability test than the manager and the higher it is, the greater the gap in cognitive ability. This variable has a mean= -0.9, confirming that managers are on average about one unit smarter than employees— consistent with figure 2a. The cognitive scores we use to construct the relative ability measure are *proxies* of individuals' cognitive skill and intelligence. Thus a specific value (e.g. zero) of Relative Cognitive Ability does not mean much theoretically. However, higher values imply that the employee is— and likely feels— smarter than the firm's CEO. We examine the role of this variable in more detail below.

[Insert Table 3 about here]

The results for equation 2 are in Table 3, where we report the coefficients for our variables of interest, i.e. cognitive ability and relative cognitive ability — Appendix 2 reports the full model for all variables, including controls. In Model 1, the main effect of cognitive ability remains negative (p-value=0.000), with a higher magnitude relative to the estimates in Table 2 — a one standard deviation increase in cognitive ability is associated with a 4.9 percent decrease in the baseline probability of mobility. The coefficient for relative cognitive ability, however, is positive (p=0.000). The coefficient shows that a one standard deviation increase in relative cognitive ability is associated with a 4.2 percent increase the baseline probability of mobility.

In Model 2, we replace our linear relative cognitive ability measure with quartiles (1st quartile is the excluded baseline category). The estimates reveal that the effect is monotonically increasing in magnitude, as the coefficient for the 4th quartile is almost three times the magnitude of the coefficient for the 2nd quartile (P-value=0.000 across all quartiles). Regarding the magnitude of the effect, moving from the first to the fourth quartile of relative cognitive ability is associated with an approximate 1.3 percent increase in

the probability of mobility, an effect which represents an approximate 9 percentage point increase relative to the mobility baseline. In Model 3, we include a simple dummy indicator of 1 if the employee has a cognitive ability score higher than the CEO. The point estimate for this indicator is positive (p-value=0.00), suggesting that employees are more likely to exit (3.5 percentage point increase relative to the baseline) when they are smarter than their boss.

In line with these results, we argue that higher relative cognitive ability — i.e. having a less smart direct manager— would discourage the employee through both tangible and non-tangible factors, and drive their exit decisions. One could expect lower performance in situations in which the employee is much smarter than the manager (e.g. because of poor match, sub-optimal delegation of autonomy to the employee and eventually poor outcomes in projects). In our data, we cannot observe the direct performance of the employee. Nevertheless, to test this mechanism, we use employee wage as a performance proxy and investigate how cognitive scores are related to earnings. Our complementary analyses in the Appendix 3 show that while cognitive score has a strong positive correlation with employee wages, relative cognitive ability proxies are negatively related with employee earnings. This is consistent with the argument that higher relative ability is related to low performance and part of our rationale to control for employee wage in equation (2)— see the full control list in Appendix 2. Nevertheless, the effect of relative cognitive ability on employee exit is fully robust to the inclusion of wage as a control variable. This implies that the adverse effect of relative cognitive ability is not only limited to tangible (performance-related) factors, but that other intangible factors – e.g. disutility and motivational costs of being of managed by less smart individuals— also contribute to this relationship.

To make sure these effects are not driven by confounds or other unobservables, we estimate a series of more restrictive fixed effect models. In Models 4 and 5 we replicate Models 1 and 2, but with industry-year fixed effects. Our results remain robust in this specification. Next, we include firm fixed effects to account for unobserved firm heterogeneity. To do so, we need to build a sample where the

manager's cognitive ability varies within firm— otherwise, it would be absorbed by the firm fixed-effect. We therefore focus on a subsample of firms that changed their CEO and consider observations three years pre and post the CEO change. This reduces our sample to 140,654 observations (5435 firms). Using this strategy, Models 6 and 7 replicate Models 1 and 2, but with a firm fixed effect allowing us to control for time-invariant unobserved characteristics. In Model 6, the effect of relative cognitive ability on mobility remains positive and with a larger magnitude (p-value: 0.031) as do the relative ability quartile coefficients in Model 7 (p-values for quantiles ranging from 0.015 to 0.046).[13] These results are robust across industries (Appendix 4).

In sum, we find that employees with high cognitive ability are less likely to leave their employer on average, but more likely to leave as their relative cognitive ability compared to their manager's increases. While these results are robust to a multitude of controls and fixed effects, we present further tests in the Appendix, including wage regressions (Appendix 3) and industry splits (Appendix 4).

Discussion and Conclusion

Our headline findings using a large sample of male Swedish employees are striking: Smart employees are less likely to leave, unless they are smarter than their CEO, in which case they are more likely to leave. Of course, our results are subject to a number of limitations, which at the same time present promising avenues for future research: First, our data, while highly detailed in many dimension, is limited in geography (Sweden only) and gender. While the restriction to Sweden is unlikely to present a major problem in terms of the generalizability to other developed economies (if anything, discretionary non-pecuniary means of retaining smart employees may be more limited in Sweden, dampening our effect as compared to other countries), the restriction to male employees and CEOs deserves deeper discussion. If, for example, female employees left firms for different reasons (or negotiated for different financial and

[13] Since the cognitive ability of CEO does not vary across firm-year, we cannot include relative cognitive ability in the model with firm-year fixed effects. If we include relative cognitive ability, all variation will come only from differences in cognitive ability across employees, meaning that model will be identical to the estimates presented in Model 6, Table 2.

non-financial rewards) than male employees, our results may not extend to female employees. As female employees are commonly considered to negotiate less aggressively than male employees, they may not be more likely to stay if they have higher cognitive ability because their value to the firm is not recognized and/or not rewarded. Moreover, female-led firms are not included in our sample, which poses some interesting questions. For example, if the selection process for female CEOs is more stringent and the cognitive ability of female CEOs is higher on average than their male counterparts,[14] relative cognitive ability, i.e. the negative consequences associated with working for a less intellectually capable CEO, may be less prevalent in female-led firms. Relatedly, if female CEOs display different management styles, e.g. by granting more autonomy to subordinates, the negative effects of working for a less cognitively able boss may be felt less prominently. A key finding of our study is that smart employees are less likely to leave. We argue that this may be because employers observe cognitive ability in the employment relation and devise strategies to keep these employees. Although we do control for salaries, we do not observe the non-pecuniary perks offered to employees with high cognitive ability as incentives to stay. More generally, we cannot distinguish between supply-side (i.e. firm-specific) and demand-side (i.e. employee-specific) reasons for the increased proclivity to remain in the firm by smart employees.

Despite the limitations pointed out above, our paper makes a number of important contributions: First, hiring smart employees in the first place does not seem a priori inconsistent with retaining them in the long run. Indeed, employees with high cognitive ability may be "undervalued assets" whose contributions may be worth more within the current firm than on the outside market. This is in contrast to anecdotal observations about "star markets" in which the best employees shop around for the highest-paying outside opportunities and move frequently. Our study suggests that the current employer can counteract this effect because abilities are better known internally and can therefore be rewarded with

[14] Dezsö and Ross (2012) and Dezsö et al. (2016) provide some evidence that female representation in top management is both more selective (Dezsö et al., 2016) and leads to higher performance (Dezsö and Ross, 2012), indicating that female managers that make it into leadership positions may be more competent both in "soft" and "hard" managerial skills.

incentives to stay. Second, in addition to the often-suggested benefits of promoting the smartest employees to leading positions, bosses with high cognitive ability may provide an "umbrella" under which other smart employees can thrive. The notion that smart people like to work for smart people seems intuitive. However, our results indicate that the positive effects of working in such an environment (possibly also because a smart boss is likely to recognize cognitive ability in others more easily and reward it accordingly) more than outweighs the potential downside of reduced promotion opportunities because the direct superior is unlikely to be replaced by a subordinate. Hence, in this respect, the opening quote that one should always "hire people smarter than you" seems to carry significant risks, at least in our data and setting. We hope that our research provokes further studies in this as yet underexplored field.

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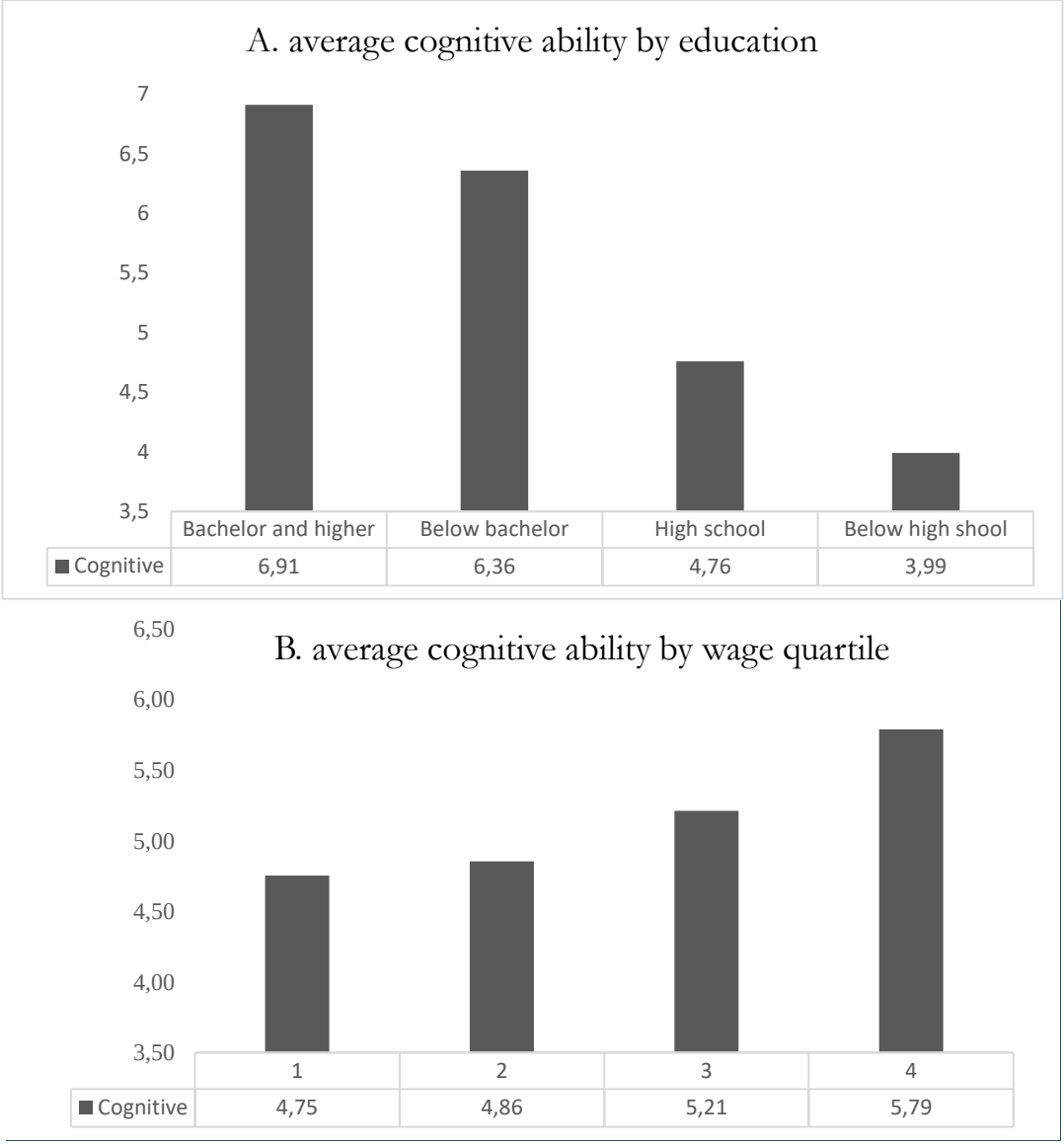
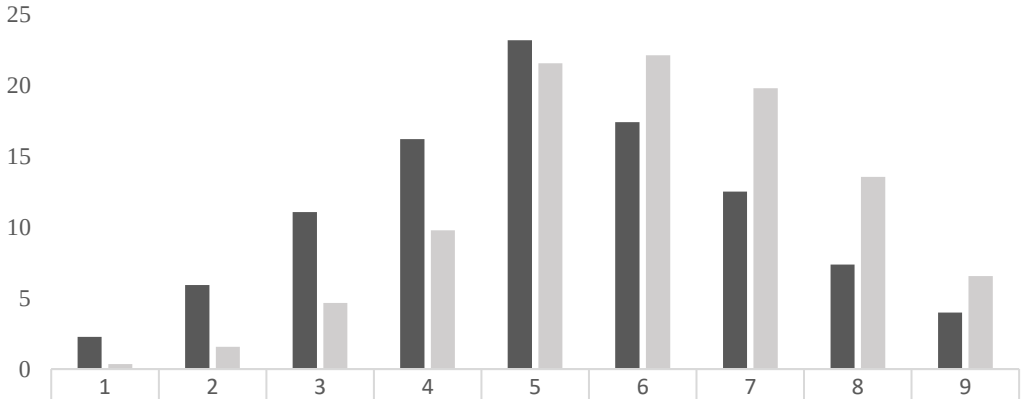


Figure 1a and 1b- Average cognitive ability by education and across wage quartiles

A. distribution of Employee and CEO cognitive ability scores (1-9)



	1	2	3	4	5	6	7	8	9
Employee Cognitive	2,28	5,93	11,07	16,23	23,19	17,42	12,51	7,37	3,99
CEO Cognitive	0,35	1,57	4,67	9,78	21,57	22,15	19,81	13,55	6,55

B. average employee and CEO cognitive ability across sectors

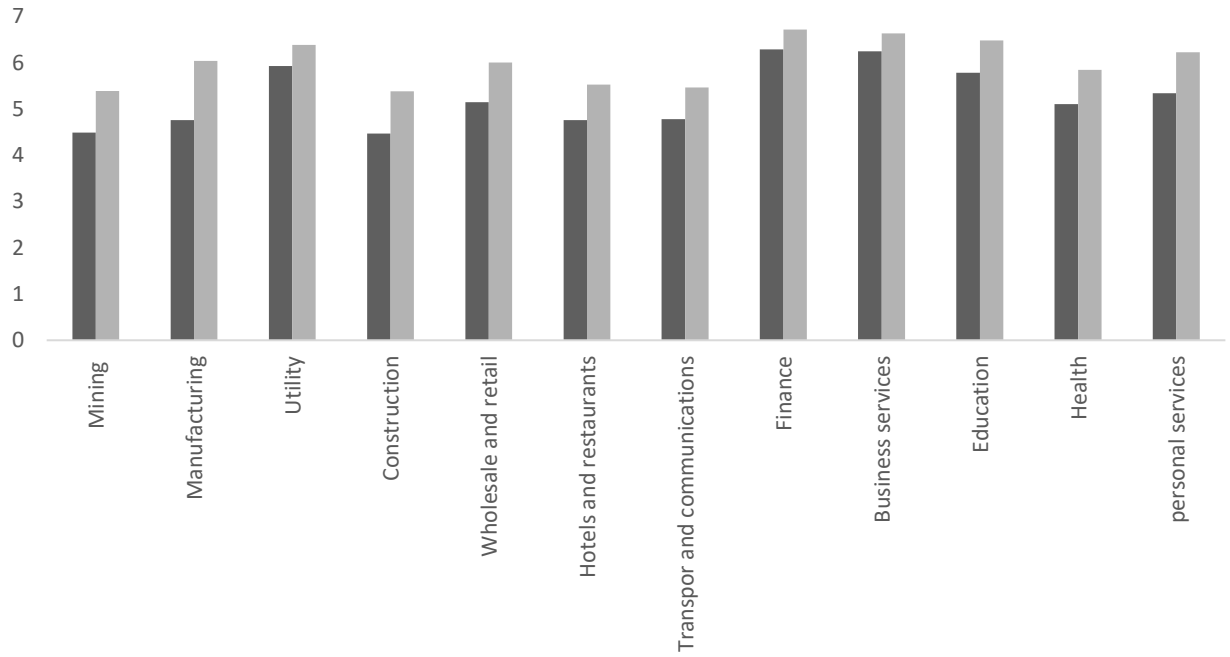


Figure 2a and 2b- Employee and CEO cognitive ability across scores and industries

Table 1-List of Control Variables

Variable name	Definition	Data Source	Mean	Std. Dev.	Min	Max
Wage(log)	Natural Logarithm of annual income from employment	LISA	8.10	0.50	-4.61	12.72
Bachelor	At least three years after high school education	LISA	0.11	0.32	0.00	1.00
After high school	Less than three years after high school education	LISA	0.17	0.37	0.00	1.00
High school	High school education	LISA	0.56	0.50	0.00	1.00
Industry exprience	#years working in the same industry as current firm	LISA	4.07	5.15	0.00	20.00
Tenure	#years working in the firm.	LISA	5.32	4.44	1.00	23.00
Age	Age in years	LISA	38.96	9.65	20.00	60.00
Age_squared	Age squared	LISA	1611.10	769.03	400.00	3600.00
Foreign born	A dummy=1 if employee is not born in Sweden	LISA	0.03	0.16	0.00	1.00
Married	A dummy=1 if employee is married	LISA	0.38	0.49	0.00	1.00
Child under 18	#children under 18 years old	LISA	0.84	1.04	0.00	10.00
Share cognitive score	Share of employees with cognitive score	LISA	0.62	0.16	0.10	1.00
Number of employees	Natural Logarithm of number of employees	Serrano	3.12	0.53	1.61	3.91
Total Assets	Natural Logarithm of total assets of firm	Serrano	16.75	1.15	11.94	27.55
Operating margin	Operating profit divided by sales of firm	Serrano	0.03	0.17	-1.31	0.35
Employement growth	(#employees at t − #employees at t-1)/#employees at t-1	Serrano	0.06	0.19	-0.49	1.38
Firm age	#years since registration of firm	Serrano	11.80	7.80	1.00	28.00
Non-cognitive ability[1]	Non-cognitive ability test result for employee	SDRA & MA	5.08	1.64	1.00	9.00
CEO non-cog. ability[1]	Non-cognitive ability test result for CEO	SDRA & MA	6.11	1.59	1.00	9.00

Notes: LISA (*Longitudinell Integrationsdatabas för Sjukförsäkrings- och Arbetsmarknadsstudier*) is the Swedish Longitudinal Integrated Database for Health Insurance and Labour Market Studies. Serrano database covers historical financial statements for Swedish companies. SDRA and MA refer to the Swedish Defense Recruitment Agency and Military Archives, respectively. [1] As part of the military enlistment process, each individual is required to complete a 25-minute interview with a certified psychologist, with the objective being to assess the individual's ability to cope with the psychological requirements of the military service. To do so, the interview covers five areas pertaining to the individual's life: experience in school, work experience, leisure and tendencies for introversion/extroversion, home life and upbringing, and finally emotional stability (see Lindqvist and Vestman, 2011: Appendix F for a detailed description of the interview protocol). The psychologist then assigns each individual a composite score which captures general non-cognitive ability, which ranges from 1 to 9, and follows the same distribution as the scores for cognitive ability.

Table 2- Cognitive ability and departure

	(1)	(2)	(3)	(4)	(5)
Model	LPM	Logit	LPM	LPM	LPM
	(b/se/p)	(b/se/p)	(b/se/p)	(b/se/p)	(b/se/p)
Cognitive ability	-0.00127	-0.01921	-0.00094	-0.00129	-0.00062
	(0.00023)	(0.00194)	(0.00019)	(0.00023)	(0.00025)
	(0.000)	(0.000)	(0.000)	(0.000)	(0.015)
Controls	YES	YES	YES	YES	YES
Ownership FE	YES	YES	YES	YES	NO
Industry FE	YES	YES	YES	NO	NO
Region FE	YES	YES	YES	YES	NO
Year FE	YES	YES	YES	NO	NO
Industry-year FE	NO	NO	NO	YES	NO
Firm-Year FE	NO	NO	NO	NO	YES
Observations	996,733	996,733	1,474,780	996,733	996,733
R-square	0.100		0.0986	0.101	0.215
Number of firms	22640	22640	24808	22640	22640

Notes: Standard errors in parentheses below coefficient estimates. P-values in parentheses below standard errors.

Table 3- Relative cognitive ability and departure

	(1)	(2)	(3)	(4)	(5)	(6)	
	(b/se/p)	(b/se/p)	(b/se/p)	(b/se/p)	(b/se/p)	(b/se/p)	
Cognitive ability	-0.00384	-0.00287	-0.00206	-0.00385	-0.00288	-0.00566	-0
	(0.00038)	(0.00033)	(0.00027)	(0.00038)	(0.00033)	(0.00212)	(0
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.008)	(0
Relative cognitive ability	0.00274			0.00274		0.00427	
	(0.00032)			(0.00032)		(0.00198)	
	(0.000)			(0.000)		(0.031)	
Q2 Rel Cog ability		0.00465			0.00460		0.
		(0.00110)			(0.00110)		(0
		(0.000)			(0.000)		(0
Q3 Rel Cog ability		0.00538			0.00532		0.
		(0.00120)			(0.00120)		(0
		(0.000)			(0.000)		(0
Q4 Rel Cog ability		0.01311			0.01315		0.
		(0.00177)			(0.00176)		(0
		(0.000)			(0.000)		(0
Cognitive higher than CEO			0.00572				
			(0.00107)				
			(0.000)				
Controls	YES	YES	YES	YES	YES	YES	
Ownership FE	YES	YES	YES	NO	NO	YES	
Industry FE	YES	YES	YES	NO	NO	NO	
Region FE	YES	YES	YES	NO	NO	YES	
Year FE	YES	YES	YES	NO	NO	NO	
Industry-Year FE	NO	NO	NO	NO	NO	YES	
Firm FE	NO	NO	NO	YES	YES	NO	
Observations	996733	996733	996733	996733	996733	140654	
R-square	0.100	0.100	0.100	0.101	0.101	0.147	
Number of firms	22640	22640	22640	0.101	0.101	5435	

Notes: Standard errors in parentheses below coefficient estimates. P-values in parentheses below standard errors.

APPENDIX

Appendix 1- Complete point estimates of Table 2 in the main document.

Model	(1) LPM	(2) Logit	(3) LPM	(4) LPM	(5) LPM
Cognitive ability	-0.00127	-0.01921	-0.00094	-0.00129	-0.00062
	(0.00023)	(0.00194)	(0.00019)	(0.00023)	(0.00025)
CEO Non-cognitive ability	-0.00007	-0.00038	0.00018	-0.00003	
	(0.00031)	(0.00260)	(0.00031)	(0.00031)	
Non-cognitive ability	0.00621	0.04311	0.00612	0.00619	0.00583
	(0.00024)	(0.00194)	(0.00020)	(0.00024)	(0.00026)
Wage(log)	-0.13336	-0.81437	-0.12780	-0.13357	-0.14295
	(0.00135)	(0.00848)	(0.00117)	(0.00134)	(0.00151)
Bachelor	0.03013	0.18952	0.03415	0.03037	0.03114
	(0.00177)	(0.01422)	(0.00152)	(0.00176)	(0.00198)
After high school	0.01632	0.07597	0.01905	0.01640	0.01672
	(0.00141)	(0.01160)	(0.00119)	(0.00141)	(0.00158)
High school	-0.00293	-0.03559	-0.00226	-0.00295	-0.00148
	(0.00101)	(0.00865)	(0.00084)	(0.00101)	(0.00112)
Industry exprience	-0.00064	-0.00930	-0.00073	-0.00060	-0.00043
	(0.00011)	(0.00100)	(0.00010)	(0.00011)	(0.00014)
Tenure	-0.01734	-0.30214	-0.01696	-0.01733	-0.01676
	(0.00012)	(0.00216)	(0.00011)	(0.00012)	(0.00014)
Age	-0.01621	-0.11031	-0.01768	-0.01621	-0.01643
	(0.00037)	(0.00276)	(0.00032)	(0.00037)	(0.00041)
Age^2	0.00021	0.00145	0.00022	0.00021	0.00021
	(0.00000)	(0.00004)	(0.00000)	(0.00000)	(0.00001)
Foreign born	0.01180	0.07208	0.01297	0.01185	0.00729
	(0.00231)	(0.01679)	(0.00190)	(0.00231)	(0.00252)
Married	0.00316	0.02193	0.00265	0.00318	0.00343
	(0.00078)	(0.00734)	(0.00064)	(0.00078)	(0.00086)
Child under18	0.00111	0.00274	0.00170	0.00117	0.00182
	(0.00037)	(0.00348)	(0.00031)	(0.00037)	(0.00041)
Employees with cognitive score	-0.00456	-0.01060	-0.00849	-0.00453	
	(0.00331)	(0.02711)	(0.00310)	(0.00330)	
Number of employees (log)	0.01090	0.10065	0.00716	0.01095	
	(0.00113)	(0.00946)	(0.00095)	(0.00113)	
Total Assets (Log)	-0.00122	-0.02959	-0.00178	-0.00123	
	(0.00059)	(0.00488)	(0.00056)	(0.00058)	
Operating margin	-0.06141	-0.43349	-0.06449	-0.06123	
	(0.00359)	(0.02387)	(0.00354)	(0.00358)	
Employment growth	-0.03517	-0.39240	-0.04280	-0.03565	

	(0.00242)	(0.01973)	(0.00232)	(0.00242)	
Firm age	-0.00077	-0.00673	-0.00069	-0.00079	
	(0.00007)	(0.00059)	(0.00007)	(0.00007)	
Ownership FE	YES	YES	YES	YES	NO
Industry FE	YES	YES	YES	NO	NO
Region FE	YES	YES	YES	YES	NO
Year FE	YES	YES	YES	NO	NO
Industry-year FE	NO	NO	NO	YES	NO
Firm-Year FE	NO	NO	NO	NO	YES
Observations	996733	996733	1474780	996733	996733
R-square	0.100		0.0986	0.101	0.215
Number of firms	22640	22640	24808	22640	22640

Notes: Standard errors in parentheses below coefficient estimates.

Appendix 2- Complete point estimates of Table 3 in the main document.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Cognitive ability	-0.00384	-0.00287	-0.00206	-0.00385	-0.00288	-0.00566	-0.00366
	(0.00038)	(0.00033)	(0.00027)	(0.00038)	(0.00033)	(0.00212)	(0.00124)
Rel cog ability	0.00274			0.00274		0.00427	
	(0.00032)			(0.00032)		(0.00198)	
Q2 Rel Cog ability		0.00465			0.00460		0.00883
		(0.00110)			(0.00110)		(0.00363)
Q3 Rel Cog ability		0.00538			0.00532		0.00913
		(0.00120)			(0.00120)		(0.00456)
Q4 Rel Cog ability		0.01311			0.01315		0.01567
		(0.00177)			(0.00176)		(0.00685)
Cognitive higher than CEO			0.00572				
			(0.00107)				
CEO Non-cognitive ability	0.00067	0.00041	0.00017	0.00070	0.00044	-0.00541	-0.00582
	(0.00032)	(0.00032)	(0.00032)	(0.00032)	(0.00032)	(0.00186)	(0.00184)
Non-cognitive ability	0.00617	0.00622	0.00622	0.00615	0.00620	0.00636	0.00638
	(0.00024)	(0.00024)	(0.00024)	(0.00023)	(0.00024)	(0.00070)	(0.00070)
Wage(log)	-0.13324	-0.13321	-0.13326	-0.13344	-0.13342	-0.12445	-0.12441
	(0.00135)	(0.00135)	(0.00135)	(0.00134)	(0.00134)	(0.00344)	(0.00344)
Bachelor	0.03160	0.03106	0.03058	0.03183	0.03130	0.03491	0.03489
	(0.00177)	(0.00177)	(0.00177)	(0.00177)	(0.00176)	(0.00505)	(0.00505)
After high school	0.01725	0.01694	0.01663	0.01732	0.01701	0.01516	0.01519
	(0.00142)	(0.00142)	(0.00141)	(0.00142)	(0.00142)	(0.00424)	(0.00424)
High school	-0.00280	-0.00270	-0.00278	-0.00282	-0.00272	0.00133	0.00144
	(0.00101)	(0.00101)	(0.00101)	(0.00101)	(0.00101)	(0.00319)	(0.00319)
Industry experience	-0.00063	-0.00064	-0.00064	-0.00059	-0.00059	-0.00030	-0.00031
	(0.00011)	(0.00011)	(0.00011)	(0.00011)	(0.00011)	(0.00031)	(0.00031)
Tenure	-0.01733	-0.01733	-0.01734	-0.01732	-0.01732	-0.01728	-0.01728
	(0.00012)	(0.00012)	(0.00012)	(0.00012)	(0.00012)	(0.00030)	(0.00030)
Age	-0.01619	-0.01620	-0.01621	-0.01619	-0.01620	-0.02252	-0.02254
	(0.00037)	(0.00037)	(0.00037)	(0.00037)	(0.00037)	(0.00110)	(0.00110)
Age^2	0.00021	0.00021	0.00021	0.00021	0.00021	0.00029	0.00029
	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00001)	(0.00001)
Foreign born	0.01188	0.01172	0.01170	0.01192	0.01177	0.00640	0.00620
	(0.00231)	(0.00231)	(0.00231)	(0.00231)	(0.00231)	(0.00628)	(0.00628)
Married	0.00324	0.00324	0.00323	0.00326	0.00325	0.00274	0.00276
	(0.00078)	(0.00078)	(0.00078)	(0.00078)	(0.00078)	(0.00236)	(0.00236)
Child under 18	0.00108	0.00109	0.00110	0.00114	0.00116	0.00545	0.00545
	(0.00037)	(0.00037)	(0.00037)	(0.00037)	(0.00037)	(0.00111)	(0.00111)
Employees with cognitive score	-0.00359	-0.00389	-0.00423	-0.00356	-0.00387	0.26229	0.26200
	(0.00329)	(0.00330)	(0.00330)	(0.00329)	(0.00329)	(0.02233)	(0.02236)
Number of employees (log)	0.01108	0.01099	0.01092	0.01113	0.01105	0.14447	0.14431
	(0.00113)	(0.00113)	(0.00113)	(0.00112)	(0.00112)	(0.01032)	(0.01033)

Total Assets (Log)	-0.00106	-0.00113	-0.00117	-0.00107	-0.00114	-0.04065	-0.04070
	(0.00059)	(0.00059)	(0.00059)	(0.00058)	(0.00058)	(0.00589)	(0.00590)
Operating margin	-0.06228	-0.06195	-0.06172	-0.06211	-0.06177	-0.06921	-0.06904
	(0.00358)	(0.00358)	(0.00359)	(0.00357)	(0.00357)	(0.01553)	(0.01554)
Employement growth	-0.03517	-0.03518	-0.03518	-0.03566	-0.03566	-0.02856	-0.02857
	(0.00241)	(0.00242)	(0.00242)	(0.00242)	(0.00242)	(0.00799)	(0.00799)
Firm age	-0.00075	-0.00076	-0.00076	-0.00077	-0.00078	0.00491	0.00497
	(0.00007)	(0.00007)	(0.00007)	(0.00007)	(0.00007)	(0.00126)	(0.00125)
Ownership FE	YES	YES	YES	NO	NO	YES	YES
Industry FE	YES	YES	YES	NO	NO	NO	NO
Region FE	YES	YES	YES	NO	NO	YES	YES
Year FE	YES	YES	YES	NO	NO	NO	NO
Industry-Year FE	NO	NO	NO	NO	NO	YES	YES
Firm FE	NO	NO	NO	YES	YES	NO	NO
Observations	996733	996733	996733	996733	996733	140654	140654
R-square	0.100	0.100	0.100	0.101	0.101	0.147	0.147
Number of firms	22640	22640	22640	0.101	0.101	5435	5435

Notes: Standard errors in parentheses below coefficient estimates.

Appendix 3- Effect of cognitive ability and relative cognitive ability on employee wage.

Dep. Var: Wage	**(1)**	**(2)**	**(3)**	**(4)**
	(b/se/p)	**(b/se/p)**	**(b/se/p)**	**(b/se/p)**
Cognitive ability	0.01397	0.01700	0.01718	0.01668
	(0.00047)	(0.00091)	(0.00077)	(0.00060)
	(0.00000)	(0.00000)	(0.00000)	(0.00000)
Relative Cognitive ability		-0.00324		
		(0.00080)		
		(0.00005)		
Q2 Rel Cog ability			0.00595	
			(0.00229)	
			(0.00948)	
Q3 Rel Cog ability			-0.00573	
			(0.00280)	
			(0.04091)	
Q4 Rel Cog ability			-0.03013	
			(0.00434)	
			(0.00000)	
Cognitive higher than CEO				-0.01967
				(0.00253)
				(0.00000)
Ownership FE	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES
Region FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Observations	996733	996733	996733	996733
R-square	0.395	0.396	0.396	0.396
Number of individuals	22640	22640	22640	22640

Notes: Standard errors in parentheses below coefficient estimates. P-values in parentheses below standard errors.

Appendix 4- Effect of cognitive ability and relative cognitive ability on departure across different industries.

Industry:	**(1) Manufacturing**	**(2) Construction**	**(3) Retail**	**(4) Business activities**	**(5) Transport and Communication**	**(6) Other industries**
	b/se/p	b/se/p	b/se/p	b/se/p	b/se/p	b/se/p
Cognitive ability	-0.00238	-0.00227	-0.00562	-0.00559	-0.00649	-0.00245
	(0.00066)	(0.00074)	(0.00105)	(0.00083)	(0.00155)	(0.00183)
	(0.000)	(0.002)	(0.000)	(0.000)	(0.000)	(0.180)
Rel Cog ability	0.00260	0.00263	0.00255	0.00201	0.00359	0.00193
	(0.00055)	(0.00060)	(0.00088)	(0.00071)	(0.00123)	(0.00153)
	(0.000)	(0.000)	(0.004)	(0.004)	(0.004)	(0.206)
Controls	YES	YES	YES	YES	YES	YES
Ownership FE	YES	YES	YES	YES	YES	YES
Region FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Observations	303,698	249,570	136,628	206,281	58,415	42,141
R-Square	0.104	0.0952	0.104	0.0914	0.122	0.140
Number of firms	6,450	6,014	2,844	5,766	1,444	1,708

Notes: Standard errors in parentheses below coefficient estimates. P-values in parentheses below standard errors.