Are There Glass Ceilings for Female Executives?

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Abstract

Fewer women than men become executive managers. They earn less, hold more junior positions, and attrit faster. We compiled a large panel data set on executives and formed a career hierarchy to analyze promotion and compensation rates. Given executive rank and background, women are paid more than men, experience less income uncertainty, and are promoted as quickly. Amongst survivors, being female increases the chance of becoming CEO. Hence the gender pay gap and job rank differences are primarily attributable to female executives attriting at higher rates than males in an occupation where survival is rewarded with promotion and higher compensation.

I. Introduction

Fewer women than men become executives, on average female executives rank lower than male executives, they are paid less, and are more likely to attrit than their male counterparts. A simple explanation for these stylized facts is that female executives have less promotion opportunities than males in a labor market segment infamous for its lucrative compensation to top players, making them more reluctant than males to accept positions in management, and also more likely to quit.

Many other occupations fit the stylized facts that broadly characterize the gender differentials in promotion, wages and separation in the executive market, and several explanations

have been forthcoming. One view is that women are less attached to the labor force because of births and childcare responsibilities, which come at the expense of gaining greater experience on the job. There is abundant evidence that taking time off the job to parent depreciates market human capital, and furthermore that employers anticipate loss in firm specific human capital by using gender as a signalling device.[1] Another explanation is that in unionized industries, women and other minorities traditionally have not been as well treated as males, and only relatively recently have they become a more effective force with the unionization of the white collar class. The role of informal networking in making business connections is sometimes mentioned as facilitating or maintaining the gender gap.[2]

Managing a corporation is not a union job, and executives are typically in mid-life when most women having put their child bearing years behind them. But the argument that intangible factors impede the promotion of women to the apex of their profession, is captured well by the phrase "glass ceiling". Thus the executive market lends itself to investigations seeking to confirm their existence, nature and durability. This paper provides new evidence for answering the question how and whether female executives are differentially treated from males with respect to wages and promotions.

Behind the notion of a glass ceiling is the premise of an occupation with a career hierarchy. Our approach draw from a case study of internal promotions within a single firm by George Baker, Michael Gibbs and Bengt Holmstrom (1994), which ranks the firm's white collar workers over a broader span of their life cycle. Our framework covers job transitions within and between firms. Following the spirit of Baker et al, we adopt two axioms for defining a job hierarchy, that promotions should reflect life cycle job transitions, and that employee compensation, and payoff relevant variables which change over time within a job spell, should not determine rank. We add a third axiom every hierarchy should satisfy, called transitivity, that no sequence of consecutive promotions should constitute a demotion.[3] Defined this way, a hierarchy is an example of a rational ordering. Our data on promotion and turnover, described in Section 3, are drawn from roughly 2,500 publicly listed firms, 30,000 executives and 60 job descriptions over a 14 year period. From this large longitudinal

data set compiled from observations on executives and their firms, we define and construct a career hierarchy, ranking jobs in the executive market, and reporting on its transition matrices.

Only five percent of executive management is female. This fact begs the question whether females executives are drawn from a more select population than males, and consequently are not directly comparable. Finding compensation and promotion rates do not vary with gender, but that females are better qualified and more experienced than males, could well be treated as evidence supporting gender discrimination. To address these selection issues, we augmented about half the data on executive promotion, turnover and compensation with their professional and demographic background information compiled from the Marquis "Who's Who". It contains detail about their age, gender, education, executive experience and the types of firms they work for. The educational and background characteristics of women executives closely resemble their male counterparts. On average they are younger and have less experience, but this is mainly because they attrit faster.

Section 3 reports logits on promotion, turnover and attrition, as well as wage regressions, using the career hierarchy constructed in Section 2. We find that female executives are promoted at the same rate as males with similar background characteristics and occupational experience. Women are promoted more quickly internally, but this is offset by a lower external promotion rate, and are also more likely to accept lower ranked positions with other firms. The other striking feature distinguishing men from women about job transitions is that the women exit the sample at a much higher rate.[4] We find that females are paid slightly more than males at each rank after controlling for observed heterogeneity. Furthermore their compensation varies less than male compensation with the excess returns of firms, and is therefore less volatile. It follows that a risk averse executive of either gender with any given educational and experience variables characteristics would prefer to receive compensation paid to female rather than male executives.[5]

There are essentially three factors that can explain why upon becoming executives, female experience different career profiles than males, namely their initial conditions upon

entering this highly select group (measures in terms of age, rank and experience), their job transitions throughout their executive career (both internal rank changes compounded by turnover in the case of external changes), and when they attrit from the population. We used our estimates to form a dynamic model of executive careers, and decompose gender differences by these three factors. We found that gender differences in initial conditions, especially rank, and higher female attrition rates are most important in explaining the differences, while differences in promotion rates and firm turnover are less important. Focusing on survivors, which eliminates the role of attrition, and over time diminishes the importance of initial conditions, female executives have a greater chance than males of making CEO, and more generally the top of the executive ladder! And given the same career distribution of initial conditions, transitions and attrition behavior, females earn more than males.

In the final section we compare our results with several published studies on gender differences that emerge in career hierarchies of the only two other occupations of which we are aware, academics and metal workers, and offer some remarks that might partially reconcile our results to this previous work. We have found little evidence suggesting women are less likely than males to be promoted, or earn less for a given set of background variables, but in conclusion we note there are other features of the executive workplace, not recorded in our data, where gender differences might persist, and thus help explain the higher rate of female attrition from the executive market that we do observe.

II. Career Hierarchy and Job Transitions

General management is a very broad and loosely defined occupational category. The identifying feature of the managers in our study is that they are so highly paid and exercise so much discretion within their firms, that their employers make available for public scrutiny their compensation records, typically determined at the highest levels by an executive compensation committee. So for the purposes of this study, we define executive management as an occupation of general managers in publicly traded firms whose compensation and financial assets in their employer firm are reported to the Securities and Exchange Commission.

Although firms are only required to report on its top five executives, the SEC accepts and publishes data from firms which provide the records on a greater number of its employees, and most firms do. For all such firms, the SEC requirement is not a binding constraint, but a device to help the firms establish and maintain credibility with their shareholders and bondholders.

Like any tightly defined occupation, executive management is porous. People become executive managers through promotion within the firm or from another publicly traded company, transfer from a private held company or a nonprofit organization, or coming out of retirement. They attrit from executive management by retiring, by accepting less prestigious and worse paid positions within management (having been overtaken by other executives within the company and sidelined without a title change or summarily demoted), by transferring to an organization not listed on an exchange (such as starting a sole proprietorship), or entering another occupation (that makes more use of previously acquired professional qualifications for example). Nonetheless it is instructive to compare the fortunes of top executives by gender and probe for glass ceilings in publicly traded firms. Executive management epitomizes the pinnacle of employment within the firm. It is heavily dominated by males but not their exclusive domain. The records of compensation are comprehensive, reliable and accessible, especially when compared with survey data on wages and benefits in other occupations.

The notion of a glass ceiling presupposes a career hierarchy, the upper echelons of which are hard to penetrate by easily identified groups for reasons that are not readily apparent, aside from the catch-all tautology of discrimination. The data we used to construct a career hierarchy was compiled from annual records on 30,614 individual executives, taken from Standard & Poor's ExecuComp database, itemizing their compensation and describing their title. Each executive worked for one of the 2,818 firms comprising the (composite) S&P 500, Midcap, and Smallcap indices for at least one year spanning the period 1992 to 2006, which covers about 85 percent of the U.S. equities market; in the years for which we have observations, the executive was one of up to the top eight paid in the firm whose

compensation was reported to the SEC. We coded the position of each executive in any given year by one of 35 abbreviated titles listed in Table 1, which formed the basis of the hierarchy we constructed.[6]

We define a career hierarchy as a rational (complete and transitive) ordering over a set of job titles based on transitions. Specifically, let J denote a finite collection of job titles, denoted $j \in \{1, \ldots, J\}$. We denote the probability of switching from the jth job to the kth by p_{jk}. Supposing $p_{jk} \geq p_{kj}$, we write $j \succeq k$. We also impose the property of transitivity. Thus if $p_{jk} \geq p_{j'j} \geq p_{j''j}$ then $j \succeq j''$. Finally if $j \succeq k$ and $k \succeq j$ then $j \sim k$. If $j \succeq k$ but $j \nsim k$ then $j \succ k$, in which case we say that the jth job ranks higher than the kth. Thus indifference occurs if $p_{jk} = p_{kj}$, of if say $p_{jk} > p_{kj}$ but $p_{kj} \geq p_{j'j} \geq p_{jk}$. An ordered rank is ascribed to each of the distinct indifference sets, with Rank 1 topping the hierarchy.

Since there are only a finite number of jobs, the algorithm described above ensures the ranking is complete. This ranking has a second desirable property. Suppose we strengthened the requirement to say that $p_{jk} - p_{kj} \geq p$ for some $p > 0$ as a necessary condition for $j \succ k$, then it is straightforward to show that we would end up with a coarser partition defining the hierarchy. Similarly relaxing our definition to say that $p_{jk} - p_{kj} \geq p$ for some $p < 0$ as a sufficient condition for $j \succeq k$ would yield a coarser partition. In this respect the definition we adopt maximizes the number of ranks.

Upon applying the algorithm to our data, summarized by the 35 job titles and the one period estimated probability job transitions, fourteen ranks emerged, which are displayed in Figure 1. The numbered circles in the figure are keys to the job titles in Table 1, and each job title is aligned to its rank indicated on the left. To convey a sense of the lifecycle flow through jobs, we have drawn arrows pointing from title j to title k if at least 2 percent of the executives in job j move to job k the next period. Because there are so few female executives, evident from the last column in Table 1, we further consolidated the fourteen ranks into seven, as indicated by the first two columns.

Table 2 describes the patterns of job to job transitions within firms per year, the lower-right triangle showing promotions (yearly transitions into higher ranks) and the upper tri-

angle showing demotions.[7] Its diagonal elements shows that changing rank occurs only infrequently. Depending on rank, between about 80 percent and 95 percent remain in their position at the end of the year. Our definition of the ordering for jobs aggregates to ranks and hence the integer in any off-diagonal cell (i, j) of the transition matrix exceeds the number in (j, i), almost without exception. Thus promotion is more common than demotion, by construction. Thus 99 percent of Rank 2 officers remain at that level or are promoted, that is conditional on staying in the sample. However demotion is not a rare event, particularly in the middle levels, where demotion by one rank from Rank 4 is more common than promotion by one rank. Promotion to an adjacent rank is almost invariably more common than promotion to any other rank, but at lower ranks skipping a rank is more common than being promoted to the next one. Demotions are also monotone decreasing in rank, for example more than twice as many slipping one rank as opposed to three.

The last two rows in Table 2A represent the number/percent of entries into the rank from other ranks, while the two right columns give the number/percent who exit the rank for another one, that is conditional on remaining in the sample. The two right columns are the number/percent of executives exiting the rank. For example, the highest rank, Rank 1 has 33 percent of entry but only a 12 annual exit rate yearly, Rank 2 also has more entries than exits, the differences decline in the rank, but in the lower ranks, there is more exit than entry as would be expected of entry level jobs.

Table 2C provides the analogous matrix for the female subsample. It exhibits similar patterns to those observed in Table 2A. Conditional on survival in the sample, the probability of remaining in the same rank ranges from 79 to 95 percent, promotions are more likely than demotions, and movement to adjacent ranks are much more likely than jumps.

Executive turnover rates from one firm to another are displayed in Table 2B. Overall, transitions that involve changing firms are small relative to internal transitions, accounting for 1.6 percent of the observations. The bottom row shows that a substantial fraction of all firm-to-firm transitions are into higher ranks. Taking proportions of the bottom row elements to their corresponding rank sizes, the panel also shows that the rate declines with

rank, very few executives changing firms into the lower ranks. The row entries describe the percent of transitions from a rank as a fraction of all transitions involving firm turnover from the rank. For example, 52% of executives who moved from Rank 1 move into the same rank in a different firm. The rest of the movers move into lower levels in other firms. External transition patterns are different from the internal transitions. Below Rank 2, conditional on turnover, a promotion is more likely than not, in contrast to the top panel, where the diagonal elements are dominant. A large percent of executives who change firms in Ranks 2 and 3 move to Rank 1. Comparing external moves into a rank with total moves into the same rank, more than one quarter of Rank 2 officers are brought in from outside (496 out of 1872), a much higher proportion than for any other rank. Note too, from the top panel, that conditional on remaining in the sample, Rank 2 executives have a lower hazard rate out of their job than the other ranks.

III. Job Mobility and Compensation

Data on the 2,818 firms for the ExecuComp database were supplemented by the S&P COMPUSTAT North America database and monthly stock price data from the Center for Securities Research database. We also gathered background history for a sub-sample of 16,300 executives, recovered by matching the 30,614 executives from our COMPUSTAT data base using their full name, year of birth and gender with the records in Who's Who, which contains biographies of about 350,000 executives. The matched data gives us unprecedented access to detailed firm characteristics, including accounting and financial data, along with their managers' characteristics, namely the main components of their compensation, including pension, salary, bonus, option and stock grants plus holdings, their socio-demographic characteristics, including age, gender, education, and a comprehensive description of their career path sequence described by their annual transitions through the 35 possible positions.

Most of the characteristics of the executives and firms in the subsample of matched data require no (further) explanation, but the construction of several variables merit a remark. The sample of firms was initially partitioned into three industrial sectors by GICS code.

Sector 1, called primary, includes firms in energy (GICS:1010), materials (1510), industrials (2010,2020,2030), and utilities (5510). Sector 2, consumer goods, comprises firms from consumer discretionary (2510,2520,2530,2540,2550) and consumer staples (3010,3020,3030). Firms in health care (3510,3520), financial services (4010,4020,4030,4040), information technology and telecommunication services (410, 4520, 4030, 4040, 5010) comprise Sector 3, which we call services. In our sample 37 percent of the firms belong to the primary sector, 28 percent to the consumer goods sector, and the remaining 35 percent to the services sector. Firm size was categorized by total employees and total assets, the median firm in each size category determining whether the other firms are called large or small. The sample mean value of total assets is $18.2 billion (2000 US) with standard deviation $76.2 billion, while the sample mean number of employees is 23,659 with standard deviation 65,702.

Four measures of experience were included to capture the potential of on-the-job training. Managerial experience is the number of years elapsed since the manager was first recorded as holding one of the 35 titles listed in Table 1. Tenure is years spent working at the executive's current firm. We also tracked the number of moves the executive made throughout his career in various jobs described in Table 1 as he accumulated managerial experience, as well as the number of moves since becoming an executive. Promotion is a indicator variable for whether the manager was promoted the previous year or not.

We followed Rick Antle and Abbie Smith (1985, 1986), Brian Hall and Jeffrey Liebman (1998), Mary Margiotta and Robert Miller (2000) and Gayle and Miller (2008a, 2008b) by using total compensation to measure executive compensation. Total compensation is the sum of salary and bonus, the value of restricted stocks and options granted, the value of retirement and long term compensation schemes, plus changes in wealth from holding firm options, and changes in wealth from holding firm stock relative to a well diversified market portfolio instead.[8] Hence the change in wealth from holding their firms' stock is the value of the stock at the beginning of the period multiplied by the abnormal return, defined as the residual component of returns that cannot be priced by aggregate factors the manager does not control.[9]

A. Executive Background

Table 3 displays summary measures of the background variables by gender. On average, women have two years less tenure in the firm and two and a half years less executive experience than males. Female executives are a little less likely to have an undergraduate degree than males, but a little more likely to have professional certification or a doctorate. Women earn lower salaries and compensation, and reflecting the higher attrition rates shown in Table 3, are younger than males by three years on average. Promotion rates by gender are identical.

Differences in executive background by firm type are summarized in Table 4. The sectors are ranked the same way with respect to age and tenure. There are two rank and/or firm previous turnover moves per observation, one of which occurred since acquiring executive status. The incidence of an MBA, some other Master's degree, and a Ph.D. is about the same, and all them are more or less evenly dispersed over different firm and sector sizes. Firms with small assets have both the oldest executives and the longest tenured. The rate of promotion is lower in small firms than large. Perhaps the most important differences between the executives across firm size and sector relate to compensation. Regardless of which measure is used, the mean salary and bonus in small firms is about two thirds the mean in large firms, about half the total compensation, with standard deviations about one third smaller.

Table 5 describes the characteristics of executives by rank. The average age between Rank 1 and 3 declines from 60 to 52, but is more or less constant as rank falls off further. Similarly average tenure is roughly constant in the lower and middle ranks at 14 but rises to 15 and 17 for Ranks 2 and 1 respectively. The average gap between Ranks 1 and 3 in executive experience is 6 years. Relative to the lower ranks, Ranks 1 and 2 are 8 years older, with only 6 years more executive experience and just 2 years more tenure. Executives with MBA degrees are more concentrated in the top 4 ranks, those with another Masters degree or a Ph.D. are more concentrated in the lower ranks. Average total compensation, their

salary components and the their respective standard deviations rise from the lower ranks, are maximized at Rank 2, at levels that are more than twice as high as the corresponding figures for Rank 7, and decline.

Females form a very small fraction of the executive sample, and they are not uniformly distributed by rank. By a factor of two to three, females congregate in the lower executive ranks relative to males. Only 2 percent of the top two ranks are females, while 6 percent of Ranks 5 and 6 are female.

Only 1800 of the 2,818 firms in the full sample contain at least one executive listed in Who's Who. With this fact in mind, we checked for differences between the composition of the full and matched samples for those characteristics observed in both data sets, namely gender, promotion, salary and compensation. Comparing the means and standard deviations of the bottom panels in Tables 3 through 5, there are no statistically significant differences between the sample means on the these dimensions, and many of the values for corresponding means and standard deviations are numerically equal up to three significant digits. The most notable differences, in mean salary and compensation, arise because executives in the matched sample come from larger firms than those for which there is no background information. As a further diagnostic for interpreting the results from the logits and regressions described in this section, the Appendix reports on the explanatory contribution of including the background variables obtained from Who's Who, and on the sample selection induced by restricting the analysis to executives who are listed there. Here we only add that the background variables from Who's Who are significant in many of the estimations, increasing the coefficient of variation from 0.2 to over 0.6 in the wage regressions for example.

B. Promotion, Turnover and Attrition

The logistic regressions, reported in Table 6, show how the probability of promotion, external promotion, turnover and attrition vary with firm and individual characteristics. The coefficients on ranks (relative to Rank 7) show the lower the rank, the higher the probability of being promoted, implying that promotions become more infrequent, and that the hierarchy

looks like a pyramid. The same point applies to external promotions. Attrition is highest from Rank 1, not surprising given our definition of a career hierarchy. Similarly there is more turnover in Rank 1. For the most part the effects of firm size and sector are less pronounced than the effects of rank. The most important feature is that managers are promoted more quickly in, and are more likely to attrit in, firms with more employees. It is also noteworthy that the rate of attrition is higher in the primary sector than the other two. Past turnover has a positive effect on promotion, suggesting the managers are sometimes hired from outside at a lower position than is planned for them, to first serve an apprenticeship or receive orientation. Lower excess returns increase the probability of promotion, turnover, and attrition, as the career ladder opens up new opportunities for those executives left with the firm when it becomes unprofitable. Finally, lower compensation increases the rate of attrition.[10] We do, however, find evidence of gender differences in promotions. The external rate of promotion for females is lower than males, implying their internal promotion rate is higher, results that are revealed only when the background controls are included. Finally the logits for both samples show that the hazard rate out of the occupation is higher for females than males.

Tenure with the firm increases the probability of internal promotion, as does experience with other firms. Age is negatively correlated with internal promotion and turnover, but older executives behave the same way as their younger counterparts when it comes to outside promotions. Greater numbers of previous moves increase the probabilities of internal promotion and turnover, but reduces the probability of external promotion. Managers who moved more in the past are more likely to turn over but less likely to receive an external promotion. For the most part, educational background plays only a minor role in transitions through the job hierarchy. The most noticeable effects are that executives with MBA degrees are more likely to move to jobs of the same or lower rank, while those with doctorates are less likely to receive an external promotion but just as likely to leave. Both these highly educated groups exhibit a greater willingness to take lower ranked jobs in other firms.

Our empirical results in Column 3 of Table 6 shows the equality between male and female executives in the overall promotion rate masks a more subtle finding, that women

are promoted more quickly internally, but promoted to external positions significantly more slowly than men, evident from Column 5. These results are not informative about the differential incidence of small (one rank) promotions versus larger (multi-rank) promotions, turnover between firms at the same level (that result in the loss of firm specific capital but broaden general managerial experience), and demotions.

To address these outstanding questions we estimated a multinomial logit model of the rank and employment transitions as a function of covariates on executive and firm characteristics. Table 7 reports the coefficients (plus standard errors) on rank, gender and experience of the estimated multinomial logit.[11] The excluded outcome category are internal transitions to Rank 2. We see from summing the column rank constant next year plus the row/column cell coefficient for the current/next year transition, that in Ranks 4 through 7, the most likely outcome is hold the current position, and one step promotions are more likely than multistep promotion or demotions. Similarly managers in Ranks 2 and 3 are more likely to remain in the their current position than switch to any one of the other 13 combinations. Remarkably Rank 1 executives are, however, more likely to be internally demoted to a lower level below Rank 2 than remain in their current position. This last result corroborates our earlier finding that Rank 1 are most likely to attrit, leading us to conclude that managers in this position are the most prone.

Differences in transition patterns between the genders emerge from modeling the data at this finer level of detail. The highly significant positive coefficients on the female indicator variables for Ranks 4 through 7 reveal that conditional on staying with the firm, compared to males, females gravitate towards the lower ranks. Having been promoted, females are less likely than males to remain in the top two ranks. They are also more likely than males to be attracted to a new firm at Rank 2, and more likely to switch firms but restart at the bottom of the career ladder, Rank 7. In an extended model not reported here, formed from interacting the female indicator variable with each rank, we found that the probability of promoting a woman was not significantly different from promoting a man, that the probability of a Rank 2 female switching to Rank 2 in another firm is significantly higher than for a male,

and that several of the demotion probabilities were significantly higher for women. The evidence from Table 7 broadly consistent with the notion of a glass ceiling restricting the upward mobility of female executives. One interpretation of these findings is that ambitious women executives are more likely than their male counterparts to see limited opportunities for internal advancement, and consequently move laterally, or even accept a lower ranked position at another firm.

C. Compensation

We ran least squares (LS) and median quantile (LAD) regressions of compensation on firms' and executives' characteristics, corrected for heteroskedasticity, on the full and matched samples. Table 8 reports the results from the four regressions in eight columns. The conditional level effects are presented in the first four columns of estimates, their interactions with abnormal returns in the second four.

After controlling for the background variables and rank, we find women executives receive significantly more compensation than males and that their compensation packages that are less sensitive to their firm's excess return. Assuming executives are risk averse, the compensation packages awarded to women executives are therefore superior to what equivalently qualified males would receive.

Most of the coefficients on rank, firm size and sector do not vary much in magnitude with the regression technique or the sample used, and only one changes sign. Controlling for background demographics and tenure more or less leaves intact the qualitative rank ordering on total compensation displayed in Table 4. Total compensation to Ranks 6 and 7 differ by a statistically insignificant amount, and then rises with promotion, spiking at Rank 2, compensation to Rank 1 falling between Ranks 3 and 4. In contrast the unconditional means and standard deviations reported in Table 3, the results from the regression analysis separate the effects of excess return, which induces uncertainty to manager's total compensation, from the background variables that determine observed heterogeneity.

Rank 1 is more affected by excess returns than every rank except Rank 2. Rank 1 has

a lower (LS) or the same (LAD) estimated mean and more dependence on abnormal returns than Rank 3, while Rank 2 has a higher mean but more dependence than Rank 3. Therefore Rank 3 offers a superior total compensation package to Rank 1, and for sufficiently risk averse executives, a more attractive compensation package than the Rank 2. Continuing in this vein; our results show that Ranks 4 though 7 are less affected by excess returns. Both measures of firm size and sector variables significantly affect compensation; working for bigger firms raises average compensation level and also its dependence on the firm's excess returns.

Several background variables are significant. Compensation is quadratic in age, reflecting a pattern evident in many occupations. Executives who have college degrees only earn less than those who also hold an MBA, but compensation of the latter is also more exposed to the vicissitudes of their firm's profitability. In this occupation other professional qualifications and post college degrees do not increase compensation. There is a large sign-on bonus from joining the firm, but reductions associated with increased tenure and the number of past moves; past executive moves are less penalized than earlier moves. Compensation to newcomers is not as sensitive to excess returns, and similarly greater tenure and fewer moves in the past tie compensation more closely to the fortunes of the firm.

IV. Decomposition

Our empirical results show three factors might explain why female executives earn less than their male counterparts, even though they are paid significantly more compensation at any given level for the same experience, and their overall rate of promotion is as fast as men. First, women come from slightly different backgrounds and differ in their mix of experience to men, which might affect their career trajectories through the executive ranks; for example a greater proportion have doctorates, but a slightly higher percentage have no degree. Second, in a profession that rewards experience, given the same background and experience, women are more likely to leave the sample population. Third, their equality with males in the overall promotion rate masks some more subtle findings. Within the firm

they are promoted more quickly, but are promoted to external positions significantly more slowly than men. They are also demoted more frequently internally, and exhibit a greater proclivity to accept positions at new firms at the same or even lower ranked levels.[12] To untangle these factors we construct a dynamic system from the estimated equations obtained in the previous sections to explain how they affect the length of careers, how high executives of different types climb the career ladder, and how executive compensation evolves with rank and over time.

A. A Framework

Let h denote a set of state variables characterizing firm specific and general human capital that help determine compensation and job transitions between and within firms. The exact definition of this vector, discussed below, is determined by the results of our empirical analysis. Let $p_t\left(r', h' \left| r, h\right.\right)$ denote the joint probability that an executive aged $t \in \{t_0, t_0+1, \ldots\}$ holding rank $r \in \{1, 2, \ldots, R\}$ and experience $h \in H$, moves to rank $r' \in \{1, 2, \ldots, R\}$ and acquires experience $h' \in H$ next period, conditional on remaining in executive management for another period (empirically determined by our estimates from Table 7). Let $p_{tr0}\left(h\right)$ denote the corresponding probability of retiring at age t from rank r (estimated with the discrete hazard reported in Table 6). Then $q_{tr}\left(h\right)$, the probability of a person who was an executive at age t_0, is still in the executive population at age t, and at that age holds rank r and has experience h is recursively defined by the formula:

$$q_{t+1,s}(h') = \sum\nolimits_{h}^{H} \sum\nolimits_{r=1}^{R} p_t\left(s, h' \left| r, h\right.\right)\left[1 - p_{tr0}\left(h\right)\right] q_{tr}\left(h\right) \tag{1}$$

for some initial assignment probabilities $q_{t_0,r}\left(h\right)$, estimated from our data and reported in Table 9 discussed below. Hence the survivor function, denoted by Q_t, can be expressed as:

$$Q_t = \sum\nolimits_{r=1}^{R} \sum\nolimits_{h=1}^{H} q_{tr}\left(h\right) \tag{2}$$

and summing over Q_t we obtain the expected future duration remaining in management for an executive age t_0, defined by:

$$T \equiv \sum_{t=t_0}^{\infty} Q_t \tag{3}$$

Finally, let $w_{tr}(h)$ denote compensation as a function of human capital, rank and age (as estimated in Table 8), Expected undiscounted cumulative earnings is then:

$$W \equiv \sum_{t=t_0}^{\infty} \sum_{r=1}^{R} \sum_{h=1}^{H} w_{tr}(h)\, q_{tr}(h) \tag{4}$$

Hence expected compensation per period, averaged over time spent in the occupation, is $T^{-1}W$.

The main purpose of this framework is to conduct dynamic decompositions illustrating the quantitative impact of different features of the background variables, wage regressions, probability transitions for promotions, demotions and firm mobility, and attrition on the gender gap in executive careers. But it is also a useful tool for proving that questions about glass ceilings cannot be definitively answered without recourse to detailed data on compensation, rank, experience, and promotion rates. Aggregate measures of these outcome variables might give a misleading summary of gender differences. Simply put, if women are more likely to attrit than males, but the rate of promotion does not depend on gender, then a higher proportion of males at any given rank are promoted. If in addition average compensation for the career rises with rank, but does not depend on gender, then males in the profession earn more than females on average. The upshot is that if some groups of workers are more likely to quit than otherwise identical workers, and we do not control for differential wages paid to workers by rank, then we might confuse a premium paid to higher ranked workers with wage discrimination.

For suppose that at some point γ the probability of attriting is increased by δ. The

expected time spent in the occupation declines to:

$$\sum_{t=t_0}^{\infty}\sum_{r=1}^{R}\sum_{h=1}^{H} q_{tr}(h) - \delta\sum_{s=\gamma}^{\infty}\sum_{r=1}^{R}\sum_{h=1}^{H} q_{sr}(h) \equiv T - \delta A$$

and undiscounted expected cumulative earnings falls to:

$$\sum_{t=t_0}^{\infty}\sum_{r=1}^{R}\sum_{h=1}^{H} w_{tr}(h)\, q_{tr}(h) - \delta\sum_{t=\gamma}^{\infty}\sum_{r=1}^{R}\sum_{h=1}^{H} w_{tr}(h)\, q_{tr}(h) \equiv T - \delta B$$

Consequently the expected average wages change from $T^{-1}W$ to $(T-\delta A)^{-1}(W-\delta B)$. We now prove that if average wages increase with tenure then:

$$T^{-1}W > (T-\delta A)^{-1}(W-\delta B)$$

Note expected wages from period ρ onwards are:

$$\left(\sum_{s=\gamma}^{\infty}\sum_{r=1}^{R}\sum_{h=1}^{H} q_{sr}(h)\right)^{-1}\left(\sum_{t=\gamma}^{\infty}\sum_{r=1}^{R}\sum_{h=1}^{H} w_{tr}(h)\, q_{tr}(h)\right) = A^{-1}B$$

Because expected wages per period after ρ exceed those received before γ if and only if the former exceeds average wages received over the whole career, it now follows that if average wages increase with tenure then $A^{-1}B > T^{-1}W$. But:

$$\begin{aligned} T^{-1}W &< A^{-1}B \\ &\iff -\delta A T^{-1}W > -\delta B \\ &\iff (T-\delta A)\, T^{-1}W > W - \delta B \\ &\iff T^{-1}W > (T-\delta A)^{-1}(W-\delta B) \end{aligned}$$

Therefore the expected wage from γ onwards is higher than the expected wage beforehand if and only if an increase in the probability of quitting at γ reduces the average expected wage overall.

B. Attrition

In principle, differential attrition rates, rank probability transition or initial conditions can explain the longer duration of males in executive management. To quantify comparisons between female and male executive careers, it is convenient to let an f superscript stand for females and an m superscript stand for males, writing $q_{t_0 r}^{(g)}(h)$ for $q_{t_0 r}(h)$ and $p_t^{(g)}(s, h' | r, h)$ for $p_t(s, h' | r, h)$ when referring to an executive of gender $g \in \{f, m\}$. Thus the defective distribution of ranks conditional on human capital, age and gender is recursively defined as:

$$q_{t+1,s}^{(f)}(h') = \sum_{h}^{H} \sum_{r=1}^{R} p_t^{(f)}(s, h' | r, h) \left[1 - p_{tr0}^{(f)}(h)\right] q_{tr}^{(f)}(h) \tag{5}$$

for initial probabilities $q_{t_0,r}^{(f)}(h)$, and for males in an analogous manner. As we just shown, differential attrition between the genders creates a spurious gap in average lifetime compensation if average compensation rises with ranks that are defined using a lifecycle criterion. Table 6 shows that women are more likely to attrit than men. To illustrate the quantitative importance of this point, we computed the survivor rates for the population, and showed how they are affected by different features of gender specific behavior.

In our empirical model, there are seven ranks so $R = 7$. Executive experience $EEXP_t$, tenure with the firm TEN_t, the number of previous moves NPM_t and the number of previous moves as an executive $NPEM_t$ are affected by past outcomes and also help determine future outcomes. So for this application we define experience by $h_t \equiv (EEXP_t, TEN_t, NPM_t, NPEM_t)$. By definition h_t follows the law of motion:

$$h_{t+1} = k_t \Gamma_1(h_t) + (1 - k_t) \Gamma_0(h_t)$$

where $k_t \in \{0, 1\}$ is an indicator variable for staying in the firm versus moving to another

firm and:

$$\begin{aligned}\Gamma_1(h_t) &\equiv (EEXP_t+1, 0, NPM_t+1, NPEM_t+1)\\ \Gamma_0(h_t) &\equiv (EEXP_t+1, TEN_t+1, NPM_t, NPEM_t)\end{aligned}$$

Estimates of experience and rank, $p_{tr0}(h)$, attrition as a function of the same variables, and and $p_t(s, h'|r, h)$ the rank and experience transition probability, were found by respectively integrating the exit hazard, and transition probability with respect to the remaining variables, namely educational background, firm size and sector characteristics, and excess returns.

Since age is a significant determinant of compensation and rank, we computed all our measures for executives who were in executive management at the median age, 49, and also at the twentieth percentile, 39. Table 9 displays the probability distribution over the ranks and backgrounds of executives by gender for those two age groups. There are thirteen times as many 39 year old males in the top two ranks as females, but only twice as many 49 year old males as females in those ranks. Yet 39 year old females have as much managerial experience as their male counterparts while 49 year old females have a little less. Controlling for age, females have slightly less tenure and exhibit more job movement.

Figure 2 depicts the survival function by genders $g \in \{f, m\}$, now denoted by $Q_t^{(g)}$ found by substituting $q_{tr}^{(g)}(h)$ for $q_{tr}(h)$ in Equation (2), for $t_0 = 39$ and $t_0 = 49$. At both ages just over one third of female executives leave after one year, and only about 10 percent survive six years or more. The survivor rate for males is much higher. Over 80 percent last more than a year, and more than 20 percent longer than six years, the older group of males experiencing less attrition than younger ones. From our estimates of the survivor function, we computed $T_{t_0}^{(g)} \equiv \sum_{t=t_0}^{75} Q_t^{(g)}$, the gender specific analogue to Equation (3), total expected future career length for an executive of gender $g \in \{m, f\}$ and age t_0. The two top left entries in the two panels of Table 10 show that regardless of the two methods of selection, being an executive manager at age 49, being an executive manager at age 39, the expected remaining duration

in executive management is just over 3 years for women and about 5 for men, almost two years longer for males versus females.

Suppose females changed in just one respect, by following the attrition behavior of males. That is instead of the discrete hazard $p_{tr0}^{(f)}(h)$, we now suppose $p_{tr0}^{(m)}(h)$ applied. Denoting the defective probability distribution for describing the survivors in this counterfactual by $q_{tr}^{(attrit)}(h)$, we computed estimates of $q_{tr}^{(attrit)}(h)$ from the recursion:

$$q_{t+1,s}^{(attrit)}(h') = \sum_{h}^{H} \sum_{r=1}^{R} p_t^{(f)}(s, h' | r, h) \left[1 - p_{tr0}^{(m)}(h)\right] q_{tr}^{(attrit)}(h) \tag{6}$$

by replacing $p_{tr0}^{(f)}(h)$ with $p_{tr0}^{(m)}(h)$ and $q_{tr}^{(f)}(h)$ with $q_{tr}^{(attrit)}(h)$ in Equation (5). Summing $q_{tr}^{(attrit)}(h)$ over h and r we obtained the survivor function for females when they leave from the sample population at the same rate as males given the same experience and rank. From Figure 2 we see that this counterfactual exercise practically closes the gender gap between the survivor functions. Reflecting the importance of this factor, Table 10 shows that the expected career duration increases one and a half years to about four and a half years, not quite equalizing the expected career lengths for the genders.

Another counterfactual, which speaks to the question of why females tend to have shorter careers, is to replace $p_t^{(f)}(s, h' | r, h)$ with $p_t^{(m)}(s, h' | r, h)$ in Equation (6) to obtain:

$$q_{t+1,s}^{(rank)}(h') = \sum_{h}^{H} \sum_{r=1}^{R} p_t^{(m)}(s, h' | r, h) \left[1 - p_{tr0}^{(f)}(h)\right] q_{tr}^{(rank)}(h)$$

This would generate the survivor function for females if they experienced the same rank transitions as males throughout their career in executive management, and tell us whether women executives tend to gravitate to "dead end" positions that are associated with higher rates of attrition. We can also calculate the differential effect of initial conditions on females by replacing $q_{t_0,r}^{(f)}(h)$ with $q_{t_0,r}^{(m)}(h)$ and $q_{tr}^{(f)}(h)$ with $q_{tr}^{(initial)}(h)$ in Equation (6), defined in an analogous way. Since there are fewer women executives than men, there may be greater selectivity into the sample by those women who are less likely to leave the sample

population, suggesting that the aggregate rate of female attrition in some sense understates the underlying process.

As an empirical matter, gender differences in the rank probability transitions and initial conditions affect the differences in the survivor functions only minimally. Replacing $p_t^{(f)}(s, h' | r, h)$ with $p_t^{(m)}(s, h' | r, h)$ and $q_{tr}^{(f)}(h)$ with $q_{tr}^{(rank)}(h)$ in Equation (5) yields the survivor function for females if they experienced the same rank transitions as males throughout their career in executive management. Similarly we calculated the differential effect of initial conditions on females by replacing $q_{t_0,r}^{(f)}(h)$ with $q_{t_0,r}^{(m)}(h)$ and $q_{tr}^{(f)}(h)$ with $q_{tr}^{(initial)}(h)$ in Equation (5). In both cases the shift in the survivor function is barely visible at this level of resolution. From Table 9, swapping the initial conditions, or changing the transition probability, increases the expected career length for female executives in the panel at 39 and 49 by less than a month. Summarizing, the direct effect of attrition essentially explains almost the difference in the career length of female and male executive managers.

C. Is there a Glass Ceiling?

With estimates of $q_{tr}^{(g)}(h)$, we can now answer the question, whether women executives less likely than men to achieve the pinnacle of executive management, and if so, why. The probability that an executive in the population at t_0 with gender $g \in \{f, m\}$ is a CEO (in Rank 2) at age $t \geq t_0$ is:

$$q_{t2}^{(g)} = \sum_{h=1}^{H} q_{t2}^{(g)}(h) \tag{7}$$

The top two panels of Figure 3 show that executives in the sample at 49 are more than twice as likely to be a CEO than an executive in the sample ten years younger, reflecting our lifecycle approach to the definition of a career hierarchy. Female executives in the population at the either age are less than half likely to be CEOs than males.

What explains these gender differences? Are women are promoted within the firm more slowly and less likely to accept attractive offers from other firms? We set $g = rank$ in

Equation (7) and checked how much the probability of being a CEO increased when females transited through the ranks following the same transition matrix as males. Figure 3 shows the effect of this counterfactual is small. In other words the gender differential in probability of being a CEO is primarily due to differences in the other two factors, attrition and initial conditions.

Setting $g = initial$ in Equation (7) yields the probability of a woman executive at age being a CEO at age t if they had been assigned the initial endowment of males. By construction the probability at t_0 is equal, but quickly falls off, partly because of the differential attrition rates. Breaking things down further, we investigated to what extent their initial assignment conditional on their past experience is a determining factor, versus the different background they have at the time. We found only the initial rank counts, not initial differences in executive experience, industry background or education. For setting $g = rinitial$ in produces a line in Figure 3 that practically overlays the $g = initial$ line.

The higher rate of female attrition diminishes the size of the pool of female candidates eligible for CEO, thus contributing to the gender differences. If female attrition patterns mimicked those of their male colleagues, would the sequence of probabilities close the gap? Upon setting $g = attrit$ in Equation (7), Figure 3 shows that the sequence of probabilities would increase, but not close the gap. Thus both initial conditions and attrition are important explanatory factors in explaining why women are less likely to make CEO than men.

We can eliminate the effects of attrition, and mitigate through the passage of time, the effects of the initial conditions, by analyzing the pool of survivors. The probability of being a CEO with gender g at age t conditional on belonging to the population at age t_0 and remaining in it until at least age t is:

$$q_{t2}^{(g)} = \frac{\sum_{h=1}^{H} q_{t2}^{(g)}(h)}{\sum_{r=1}^{R} \sum_{h=1}^{H} q_{tr}^{(g)}(h)} \tag{8}$$

The panels of Figure 3 in the second row have two notable features, which characterize both

age groups. Conditional on survival, the probability of being a CEO increases for more than a decade, rising to and then remaining above one half for a further 10 years (and longer for the younger group). More remarkably, amongst those who survive longer than 15 years, a woman invariably has a higher probability of being a CEO than a man! This finding contradicts common belief that women face glass ceilings.

There are, of course, alternative definitions of top management, and we investigated whether our conclusions are sensitive to them. In our career hierarchy chairmen who are not also officers directly under the CEO (such as the CFO and the COO) are classified in Rank 1. Rather than focus on Expression (7) only we also experimented with a more inclusive definition of top executive position by combining the two top ranks, and recomputing the comparable panels of the second row. The probability of being in the two top ranks with gender g at age t conditional on belonging to the population at age t_0 and surviving until age t at least is:

$$q_{t2}^{(g)} + q_{t1}^{(g)} = \frac{\sum_{r=1}^{2} \sum_{h=1}^{H} q_{tr}^{(g)}(h)}{\sum_{r=1}^{R} \sum_{h=1}^{H} q_{tr}^{(g)}(h)}$$

There is little to distinguish between the second row panels and fourth row panels, which depict our estimates of $q_{t2}^{(g)} + q_{t1}^{(g)}$. Using either definition of top management, our results provide scant support for the view that female executives in publicly listed companies face glass ceilings.

An alternative approach to measuring female representation at the highest levels of management is to compute, by gender, the fraction of executives who pass through the rank of CEO before retiring. Denote by $q_{t2}^{(CEO,g)}$ the number of executives who were in the sample at age $t_0 \in \{39, 49\}$ and had at least one year of CEO experience by age t, as a fraction of the sum of this number plus executives who are still waiting for the job of CEO, having neither quit the sample by age t nor made CEO. Within our framework this is equivalent to treating the CEO rank as an absorbing state, thus eliminating CEO attrition, leaving the other attrition probabilities unchanged, and assuming that an executive attaining the rank of CEO never changes rank again.[13] Thus:

$$q_{t+1,s}^{(CEO,g)}(h') = \sum_{h}^{H}\sum_{r=1}^{R} p_t^{(CEO,g)}\left(s,h'\,|r,h\right)\left[1-p_{tr0}^{(CEO,g)}\left(h\right)\right] q_{tr}^{(CEO,g)}\left(h\right)$$

and

$$q_{t2}^{(CEO,g)} = \frac{\sum_{h=1}^{H} q_{t2}^{(CEO,g)}\left(h\right)}{\sum_{r=1}^{R}\sum_{h=1}^{H} q_{tr}^{(CEO,g)}\left(h\right)}$$

From the third panel we see that the cross over occurs earlier than in the second panel, thus validating our finding, that amongst survivors, females have a higher probability of reaching the position of CEO than males. The fact that their crossover age is about two years younger indicates that their tenure as a CEO is also a little lower, partly attributable to their higher rate of attrition.

D. Lifetime Compensation

Although female executives are paid more than males for a specific experience vector at any given rank, and have a higher probability of attaining the position of CEO than males conditional on remaining in top management, they attrit before males from these very senior positions. This not only reduces the net present value of their lifetime earnings in this occupation. From the results in Section 2, it also reduces their average annual earnings in the profession. One important reason why glass ceilings is a topical issue in discussions of gender discrimination is that the high ranking executive jobs are more financially lucrative than lower ranked positions. Rather than concentrate on whether female executives reach top executive positions, we can investigate the gender compensation gap directly, using estimates of $w_{tr}^{(g)}\left(h\right)$, expected compensation of executives conditional on age, gender,rank and human capital. In this part of the study we focus on two measures of lifetime earnings. The first measure is the sum of discounted expected earnings from executive management, defined by:

$$V_{t_0}^{(g)} \equiv \sum_{t=t_0}^{\infty}\sum_{r=1}^{R}\sum_{h=1}^{H} \beta^{t-t_0} w_{tr}^{(g)}\left(h\right) q_{tr}^{(g)}\left(h\right) \tag{9}$$

where β is the subjective discount factor. The second measure we use is average annual career wages, which corresponds to the steady state cross sectional average earnings. Average annual career earnings can be expressed as the ratio $W_{t_0}^{(g)}/T_{t_0}^{(g)}$, where $W_{t_0}^{(f)}$ is just Equation (4) defined for women executives, undiscounted expected future earnings for t_0 year old female executives, averaged over their experience and ranks:

$$W_{t_0}^{(f)} \equiv \sum\nolimits_{t=t_0}^{\infty} \sum\nolimits_{r=1}^{R} \sum\nolimits_{h=1}^{H} w_{tr}^{(f)}(h)\, q_{tr}^{(f)}(h) \tag{10}$$

Integrating the estimates obtained from the compensation regressions reported in Table 8 to obtain $w_{tr}(h)$, we calculated estimates of average career wage over that time $W_{t_0}^{(f)}/T_{t_0}^{(f)}$, and expected discounted sum of compensation $V_{t_0}^{(f)}$ from age t_0 onwards, and analogous quantities for males, setting the discount factor to $\beta = 0.9$. Then we computed counterfactuals for these numbers by endowing female executives with some of the factors that determine the executive careers of males.

The top entries in the middle column of the two panels imply that the estimated gender gap in (undiscounted) annual compensation for executives at age 39 and 49 averaged over the remainder of their management career is about $\$100,000$. Given the longer career horizon of males, at a 10 percent discount factor this translates to a present value of about \$2 million, which can be deduced from the third column. The gender gap in these career measures of executive compensation is not attributable to unequal pay for equal work. Our wage regressions, reported in Table 8, showed that at any given rank females are paid more for the same experience credentials. Substituting $q_{tr}^{(m)}(h)$ for $q_{tr}^{(f)}(h)$ in Equations (10) and (9) for $t_0 \in \{39, 49\}$ we find that the males would benefit about $\$100,000$ per year on average from receiving the compensation package of females, all else the same, which translates to about $\$400,000$ in present value terms over their career as executives, numbers that follow differencing the top from the bottom numbers in the middle and right columns of Table 9.

We investigated the effect of assigning the initial male distribution of ranks to female executives, substituting $q_{tr}^{(initial)}(h)$ for $q_{tr}^{(f)}(h)$ in Equations (10) and (9), and computing

$W_{t_0}^{(initial)}/T_{t_0}^{(initial)}$ and $V_{t_0}^{(initial)}$. Table 9 shows that the initial assignment has greater impact (rising by \$134,600 for the older group, \$76,400 for the younger) than the probability transition computed in a similar fashion (where the numbers are \$65,500 and \$55,900 respectively). Most of the effect from switching the initial endowments comes from switching the initial rank alone, obtained by computing $W_{t_0}^{(rinitial)}/T_{t_0}^{(rinitial)}$ and $V_{t_0}^{(rinitial)}$. Indeed giving 49 year old executives the distribution of male initial experience actually reduces their average annual earnings throughout their career. Note that because these changes hardly affect the survivor function, the effect on discounted career earnings is attenuated.

Giving female executives the same attrition rates as males significantly lengthens their expected durations and for that reason alone generates higher expected discounted sums. To determine the effect of imposing male attrition rates on females we substituted $q_{tr}^{(attrit)}(h)$ for $q_{tr}^{(f)}(h)$ in Equations (10) and (9) and computed $W_{t_0}^{(attrit)}/T_{t_0}^{(attrit)}$. The gender gap for discounted earnings over the remaining career declines substantially from \$2.3 million to \$699,000 for 49 year old executives and even more for 39 year old executives, from \$1.85 million to \$249,000. However the evidence from annual average career compensation is inconclusive. If 39 year old female executives substituted male attrition behavior for their own, then their annual compensation would rise by \$69,100 per year, but for 49 year old executives, compensation would actually fall by \$44,800.

In identifying the most important factors driving the average annual gender compensation gap, we should distinguish between the two age groups. Focusing first on the top panel we see that if 49 female executives had been assigned the initial rank distribution for males, their average career wage, \$2,296,800 would have surpassed \$2,195,200 the corresponding figure for males by about \$100,000. The remaining factors, gender differences in attrition, job transitions, and the initial distribution of experience, collectively accounted for less than \$2,000 per year of the differential between women and what men would earn if they received female compensation awards. Thus for the older group, the initial distribution of ranks fully accounts for the pay gap between men and women. This result contrasts with our findings for the younger group of executives, where switching attrition plays a much greater role in

closing the gap between female average earnings and the hypothetical earnings males would make from receiving female wages. The younger group earns less than the older one over their career, partly because they are initially in lower ranked positions. Consequently as Table 6 shows, they are promoted more quickly, and earn relatively more late in their career. The effect on total earnings from spending an average of an extra 18 months in executive management is therefore more pronounced at 39 than at 49. This explains why both attrition and initial conditions contribute to the differences in average annual compensation in executive careers for this age group.

V. Conclusion

James Albrecht, Anders Bjorklund, and Susan Vroman (2003) recently concluded there is a glass ceiling in Sweden because females are under represented in the upper quantiles of the wage distribution. Similarly Francine Blau and Lawrence Kahn (2004) concluded from their study of wage data for the U.S. that the gender gap stopped shrinking 15 years ago and has not closed. Within executive management the results are mixed. Linda Bell (2005), and Stefania Albanesi and Claudia Olivetti (2008), find that females at equivalent ranks are paid less than males, but the earliest work on this subject by Marianne Bertrand and Kevin Hallock (2001), based on a much smaller number of observations, concluded that after controlling for background and position, gender differences in compensation are minor.[14]

The sample composition varies across the three studies on executives, as does the definition of compensation, and controls for selection in the regressions. The sample in our study is also distinctive, most notably having many more observations and greater detail about executive background than previous work. Conditional on age, education, working experience with the firm, turnover history, executive experience, rank, firm size and sector, we find that women are paid more than males, and benefit from lower wage volatility due to abnormal returns. With respect to wage level, our results more or less confirm those of Bertrand and Hallock (2001), while our findings on volatility are in agreement with Albanesi and Olivetti (2008).

The existence of glass ceilings cannot be definitively determined with wage data alone. Males and females are also distinguished by their promotion rates (or more generally job transitions), as well as attrition. Donna Ginther and Kathy Hayes (1999, 2003), John McDowell, Larry Singell and James Zilliak (1999), and Ginther and Shulamit Kahn (2004) compared the trajectories of male and female academic faculty in the social sciences and humanities, and found that women tend be paid less at any given rank and are also less likely to be promoted. An empirical study by Tuomas Pekkarinen and Juhana Vartianinen (2004) of metal workers in Finland found that women are internally promoted more slowly than males. By way of contrast, we find that within executive management females and are equally likely as males to be promoted. They are more likely to be promoted internally than males, but less likely to receive and accept an outside offer.

However our results on the differential attrition rate between the genders are consistent with previous results found for academics. This brings us to the central message of this paper. Since women are more likely to attrit than males, and the rate of promotion does not depend on gender, a higher proportion of males at any given rank are promoted. Compensation is positively related to rank, and women are paid only slightly more than males for any given rank and background. Consequently males in the profession earn more than females on average. Our study shows that in aggregate, female executives rank lower than males and are paid less, largely because females are more likely to attrit than their male counterparts. Even more striking is our finding that female executives who survive as top managers in these publicly traded firms eventually have a higher chance of making the top rungs than their male counterparts.

We are not suggesting the glass ceiling is simply a manifestation of aggregation bias. That female executive survivors are ultimately more successful than males may indicate that firms are more tolerant of supporting weak males than weak females in top managerial positions. The fact that females exhibit slightly higher job movement than males, even though their external promotion rate is lower than males, is also curious. Unobserved factors that lead managers to attrit could include more unpleasantness, indignities, and tougher

unrewarding assignments at work, examples of factors that reduce the attraction of work without necessarily affecting productivity or human capital acquisition. Perhaps women are subject to this form of gender discrimination. Another hypothesis is that women acquire more nonmarket human capital than men throughout their lives, and hence find retirement a relatively attractive option. Whatever the mix of these unobservable factors, we conclude that aggregate differences observed in the executive market between genders are almost entirely driven by factors other than compensation packages and promotion opportunities.

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Notes

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[1]Jacob Mincer and Solomon Polachek (1974) pioneered the neoclassical approach to human capital as a methodology for comparing wage and job choices by females with males. The quantitative importance of human capital in the labor market and within the household is estimated in a structural model of dynamic female labor supply by Sumru Altug and Robert Miller (1998). George-Levi Gayle and Limor Golan (2008) develop and estimate an equilibrium model of statistical discrimination to explain differences in wages between males and females that cannot be directly accounted for age or experience variables alone.

[2]For example, in their seminal work on negotiation, Linda Babcock and Sara Laschever (2003) extensively document and analyze gender differences in wage and salary negotiations.

[3]The data in Baker et al (1994) automatically satisfy the third axiom without further restrictions.

[4]To evaluate their usefulness as explanatory variables, many of which are significant, we ran the promotion logits omitting the background regressors on the matched sample. The logit coefficient on the female indicator variable switched signs from positive and significant to negative and significant. This result demonstrates that excluding background variables induces bias, falsely suggesting that females are promoted more slowly than males.

[5]The greater sensitivity of compensation to firm excess returns is robust to whether background variables are included or not. However the level effect of gender switches sign in median quantile regressions. It is positive and significant if the background variables are included, but negative and significant if omitted. The change in the least squares regression

coefficients is less dramatic, because they are insignificant when the background variables are omitted.

[6]We encountered a further 60 titles used less than three times each. These jobs were easy to rank within the hierarchy we constructed, but our analysis and conclusions are not affected by omitting the small number of observations involved either. We also experimented with finer partitions of job titles, refining job title by firm size (doubling the number of titles with an indicator designating big or small), and by sector (which triples the number of jobs). The main practical difficulty of increasing the number of job titles is the resulting small number of females in many job title cells. On the overall sample we found that the transition patterns were not sensitive to the definitions of the partition we experimented with.

[7]The only exception to the transitivity rule we applied to create the hierarchy is that percentage of Rank 1 executives who transition into Rank 2 exceeds the transition rate of Rank 2 executives into rank 1. This exception is because Rank 2 is five times larger than Rank 1, but the number of executives who transition from Rank 2 to Rank 1 is substantially larger.

[8]Changes in wealth from holding firm stock and options reflect the costs a manager incurs from not being able to fully diversify his wealth portfolio because of restrictions on stock and option sales. When forming their portfolio of real and financial assets, managers recognize that part of the return from their firm denominated securities should be attributed to aggregate factors, so they reduce their holdings of other stocks to neutralize those factors.

[9]In our sample the mean abnormal return is -0.005 with standard deviation 0.6, and we do not reject the null hypothesis that it is uncorrelated with the stock market.

[10]Our results on attrition are comparable to those found in Table 5 of Margiotta and Miller (2000, page 696), whose study focuses on the three highest paid corporate executives. They also find that higher ranked executives are more likely to retire, and that higher compensation has a significant, negative effect. The sign of the coefficient on excess returns is negative in both studies, but only in ours is it significant.

[11]The coefficients on the other variables, including indicators of education and firm sector,

plus measures of firm size, excess returns, and lagged excess returns are not reported because they are less noteworthy.

[12]From Table 2 females are more concentrated in small firms than males, and, as documented in Gayle and Miller (2009) the premium on the CEO rank is much higher in large firms than small ones. From Table 4 females are least concentrated in the Primary sector, which offers the lowest compensation. These offsetting effects give the three factors we focus on greater prominence.

[13]Mathematically, we set $p_{t20}^{(CEO,g)}(h) = 0$, leave $p_{tr0}^{(CEO,g)}(h) = p_{tr0}^{(g)}(h)$ for all $r \neq 2$, and set $p_t^{(CEO,g)}(2, h' \,|2, h) = 1$, which implies $p_t^{(CEO,g)}(s, h' \,|2, h) = 0$ for all $s \neq 2$.

[14]More generally Dan Black, Amelia Haviland, Seth Sanders and Lowell Taylor (2008), report although highly educated women earn approximately 30 percent less than men, more than half, but typically less than all the difference, is accounted for by background variables such as age, education and work experience.

Figure 1: Hierarchy

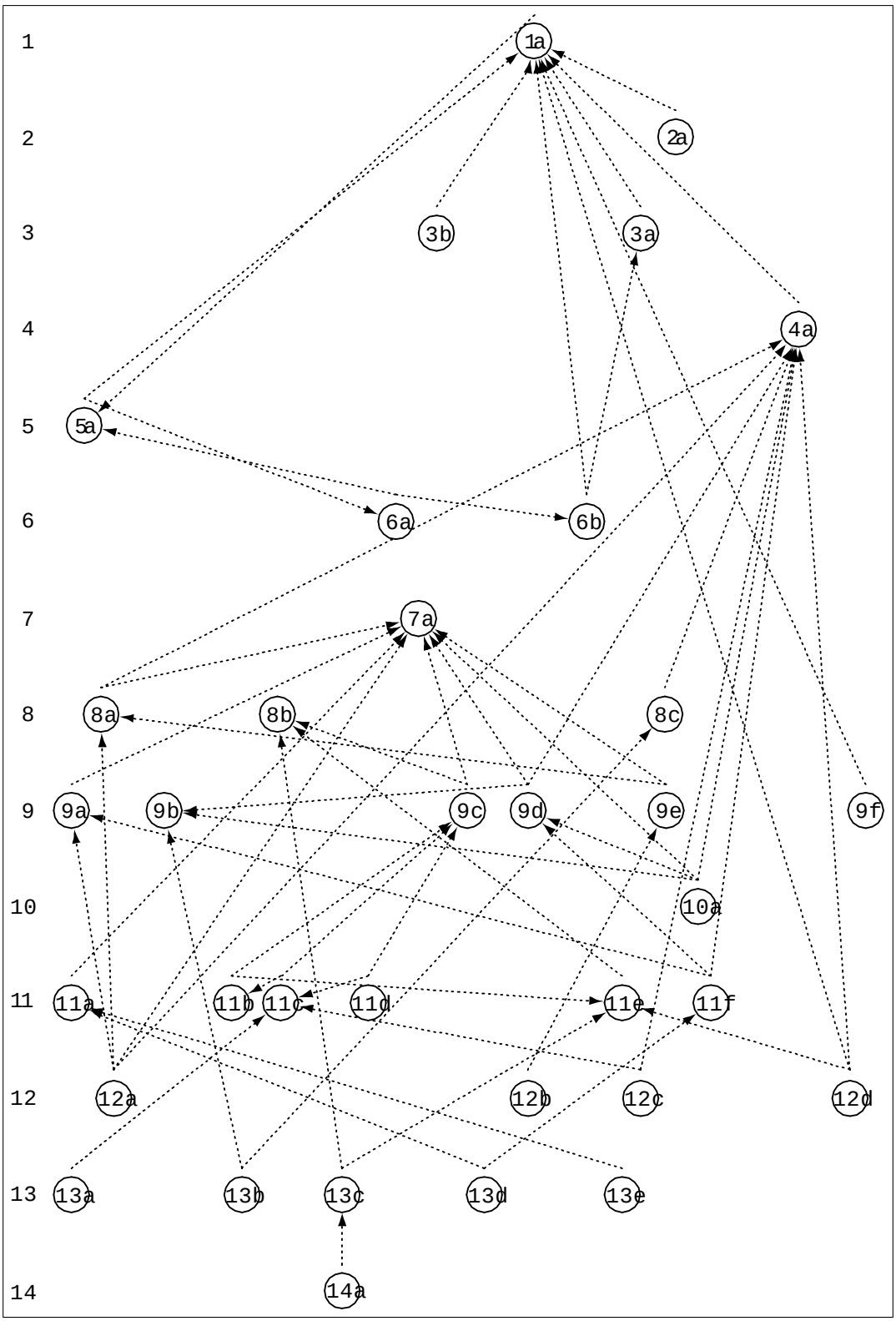

Table 1: Titles and Ranks

Rank	Code	Title(s)	# Males	# Females
R1	1a	chairman & vicechair	4135	53
	2a	schairman & sceo, chairman & sother, schairman & svicechair	1766	47
R2	3a	chairman & president & ceo	15768	193
	3b	ceo	8802	178
R3	4a	president & coo	4950	100
	5a	chairman & cfo	1326	46
	6a	chairman & execvp	121	3
	6b	chairman & coo	173	0
R4	7a	execvp	19524	1134
	8a	execvp & coo	1696	53
	8b	execvp & cfo	4464	285
	8c	coo	1027	46
R5	9a	snrvp	10692	659
	9b	spresident	5634	277
	9c	execvp & other	2471	243
	9d	execvp & spresident	1152	77
	9e	execvp & sceo, execvp & scoo	543	35
	9f	spresident & sceo, spresident & scoo	1803	80
	10a	president & execvp	120	13
R6	11a	vp	9152	524
	11b	snrvp & other	1553	207
	11c	vp & other	3669	424
	11d	cfo & other	573	51
	11e	snrvp & cfo	927	39
	11f	snrvp & spresident	3547	196
	12a	snrvp & coo	340	39
	12c	president & other	147	18
	12d	president & cfo	117	9
R7	12b	snrvp & sceo	472	22
	13a	other & sceo	1640	143
	13b	scoo	550	26
	13c	vp & cfo	2522	190
	13d	vp & spresident	1983	53
	13e	vp & sceo, vp & scoo	38	0
	14a	cfo	1126	83

Table 2A: Probability Transition Matrix for Internal Moves

(percent from base rank)

	R1	R2	R3	R4	R5	R6	R7	# observations	# exit	% exit
R1	88	6	3	1	1	0	0	3995	487	12
R2	4	95	0	0	0	0	0	20150	929	5
R3	3	14	78	3	1	1	0	6272	1370	22
R4	1	2	3	86	4	2	1	19359	2624	14
R5	1	1	2	7	85	2	1	15781	2356	15
R6	0	0	1	6	6	85	2	14646	2248	15
R7	0	1	1	6	3	7	81	5581	1035	19
# entries	1303	1872	1447	2634	1981	1086	726			
% entries	33	9	23	14	13	7	12			

Table 2B : Incidence of Turnover between Firms

(percent from base rank)

	R1	R2	R3	R4	R5	R6	R7	# moves	% exit
R1	52	36	8	4	1	0	0	165	4.1
R2	19	58	9	5	7	1	0	389	1.9
R3	10	40	26	14	9	1	1	140	2.2
R4	3	21	7	40	12	11	5	281	1.5
R5	2	36	10	14	34	3	1	211	1.3
R6	0	9	8	30	8	34	10	130	0.9
R7	2	13	4	30	6	19	26	53	0.9
Total	188	496	141	244	160	96	44	1369	1.6

Table 2C: Female Probability Transition Matrix for Internal Moves

(percent from base rank)

	R1	R2	R3	R4	R5	R6	R7	# observations	# exit	% exit
R1	86	5	2	2	0	0	5	41	6	15
R2	5	95	0	0	1	0	0	220	10	5
R3	3	9	80	3	2	3	0	116	24	21
R4	1	1	3	85	6	3	2	519	80	15
R5	1	2	2	9	84	1	1	448	71	16
R6	0	0	0	4	7	87	2	407	55	13
R7	0	0	0	8	3	10	79	101	21	21
# entries	22	28	25	71	66	32	23			
% entries	53	13	21	14	15	32	23			

Table 3: Executive Background by Gender

(Salary and Compensation are measured in thousands of 2006 US$)

Variable	Overall	Male	Female
	Matched	Sample	
No. Obs.	71,803	68,833	2,970
Age	53.7 (9.3)	53.8 (9.3)	50.9 (10.1)
No Degree	0.21	0.21	0.23
Bachelor	0.79	0.79	0.77
MBA	0.23	0.23	0.23
MS/MA	0.19	0.19	0.17
Ph.D.	0.18	0.17	0.21
Professional Certification	0.22	0.22	0.24
Managerial Experience	18.32 (42.8)	18.5 (43.7)	15.0 (11.5)
Tenure	14.37 (11.48)	14.5 (11.5)	12.54 (10.8)
# of past moves	2.04 (2.00)	2.04 (2.00)	1.97 (1.9)
# of executive moves	0.82 (1.34)	0.82 (1.35)	0.77 (1.24)
Attrition	0.231 (0.42)	0.228 (0.42)	0.30 (0.46)
Promotion	0.083 (0.28)	0.083 (0.28)	0.083 (0.28)
Salary	461 (299)	465 (301)	381 (244)
Compensation	2,460 (11,842)	2,480 (11,952)	2,040 (9,128)
	Full	Sample	
No. Obs.	162,592	154,423	8,125
Attrition	0.195 (0.37)	0.194 (0.39)	0.219 (0.41)
Promotion	0.082 (0.29)	0.082 (0.27)	0.082 (0.28)
Salary	410 (287)	414 (290)	333 (222)
Total Compensation	1,855 (11,044)	1,882 (11,130)	1,342 (11,542)

Table 4: Executive Background by Firm Type

(Salary and Compensation are measured in thousands of 2006 US$)

Variable	Service	Primary	Consumer	Asset Small	Asset Large	Employee Small	Employee Large
	Matched	Sample					
No. Obs.	18,554	19,559	14,808	5,826	47,095	7,361	44,916
Age	52.7	54.8	53.6	53.9	53.7	53.7	53.8
	(9.5)	(9.2)	(9.4)	(10.3)	(9.3)	(11.2)	(9.3)
Female	0.056	0.03	0.06	0.06	0.04	0.05	0.04
No Degree	0.20	0.18	0.26	0.23	0.21	0.21	0.21
Bachelor	0.82	0.81	0.73	0.77	0.79	0.78	0.78
MBA	0.23	0.24	0.22	0.19	0.23	0.18	0.23
MS/MA	0.22	0.19	0.15	0.24	0.18	0.23	0.19
Ph.D.	0.18	0.20	0.15	0.18	0.18	0.21	0.17
Professional Certification	0.21	0.24	0.21	0.26	0.21	0.27	0.21
Managerial Exp.	18.28	18.7	17.9	20.6	17.1	19.4	17.2
	(53.3)	(49.8)	(18.7)	(12.3)	(11.3)	(12.1)	(11.3)
Tenure	13.62	15.0	14.28	16.2	14.1	15.7	14.1
	(10.93)	(11.5)	(11.5)	(12.07)	(11.4)	(12.1)	(11.4)
# of Past Moves	2.11	2.02	2.00	2.5	2.0	2.3	2.0
	(1.98)	(2.01)	(2.00)	(2.2)	(2.0)	(2.1)	(2.0)
# of Exec. Moves	0.82	0.82	0.846	0.93	0.81	0.86	0.82
	(1.32)	(1.34)	(1.39)	(1.5)	(1.3)	(1.4)	(1.33)
Attrition	0.26	0.22	0.24	0.31	0.23	0.27	0.23
	(0.43)	(0.41)	(0.42)	(0.46)	(0.42)	(0.44)	(0.42)
Promotion	0.085	0.089	0.080	0.068	0.088	0.072	0.088
	(0.28)	(0.28)	(0.28)	(0.25)	(0.28)	(0.25)	(0.28)
Salary	442	496	584	327	544	361	546
	(271)	(296)	(392)	(185)	(334)	(233)	(334)
Compensation	3,270	1,841	2,041	1,350	3,022	1,538	3,056
	(14,435)	(8461)	(12,153)	(10,188)	(13,858)	(11,311)	(13,753)
	Full	Sample					
No. Obs.	32,676	32,115	23,826	12,667	75,950	15,120	72,405
Female	0.047	0.031	0.063	0.055	0.046	0.053	0.045
Attrition	0.21	0.19	0.19	0.22	0.20	0.20	0.19
	(0.40)	(0.39)	(0.39)	(0.41)	(0.4)	(0.40)	(0.39)
Promotion	0.085	0.085	0.079	0.074	0.086	0.077	0.084
	(0.28)	(0.28)	(0.27)	(0.26)	(0.28)	(0.27)	(0.28)
Salary	424	428	506	311	524	324	506
	(273)	(270)	(358)	(178)	(344)	(204)	(331)
Total Compensation	3,052	1,849	1,925	1,372	2,851	1,531	2,551
	(13,624)	(8,101)	(11,542)	(8,870)	(12,875)	(9275)	(12,271)

Table 5: Executive Background by Rank

(Salary and Compensation are measured in thousands of 2006 US$)

Variable	R1	R2	R3	R4	R5	R6	R7
	Matched	Sample					
No. Obs.	4,382	18,420	5,376	14,908	11,781	10,598	3,943
Age	59.6	55.7	52.4	52.0	52.8	52.4	52.2
	(9.8)	(7.6)	(8.0)	(8.8)	(10)	(10.3)	(11.2)
Female	0.02	0.02	0.03	0.05	0.06	0.06	0.05
	(0.13)	(0.12)	(0.16)	(0.23)	(0.24)	(0.24)	(0.21)
No Degree	0.25	0.21	0.25	0.21	0.21	0.17	0.21
	(0.43)	(0.41)	(0.43)	(0.40)	(0.41)	(0.37)	(0.41)
MBA	0.24	0.26	0.23	0.27	0.19	0.18	0.22
	(0.42)	(0.44)	(0.42)	(0.44)	(0.39)	(0.39)	(0.41)
MS/MA	0.16	0.17	0.17	0.19	0.21	0.21	0.21
	(0.37)	(0.37)	(0.37)	(0.39)	(0.41)	(0.40)	(0.40)
Ph.D.	0.15	0.15	0.14	0.13	0.21	0.27	0.17
	(0.37)	(0.35)	(0.34)	(0.33)	(0.41)	(0.44)	(0.38)
Prof. Certification	0.15	0.14	0.15	0.22	0.24	0.37	0.30
	(0.36)	(0.34)	(0.35)	(0.42)	(0.43)	(0.47)	(0.45)
Attrition	0.34	0.13	0.20	0.25	0.28	0.27	0.29
	(0.47)	(0.34)	(0.40)	(0.43)	(0.45)	(0.44)	(0.45)
Managerial Exp.	22.3	19.8	16.1	15.9	16.6	16.5	16.9
	(13.0)	(10.5)	(10.7)	(11.0)	(12)	(11.7)	(11.7)
Tenure	17.1	15.1	13.7	13.8	14.1	13.7	14.2
	(13.5)	(11.7)	(11.4)	(11.2)	(12)	(11.0)	(10.8)
# of Past Moves	1.9	1.9	1.7	1.9	2.2	2.3	2.3
	(2.0)	(1.9)	(1.9)	(1.9)	(2.0)	(2.1)	(2.1)
# of Exec. Moves	0.9	0.93	0.73	0.76	0.77	0.80	0.84
	(1.4)	(1.38)	(1.3)	(0.13)	(1.32)	(1.3)	(1.4)
Salary	640	767	591	438	408	323	340
	(375)	(398)	(320)	(197)	(190)	(141)	(217)
Total Compensation	2682	4199	4055	2587	2311	1598	1867
	(18229)	(20198)	(14892)	(8536)	(7319)	(5539)	(6634)
	Full	Sample					
No. Obs.	6,007	24,944	8,112	27,177	23,793	21,733	8,497
Female	0.02	0.02	0.03	0.05	0.06	0.07	0.06
	(0.13)	(0.12)	(0.16)	(0.22)	(0.23)	(0.25)	(0.24)
Attrition	0.35	0.16	0.22	0.27	0.31	0.31	0.31
	(0.47)	(0.36)	(0.41)	(0.44)	(0.46)	(0.46)	(0.46)
Salary	612	707	535	394	369	369	306
	(360)	(405)	(314)	(182)	(175)	(175)	(183)
Compensation	2,603	3,843	3,383	2,113	1,874	1,279	1,466
	(16,618)	(18,377)	(13,336)	(7,912)	(6,717)	(5,117)	(6,447)

Table 6: Logits of Promotion, Turnover and Attrition

(Standard errors in parentheses)

Current Variable	Promotion	External Promotion	Turnover	Attrition
Compensation	-0.001	0.006	0.007	-5.9e-03
	(0.001)	(0.007)	(0.003)*	(1.9e-03)**
ER	-0.21	-0.197	-0.422	-0.147
	(0.030)**	(0.156)	(0.093)**	(0.102)**
ER Lagged	-0.124	0.054	-0.229	-0.172
	(0.025)**	(0.199)	(0.076)**	(0.038)**
R2	-2.2	-2.993	-0.434	-1.254
	(0.058)**	(0.496)**	(0.114)**	(0.078)**
R3	-0.999	-1.797	-0.103	-0.688
	(0.066)**	(0.542)**	(0.146)	(0.103)**
R4	-0.99	-1.56	-0.263	-0.38
	(0.053)**	(0.505)**	(0.120)*	(0.077)**
R5	-0.658	-0.471	-0.553	-0.218
	(0.054)**	(0.58)	(0.134)**	(0.077)**
R6	-0.743	-0.963	-0.558	-0.334
	(0.055)**	(0.552)	(0.139)**	(0.079)**
R7			-0.532	-0.251
			(0.140)**	(0.102)**
Consumer	-0.021	0.318	-0.152	0.11
	(0.037)	(0.265)	(0.091)	(0.051)**
Services	0.075	0.025	-0.001	0.301
	(0.034)*	(0.22)	(0.083)	(0.046)**
Assets	0.000	0.001	0.000	2.9e-04
	(0.000)	(0.005)	(0.001)	(3.9e-04)
Employees	0.001	0.008	0.001	0.0001
	(0.000)**	(0.004)*	(0.000)*	(0.0003)
Observations	28443	757	30343	14774

* significant at 5%; ** significant at 1%

Table 6 cont.: Logits of Promotion, Turnover and Attrition

(Standard errors in parentheses)

Current Variable	Promotion	External Promotion	Turnover	Attrition
Managerial Experience	0.000	0.002	0.000	0.000
	(0.000)	(0.004)	(0.001)	(0.000)
Tenure	0.011	0.000	-0.041	0.003
	(0.001)**	(0.011)	(0.004)**	(0.002)
# of Executive Moves	0.059	-0.227	0.092	0.004
	(0.014)**	(0.111)*	(0.037)*	(0.019)
# of past moves	0.016	0.095	-0.08	0.043
	(0.011)	(0.083)	(0.030)**	(0.015)
Age	-0.107	0.008	0.185	0.022
	(0.010)**	(0.111)	(0.041)**	(0.014)
Age Square	0.001	0.000	-0.002	0.000
	(0.000)**	(0.001)	(0.000)**	(0.000)
Female	0.053	-1.153	0.012	0.482
	(0.071)	(0.483)*	(0.198)	(0.117)**
No Degree	-0.058	-0.562	0.181	-0.138
	(0.043)	(0.292)	(0.105)	(0.062)*
MBA	-0.043	-0.255	0.287	-0.059
	(0.037)	0.235)	(0.086)**	-0.052)
MSMA	0.008	0.212	-0.11	0.021
	(0.037)	(0.26)	(0.098)	(0.049)
Ph.D.	-0.05	-0.574	-0.031	-0.071
	(0.039)	(0.274)*	(0.103)	(0.053)
Prof. Certification	-0.151	-0.538	-0.044	-0.007
	(0.036)**	(0.253)*	(0.094)	(0.048)
Turnover	2.14			-0.21
	(0.088)**			(0.164)
Constant	3.583	3.366	-8.038	-1.927
	(0.292)**	(3.188)	(1.150)**	(0.421)**
Observations	28443	757	30343	14774

* significant at 5%; ** significant at 1%

Table 7: Internal and External Transition logit

Rank Next Period	Int 1	Int 3	Int 4	Int 5	Int 6	Int 7	Extl 1	Extl 2	Extl 3	Extl 4	Extl 5	Extl 6	Extl 7
Constant	0.92	4.04	3.73	3.01	2.71	3.27	-22.6	3.58	0.64	0.04	-20.8	-22.0	-24.7
	(1.71)	(1.53)**	(1.5)*	(1.60)	(1.72)	(2.01)	(8.0)**	(2.05)	(4.01)	(2.84)	(0.14)**	(0.01)**	(0.01)**
R2	-6.06	-5.31	-4.88	-4.49	-6.19	-4.12	-5.02	-2.93	-3.31	-4.39	14.2	11.8	16.3
	(0.15)**	(0.30)**	(0.46)**	(0.56)**	(1.13)**	(0.88)**	(0.28)**	(0.24)**	(0.52)**	(0.56)**	(4.3)**	(4.7)*	(6.3)*
R3	-4.11	2.23	-0.14	-0.19	-0.37	-0.01	-3.04	-1.31	0.14	-1.36	17.4	15.1	-12.4
	(0.19)**	(0.22)**	(0.37)	(0.49)	(0.61)	(0.82)	(0.44)**	(0.29)**	(0.51)	(0.60)*	(4.26)**	(4.7)**	(87.7)
R4	-3.38	0.88	5.29	2.86	2.41	2.62	-2.96	-0.62	0.19	1.84	18.5	19.1	22.6
	(0.21)**	(0.24)**	(0.34)**	(0.45)**	(0.54)**	(0.74)**	(0.62)**	(0.30)*	(0.55)	(0.46)**	(4.3)**	(4.6)**	(6.3)**
R5	-2.64	1.6	3.84	6.84	3.85	3.64	-2.94	0.84	1.08	1.49	20.5	19.1	22.7
	(0.26)**	(0.27)**	(0.37)**	(0.46)**	(0.55)**	(0.76)**	(1.04)**	(0.32)**	(0.58)	(0.53)**	(4.2)**	(4.6)**	(6.3)**
R6	-3.55	1.16	4.34	4.91	8.03	4.88	-28.4	0.17	1.14	2.99	20.4	21.1	24.4
	(0.49)**	(0.35)**	(0.41)**	(0.49)**	(0.57)**	(0.77)**	(52.2)	(0.47)	(0.69)	(0.53)**	(4.3)**	(4.6)**	(6.3)**
R7	-3.54	0.99	3.89	4.0	4.94	8.22	-39.9	-0.68	0.82	2.82	18.4	20.5	25.2
	(0.67)**	(0.46*	(0.47)**	(0.56)**	(0.62)**	(0.79)**	(240)	(0.81)	(0.91)	(0.60)**	(4.4)**	(4.6)**	(6.3)**
Female	-0.18	0.11	0.95	1.08	1.14	1.83	0.34	1.0	-0.37	0.93	0.68	1.07	1.94
	(0.41)	(0.32)	(0.3)**	(0.31)**	(0.33)**	(0.36)**	(1.04)	(0.32)**	(1.03)	(0.50)	(0.64)	(0.59)	(0.68)**
Age	-0.04	-0.19	-0.25	-0.26	-0.27	-0.32	0.73	-0.19	-0.10	-0.14	-0.02	0.05	-0.04
	(0.06)	(0.06)**	(0.06)**	(0.06)**	(0.06)**	(0.07)**	(0.28)**	(0.07)*	(0.15)	(0.11)	(0.16)	(0.18)	(0.25)
Age Sq.	0.00	0.00	0.00	0.00	0.01	0.00	-0.01	0.00	0.00	0.00	0.00	-0.001	0.00
	(0.00)*	(0.00)**	(0.00)**	(0.00)**	(0.00)**	(0.00)**	(0.00)*	(0.00)**	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Mana. Exp.	0.00	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	-0.02	0.01	-0.03
	(0.01)	(0.02)	(0.01)	(0.01)*	(0.01)	(0.01)	(0.01)	(0.01)*	(0.01)	(0.01)	(0.02)	(0.01)	(0.03)
Tenure	0.01	0.01	0.01	0.01	0.01	0.02	-0.06	-0.03	-0.03	-0.04	-0.01	-0.03	0.03
	(0.01)*	(0.01)	(0.01)	(0.01)*	(0.01)	(0.01)*	(0.02)**	(0.01)**	(0.01)*	(0.01)**	(0.02)	(0.02)	(0.03)
# Exec. Moves	-0.01	-0.07	-0.07	-0.14	-0.11	-0.11	0.30	0.06	-0.01	-0.20	0.05	-0.09	0.29
	(0.06)	(0.05)	(0.05)	(0.06)*	(0.06)	(0.07)	(0.16)	(0.07)	(0.13)	(0.10)*	(0.13)	(0.13)	(0.21)
# Past Moves	0.07	0.05	0.11	0.16	0.18	0.17	-0.19	0.01	-0.03	0.14	0.15	0.01	0.06
	(0.04)	(0.04)	(0.04)**	(0.04)**	(0.04)**	(0.05)**	(0.13)	(0.05)	(0.1)	(0.07)*	(0.09)	(0.10)	(0.15)

Standard errors in parentheses

* significant at 5%; ** significant at 1%

Table 8: Compensation Regressions

(Standard errors in parentheses)

Level	LS	LAD	Slope of ER	LS	LAD
Constant	804	1,222	ER	3,520	8,478
	(260)**	(192)**		(178)**	(129)**
			ER squared	-221	-238
				(5)**	(3.6)**
Consumer	26	83	ER × Consumer	-263	334
	(30)	(21)**		(66)**	(47)**
Service	265	519	ER × Service	338	1,427
	(28)**	(20)**		(54)**	(39.)**
Assets	0.026	0.03	ER × Asset	0.034	0.086
	(0.001)**	(0.0)**		(0.001)**	(0.001)**
Employees	12	17	ER × Employees	25	32.
	(0.3)**	(0.2)**		(0.82)**	(0.6)**
R2	1,043	1,388	ER × R2	2,428	1,423
	(53)**	(39)**		(120)**	(88)**
R3	269	66	ER × R3	-1,212	-5,254
	(64)**	(47)		(137)**	(100)**
R4	-253	-767	ER × R4	-2,553	-8,068
	(56)**	(41)**		(122)**	(89)**
R5	-357	-932	ER × R5	-3,237	-8,921
	(56)**	(42)**		(124)**	(90)**
R6	-610	-1,139	ER × R6	-3,462	-9,188
	(58)**	(42)**		(123)**	(90)**
R7	-529	-1,109	ER × R7	-3,417	-9,227
	(70)**	(51)**		(137)**	(100)**

* significant at 5%; ** significant at 1%

Table 8 (cont.): Compensation Regressions

(Standard errors in parentheses)

Level	LS	LAD	Slope of ER	LS	LAD
Age	26	20	ER × Age	28	29
	(8.8)**	(6)**		(2.4)**	(1.7)**
Age Squared	-0.22	-0.16			
	(0.08)**	(0.06)**			
Female	160	92	ER × Female	-41	-286
	(62)*	(46)*		(111)	(75)**
No Degree	1.1	12	ER × No Degree	-92	-68
	(34)	(25)		(60)	(44)
MBA	110	130	ER × MBA	107	234.566
	(30)**	(22)**		(58)	(43)**
MS/MA	-94	-74	ER × MS/MA	-372	-356
	(30)**	(22)**		(55)	(41)**
Ph.D.	-2.2	32	ER × Ph.D.	-31	101
	(32)	(23)		(58)	(42)*
Prof. Cert.	-76	-102	ER × Prof. Cert.	-8.3	-200
	(29)**	(22)**		(52)	(38)**
Mana. Exp.	-0.07	-0.08	ER × Mana. Exp.	-0.5	-1.1
	(0.29)	(0.2)		(0.4)	(0.2)**
Tenure	-5.6	-4.6	ER × Tenure	5.4	9
	(1.2)**	(0.9)**		(2)**	(1.5)**
# of Past Moves	-35	-321	ER × # of Past Moves	-70	-81
	(9)**	(6.6)**		(16)**	(11)**
# of Exec. Moves	21	22	ER × # of Exec. Moves	-23	11
	(12)	(8.8)*		(21)	(15)
First Year	250	552	ER × First Year	-1,176	-514
	(85)**	(63)**		(157)**	(116)**
R^2	0.64				
Observations	35602	35602			

* significant at 5%; ** significant at 1%

Table 9: Background and Rank by Cohort Gender

Cohort	39		49	
Gender	Female	Male	Female	Male
Rank 1	0.01	0.03	0.02	0.03
Rank 2	0.00	0.10	0.10	0.19
Rank 3	0.02	0.08	0.05	0.09
Rank 4	0.31	0.25	0.30	0.25
Rank 5	0.21	0.20	0.26	0.19
Rank 6	0.29	0.24	0.22	0.18
Rank 7	0.17	0.11	0.07	0.07
Managerial Exp.	11.2	11.2	12.9	13.2
	(9.0)	(9.3)	(9.1)	(8.8)
Tenure	8.9	9.5	10.0	11.1
	(7.8)	(9.2)	(8.3)	(9.3)
# of Past Moves	2.2	1.8	2.0	1.9
	(1.7)	(1.6)	(1.8)	(1.8)
# of Exec. Moves	0.6	0.5	0.8	0.7
	(1.0)	(0.9)	(1.1)	(1.2)

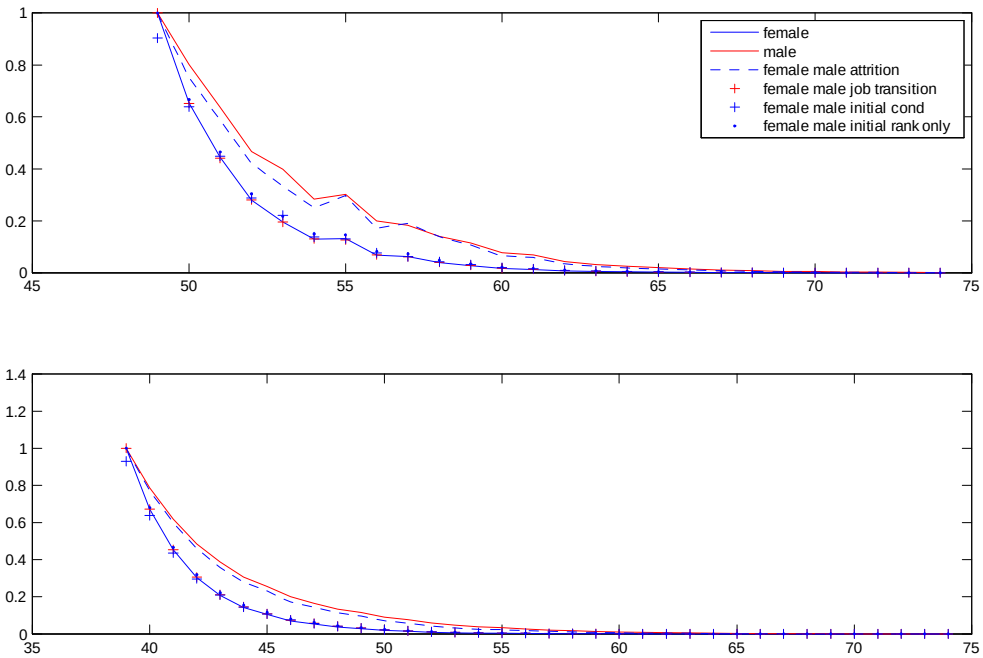

Figure 2: Survival Probabilities

Table 10: Dynamic Gender Gaps Decomposition

	Expected Career Length (T)	Average Career Wage (W/T)	Discounted Earnings
At Age 49:			
Male	4.8519	2,195,200	7,606,800
Female	3.0901	2,106,100	5,303,700
Female with Male Initial Assignment (q_0)	3.0524	2,240,700	5,494,000
Female with Male Job Transition (p_{rs})	3.0887	2,171,600	5,415,700
Female with Male Attrition (p_{r0})	4.5186	2,061,400	6,907,800
Female with Male Initial Rank Assignment	3.2660	2,296,800	6,028,800
Female with Male Career Distribution	4.8519	2,298,500	8,092,300
At Age 39:			
Male	4.9251	1,931,400	6,395,200
Female	3.1381	1,820,900	4,540,800
Female with Male Initial Assignment (q_0)	3.0495	1,897,300	4,534,500
Female with Male Job Transition (p_{rs})	3.1853	1,876,800	4,672,200
Female with Male Attrition (p_{r0})	4.5752	1,890,000	6,146,000
Female with Male Initial Rank Assignment	3.2653	1,875,800	4,790,100
Female with Male Career Distribution	4.9251	2,034,400	6,862,000

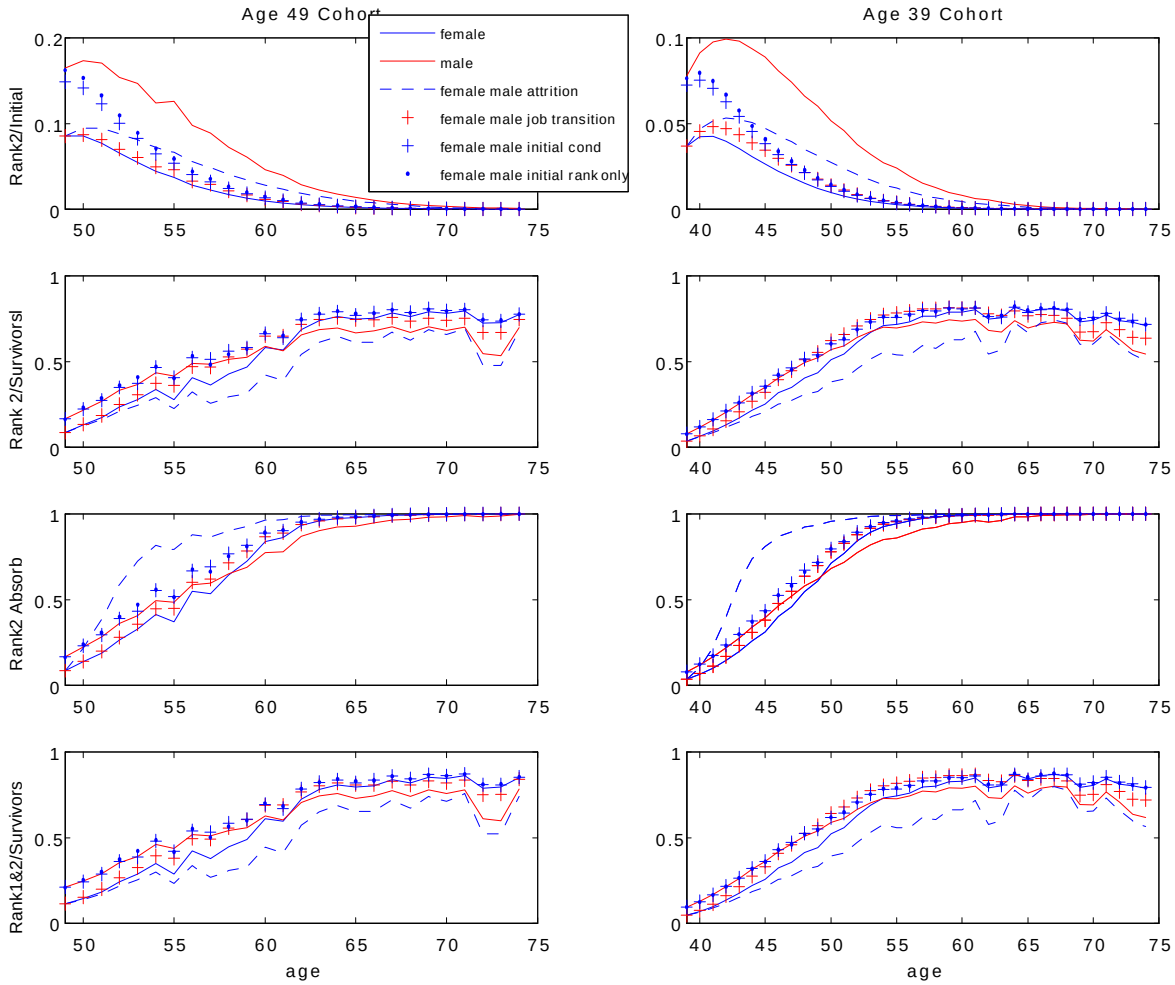

Figure 3: Glass Ceiling

VI. Appendix: A Further Assessment of the Background Variables

Our findings in Tables 6 through 8 show that many of the background variables collected for the matched sample enter significantly in the promotion, turnover and attrition logits and/or the wage regressions, thus directly attesting to their usefulness. At the same time we note from Tables 4 and 5 that the matched sample is not randomly drawn from the full sample, because many of the sample means for variables available in full sample significantly differ from the corresponding means in the matched sample. We further addressed the costs and benefits of including background variables in our analysis, by comparing logit and regression results from the full and matched samples, seeking to answer two questions.

Is there omitted variable bias from ignoring heterogeneity in executive background? To answer this question we repeated the logit and regression analyses on the matched sample, but only including those variables that are available in the full sample, and compared the coefficients with those reported in Tables 6 and 8. When background variables on education and experience are included in the analysis, from Table 6 the estimated coefficient on the female indicator variable is positive but insignificant, evidence that females are promoted as quickly as males. In contrast excluding the background variables in the matched sample yields a positive and significant estimate on the female indicator variable in Table A1, falsely suggesting that women are more likely to be promoted than males. One explanation for this contrast is that women are on average three years younger than men, and younger workers are more likely to be promoted. Moreover, when the background variables are excluded, the female coefficient in the attrition logit falls to half its value (but remains highly significant), and the negative coefficient for females we found in external logit becomes insignificant. The correlation of the background variables with the female indicator variable also affects the compensation regressions. In this case the estimated standard error on the female indicator variable is reduced by including the background variables. If excluded, a key finding of our study, that controlling for background and rank, female executives are paid more than males, is lost.

Is there selection bias in the matched sample from the way executives are chosen and elect to be included in Who's Who, and/or small sample bias by restricting the empirical analysis to matched data? To shed light on this question we ran logit and regressions on the full sample with the variables we have, and compared the results with the same logits and regressions from the matched sample. Tables A1 and A2 display the results. After controlling for rank, sector and firm size and excess return, we find that relative to males, females in the matched sample are more likely to be promoted, and are more highly compensated. Similarly our estimates suggest that females in the matched sample are less likely to attrit than those in the full sample, but the difference is not statistically significant. However we do not find any significant differences between the coefficients in the regressions of turnover and external promotions in the full and matched sample. Relative to the selection of males, we infer that females appearing in Who's Who are more successful than those who don't, mainly because of better internal matches with their employer firms.

Table A: Logit of Promotion, Turnover and Attrition

Current Variable	Promotion	Promotion	External Promotion	External Promotion	Turnover	Turnover	Attrition	Attrition
Sample	Full	Matched	Full	Matched	Full	Matched	Full	Matched
Compensation	0.012	0.000	-0.004	0.000	0.011	0.008	-6.9e-03	0.000
	(0.002)**	(0.001)	(0.008)	(0.005)	(0.002)**	(0.002)**	(1.2e-03)**	(0.000)**
ER	-0.121	-0.223	-0.067	-0.134	-0.346	-0.409	-0.201	-0.232
	(0.028)**	(0.026)**	(0.175)	(0.133)	(0.065)**	(0.076)**	(0.021)**	(0.038)**
ER Lagged	-0.003	-0.095	0.069	-0.019	-0.36	-0.235	-0.117	-0.148
	(0.021)	(0.020)**	(0.156)	(0.17)	(0.061)**	(0.062)**	(0.018)**	(0.031)**
R2	-5.457	-2.217	-3.981	-2.991	-0.311	-0.683	-1.07	-1.296
	(0.246)**	(0.048)**	(0.497)**	(0.410)**	(0.091)**	(0.108)**	(0.052)**	(0.067)**
R3	-0.318	-0.973	-1.75	-1.457	-0.058	-0.436	-0.678	-0.796
	(0.057)**	(0.054)**	(0.484)**	(0.460)**	(0.115)	(0.131)**	(0.063)**	(0.085)**
R4	-1.367	-0.991	-2.342	-1.466	-0.299	-0.552	-0.414	-0.481
	(0.052)**	(0.043)**	(0.456)**	(0.418)**	(0.090)	(0.109)**	(0.048)**	(0.063)**
R5	-0.656	-0.662	-1.047	-0.465	-0.541	-0.835	-0.237	-0.328
	(0.047)**	(0.044)**	(0.468)*	(0.479)	(0.098)**	(0.119)**	(0.047)**	(0.063)**
R6	-0.404	-0.709	-1.447	-0.776	-0.738	-0.956	-0.281	-0.445
	(0.047)**	(0.045)**	(0.476)**	(0.467)	(0.105)**	(0.125)**	(0.048)**	(0.065)**
R7					-0.514	-0.799	-0.244	-0.354
					(0.087)**	(0.164)**	(0057)**	(0.085)**
Consumer	-0.06	0.025	0.145	0.396	-0.106	-0.2	0.08	0.097
	(0.037)	(0.03)	(0.236)	(0.213)	(0.071)	(0.076)**	(0.028)**	(0.042)*
Services	-0.015	0.126	0.178	0.266	0.074	0.079	0.292	0.271
	(0.034)	(0.027)**	(0.211)	(0.179)	(0.064)	(0.068)	(0.025)**	(0.039)**
Assets	0.000	0.000	0.012	0.001	0.000	0.000	-2.8e-04	0.000
	(0.000)	(0.000)	(0.005)*	(0.004)	(0.000)	(0.001)	(2.8e-04)	(0.000)
Employees	0.001	0.001	0.001	0.004	0.001	0.001	-0.0002	0.000
	(0.000)**	(0.000)**	(0.002)	(0.002)	(0.000)**	(0.000)*	(0.0002)	(0.000)
Female	-0.269	0.115	-0.446	-0.489	-0.087	0.071	0.3	0.242
	(0.073)**	(0.056)*	(0.466)	(0.379)	(0.146)	(0.154)	(0.052)**	(0.089)**
Turnover	2.321	2.273					-0.148	-0.238
	(0.094)**	(0.075)**					(0.088)	(0.133)
Constant	-1.537	-0.054	1.326	2.454	-3.76	-2.957	-0.687	-0.719
	(0.042)**	(0.054)	(0.433)**	(0.403)**	(0.080)**	(1.101)**	(0.045)**	(0.058)**
Observations	66546	41197	1369	1094	76715	43842	44682	20757

Standard errors in parentheses

* significant at 5%; ** significant at 1%

Table A2: Compensation (w\o backgroung variables) Regressions

(Standard errors in parentheses)

Level	LS	LS	LAD	LAD	Slope of ER	LS	LS	LAD	LAD
	Full	Matched	Full	Matched		Full	Matched	Full	Matched
Constant	1,341	1823	1,586	1668.95	ER	3,747	18,584	8,164	9,612
	(27)**	(235)**	(24)**	(34)**		(60)**	(550)**	(53)**	(79)**
					ER squared	-228	-891	-100	-158
						(1.7)**	(21)**	(1.5)*	(3.2)**
Consumer	49	145	63	107	ER × Consumer	-125	2,013	-6.8	283
	(14)**	(132)	(12)**	(19)**		(27)**	(292)**	(24)	(42)**
Service	257	1159	405	515	ER × Service	268	2,278	994	1,245
	(13)**	(123)**	(11)**	(17)**		(22)**	(242)**	(19)**	(34)**
Assets	0.022	0.026	0.022	0.029	ER × Asset	0.046	0.118	0.064	0.087
	(0.001)**	(0.001)**	(0.001)	(0.000)**		(0.001)**	(0.005)**	(0.001)**	(0.000)**
Employees	12	15	14	15.9	ER × Employees	15	31.18	29	26
	(0.11)**	(1.06)**	(0.1)**	(0.15)**		(0.36)**	(3.44)**	(0.32)**	(0.49)**
R2	666	2,316	1,288	1,487	ER × R2	841	-904.65	1,146	1,951
	(29)**	(244)**	(25)**	(35)**		(61)**	(550)	(54)**	(79)**
R3	164	1,418	46	230	ER × R3	-949	-9,016	-4,598	-4,907
	(33)**	(289)**	(29)	(41)**		(67)**	(618.3)**	(59)**	(88)**
R4	-320	-282	-661	-683	ER × R4	-2,033	-13,420	-6,455	-7,641
	(29)**	(248)	(25)**	(35)**		(60)**	(554.3)**	(53)**	(79)**
R5	-427	-160	-866	-902	ER × R5	-2,424	-14,829	-7,233	-8,663
	(29)**	(254)	(25)**	(36)**		(60)**	(566.16)**	(53)**	(81)**
R6	-630	-654	-1,077	-1,119	ER × R6	-2,574	-14,477	-7,508	-8,954
	(29)**	(257)**	(26)**	(37)**		(60)**	(558)**	(53)**	(80)**
R7	-587	-513	-1,026	-1,069	ER × R7	-2,506	-13,002	-7,361	-8,874
	(32)**	(312)	(29)**	(44)**		(63)**	(609)**	(55)**	(87)**
Female	-26	198	-64	52.55	ER × Female	-184	-255	-265	-170
	(123)	(269)	(22)**	(38.7)		(36)**	(473)	(32)**	(68)**
First Year	577	1202	922	582	ER × First Year	-1,390	-1,966	-1,806	-514
	(38)**	(396)**	(33)**	(56)**		(58)**	(734)**	(51)**	(116)**
R^2	0.2	0.23							
Observations	101076	51,668	101076	51,668					

* significant at 5%; ** significant at 1%