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THE DYNAMICS OF GENDER EARNINGS DIFFERENTIALS: EVIDENCE FROM ESTABLISHMENT DATA

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ABSTRACT

We use a unique match between the 2000 Decennial Census of the United States and the Longitudinal Employer Household Dynamics (LEHD) data to analyze how much of the increase in the gender earnings gap over the lifecycle comes from shifts in the sorting of men and women across high- and low-pay establishments and how much is due to differential earnings growth within establishments. We find that for the college educated the increase is substantial and, for the most part, due to differential earnings growth within establishment by gender. The between component is also important. Differential mobility between establishments by gender can explain 27 percent of the widening of the pay gap for this group. For those with no college, the, relatively small, increase of the gender gap over the lifecycle can be fully explained by differential moves by gender across establishments. The evidence suggests that, for both education groups, the between-establishment component of the increasing wage gap is due almost entirely to those who are married.

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1. Introduction

Women have made remarkable progress in the labor market throughout the past century, resulting in clear convergence in human capital investment and employment prospects and outcomes relative to men (Blau and Kahn, 2016). However, remaining gender differences in pay still persist and, as shown by Goldin (2014), the gender earnings gap increases over the working life, especially so for college graduates.[1]

At the same time, recent studies have shown that there are large earnings differential across firms and establishments, and that sorting of workers into high- and low-paying establishments contributes to earnings inequality in the US[2] and other countries.[3] Since men are more likely to work in high paying firms and appear to capture a larger part of the establishment premium than women (Card, Cardoso, and Kline, 2016), these establishment earnings differentials tend to add to the gender pay gap. In this paper we use a unique match between the 2000 Decennial Census of the United States and the Longitudinal Employer Household Dynamics (LEHD) data to analyze how much of the increase in the gender earnings gap over the life cycle comes from shifts in the sorting of men and women across high- and low-pay establishments over the early part of their working life and how much is due to differential earnings growth within establishment.

The novelty with respect to other studies based on matched employer-employee data, is to focus on the *age dynamics* of the gender pay gap rather than its cross-sectional average. In addition, the data match to the 2000 Census of the United States allows us to study how the widening of the wage gap and its determinants vary by education, occupation and marital status, something that typically cannot be done with matched data, at least in the United States, but that can help gain a better understanding of the potential mechanisms. The drawback of our data, as we will discuss later, is that while the matched data cover several years of an individual work history (from 1995 to 2008), key demographic variables are only observed at one point in time (in

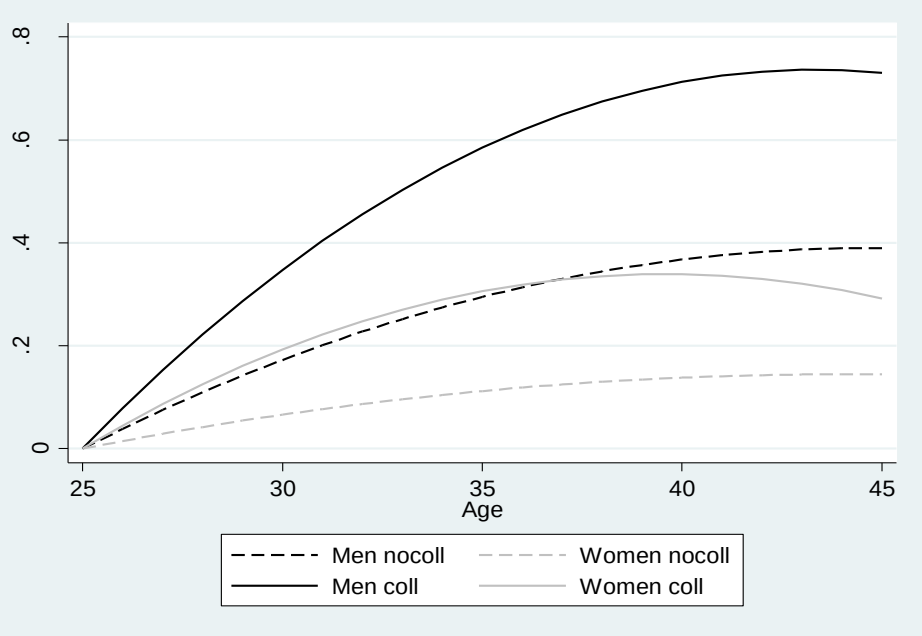
[1] For the cohort born in the early 1960s, controlling for work time and education, the difference increases from 10 log points at age 25, to 30 log points at age 40 (see Goldin, 2014, Figure 1B). The decline is even larger for earlier cohorts. Manning and Swaffield (2008) find similar results for the UK.

[2] See Abowd, Creecy, and Kramarz (2002) establishing a large earnings variation across establishments in the US, even for the same worker. Barth, Bryson, Davis, and Freeman (2016) and Song, Price, Guvenen, Bloom, and von Wachter (2015) study the contribution of establishment and firm pay to the increase in the earnings dispersion.

[3] See Card, Heining, and Kline (2013) for Germany and Félix and Portugal (2016) for Portugal.

2000). In addition, information in the LEHD is only available for the subset of states that provided UI data. We return to this point later.

Figure 1. Predicted earnings-age profiles by education and gender.



Notes: The lines represent the differences of predicted log earnings by age/gender/education relative to a 25-year old of the same gender and education. The predicted values are obtained from running separate regressions of log earnings on age and its square for each gender/education bin. All models include time dummies. Average profiles are calculated on the matched sample from 26 of the top-50 largest PMSAs in the US that are located in LEHD-covered states, see data section for details on sample construction.

Figure 1 shows the predicted earnings-age profiles by gender and education based on our data. We group workers in two education categories: those who are not college graduates and college graduates. Predicted earnings by age are measured relative to a 25-year-old worker of the same gender and education. There are striking differences in earnings profiles by education, and the comparison of black and grey lines for each group shows that the gender earnings gap widens with age for both education groups.[4] The widening of the gender earnings gap is largest for college graduates in our data. For this group the gender gap widens by 44 log-points between age 25 and 45.[5] For those with less than college, the gap widening is smaller, equal to 25 log points, but still sizable. This pattern is consistent with Goldin's (2014) evidence based on cross-sectional

[4] The regressions are based on 15 million observations; see the summary table in the Appendix. The standard errors of the estimates are thus so small that we have chosen not to draw the confidence intervals around the curves.
[5] The convention used in this paper is to refer to log changes multiplied by 100 as changes in log points.

data and the analysis in Goldin et al. (2017) based on repeated cross-sectional observations of one specific cohort in our data.

A rising age-earnings profile may be due to the combination of two different processes. The first concerns the career path *within an employer*, involving wage raises and promotions over time. The second concerns *sorting into high- versus low-paying employers*. The two processes arise from very different mechanisms. Within-employer career paths arise from different wage structures within firms, and the overall design of organizations and their job ladders. Gender differences within firms may ensue because of competition for higher positions within the hierarchy (Lazear and Rosen, 1990). The prevalence of convex reward profiles in working time, at least in some occupations, also contributes to the widening of the gender pay gap (Goldin, 2014).

Between-employer career paths arise from different wage levels across firms[6], that may be a result of frictions in the labor market, monopsonistic behavior[7] on part of the employer, and/or different forms of rent sharing. With a distribution of earnings across firms, it may be optimal to accept a job in a low-paying establishment early on, and then climb the ladder to better paying establishments over time, as those opportunities arise. In this case, gender differences across firms may arise if women have lower ability to extract rent (Card, Cardoso and Kline, 2016), and thus face a flatter earnings profile across firms than men, or if women have a less elastic job mobility pattern with respect to wages, so that employers may engage in monopsonistic discrimination (Barth and Dale-Olsen 2010).[8]

Even though these within- and between-firms paths arise from distinct mechanisms, they share some common features that apply particularly to gender differences. Career advancements along both dimensions are competitive, and require investments and efforts on part of the worker, often over and above what is required to do a good job. Both mechanisms are a function of a worker's cost of effort that are often complementary to care obligations and effort in household production, and thus might, given the prevailing gender norms, be higher for women. Job search

[6] See Groshen (1988) for an early contribution.

[7] See Manning, 2003, Green, Machine and Manning, 1996.

[8] Another frictional mechanism emphasized in this literature, has to do with employers' disutility of hiring women (Black, 1995, Bowlus and Eckstein, 2002, Flabbi, 2010). See Barth, Bratsberg, and Raaum (2012) on the importance of establishment affiliation for the development of the immigrant-native earnings gap over time.

and investment in career-enhancing job changes may be more costly for women to combine with family obligations. Gender differences are further exacerbated if household roles and market wages are tied through employers' beliefs about female labor force attachment, cost of work effort and work sharing at home (Albanesi and Olivetti, 2009).[9]

In a companion paper we document that movements within and across establishments contribute to the expanding gender earnings gap in the decade and a half after schooling ends, for narrowly defined cohort and education groups (see Goldin et al. 2017).

In this paper we quantify the importance of career movements within and across establishments using a full decomposition analysis of the establishment and individual fixed effects. The different sources of earnings growth at the individual level are estimated separately by gender and education, while establishment fixed effects are estimated separately by gender only. To resolve the methodological challenges of identifying separately the linear terms for calendar year, time, cohort, and age, we assume that the time effects for each PMSA and education group are the same for men and women. With this assumption we may directly identify the difference between the linear term in men's and women's earnings growth by age, conditional on being in the same job; i.e. conditional on the full set of individual, establishment and match effects. Next, we separate out the cohort versus the linear age effect among men by defining cohorts as spanning ten years. Finally, we are able to disentangle age and seniority effects within establishments by using workers who have more than one job in our panel.

One important advantage of our data is that we can identify directly the within-job difference in earnings profile over time between men and women. This difference arises from the combined effects of differences in wage raises and promotions within the same employer.[10]

[9] See Albanesi and Olivetti (2009) for an equilibrium model of statistical discrimination whereby firms' traditional beliefs about household roles, by lowering the incidence and 'generosity' of high-powered labor contracts offered to women, can lead to a large and persistent gender wage gap. Alternative feedback mechanisms explored in the literature rely on job segregation into piece-rate jobs (Francois, 1998), and on-the-job training (Dolado, Garcia-Penalosa and de la Rica, 2013).

[10] Lazear and Rosen (1990) develop a theoretical model of promotions in job ladders where women are paid the same as men within jobs, but where higher separation rates among women induces higher ability thresholds for promotions for women than men. Data on job-titles is necessary to sort out the mechanisms behind lower earnings growth within the same employer. According to Blau and De Varo (2007), the empirical literature on gender differences in promotions has so far produced mixed results and differs widely in terms of both type of data and the sample of firms and individuals used. Booth, Francesconi, and Frank (2005) use the British Household Panel Survey with information on promotions within the same employer, and find that women are promoted at about the same rate as men, but that they receive smaller wage gains associated with the promotions. Blau and De Varo (2007) in their study of promotion and pay for new hires in in a sample of US establishments find that women have lower probabilities of promotion than men, but that wage gains associated with promotions do not differ much between men and women, a result which is consistent with the evidence from McCue (1996) who uses data from the PSID.

While we cannot distinguish between internal promotions and earnings growth within job category in our data, we are able to distinguish between differential seniority profiles, which is experienced within the current job, but lost when changing employer[11], and differential development in the within establishment earnings distribution that is not lost when changing job, e.g. as one changes from a top position in one firm to a top position in another firm.

Our findings show that among workers without a college degree, there is only a small male advantage in within establishment earnings growth over the first 10 to 15 years of working life. However, by age 45 women catch up with men in terms of within establishment earnings growth. On the other hand, for college educated workers there is a substantial difference in within-establishment earnings growth by gender. Over the first 15 years, from age 25 to 40, men's earnings growth is 33 log points higher than women's. Unlike the non-college educated, college women do not catch up. By the time they reach age 45 the difference is still 30 log points. A fraction of this difference is due to higher returns to seniority among men, 1 log point per year of seniority, and the remaining part is due to earnings growth within establishment that is carried over in the transition to new jobs in other establishments.

The most novel results of our analysis concern the development of the establishment earnings premium over time for the same individual. For employees without a college degree, the widening of the difference in the establishment earnings premium between age 25 and 45 adds 5.4 log points to the overall increasing gender gap in pay. Note that this is the main source of the gender differential in earnings growth for the less educated given that women in this group catch up with men in terms of within establishment earnings growth by age 45. Among college-educated workers, the gender gap across establishments widens by 11 log points from age 25 to 45. As noted above, college educated workers experience a considerable widening of the within establishment earnings gap. The across establishment expansion can explain only 27 percent of the total widening of the gender wage gap for this group.

We find that the increasing across-establishments component is almost entirely due to married workers. The evolution of the establishment pay premium for the never-married (both

[11] Due to firm-specific versus general human capital investment (Becker, 1975) or to delayed payments as a solution to agency problems (Lazear, 1981).

men and women) is very similar to that of married men. Descriptive statistics based on the publicly available 2000 Census of the United States suggest that most of the loss in earnings growth for married women (relative to married men) occurs concurrently with the arrival of children.

Early contributions addressing the importance of establishment affiliation for the level of the gender pay gap include the study by Barth and Mastekaasa (1996) and Bayard, Hellerstein, Neumark and Troske (2003) who show that a gender earnings differential persists even after controlling for gender differences in human capital and sex segregation within occupation, industry and establishment based on early version of the matched data for Norway and the United States, respectively.[12] More recently, Card, Cardoso and Kline (2016) show that firm-specific pay premiums explain just over one-fifth of the average gender earnings gap in Portugal and interpret it in light of differential bargaining power between male and female workers.[13] Other authors have used matched employer/employee data to explore the role of gender segregation and pay structure for explaining the cross-sectional wage gap in Spain (Amuedo-Dorantes and Sara De la Rica, 2006), Denmark (Datta Gupta and Rothstein, 2005), Germany (Heinze and Wolf, 2009), Finland (Korkeamäki and Kyyrä, 2006) and a for cross-section of nine European countries (Simon, 2012). All these papers focus on the cross-sectional gender pay gap. The novelty in our paper is that we focus on the widening gender pay gap by age.

The distinction between job separations into non-employment, versus job-to-job separations is important for the analysis of gender differences in earnings growth and job transitions. While as discussed above, separations into non-employment may have negative effects on between establishment earnings growth, separations to other jobs may have the effect of improving earnings. Earlier studies of separation rates find that gender differences in the probability of leaving a job tend to disappear once we control for observable characteristics (Blau and Kahn, 1981) and attachment to the labor force (Light and Ureta, 1990, 1995). Royalty (1998) shows the existence of gender differentials in the destination state. Women are more likely to leave a job for non-employment, while men are more likely to move from one job to the next (see

[12] The paper by Bayard et al. (2003) uses an earlier version of our data that matched the 1990 Sample Edited Detail File (consisting of all household responses to the 1990 Decennial Census long form) to establishment records in the 1990 Standard Statistical Establishment List.

[13] In particular, they show that bargaining and sorting based on measured productivity account for about 80% of the overall impact of firm-specific pay premiums on the gender earnings gap.

also Manning 2003). There is also an earlier literature emphasizing differences in turnover rates (based on longitudinal data) as an important source of gender differentials in earnings growth for young workers. For example, Loprest (1992) shows that women gain less, in terms of wage growth, from switching jobs. Bowlus (1997) finds significant gender differences in quit rates "for personal reasons" that account for 20%–30% of the gender wage differential. More recently, Del Bono and Vuri (2008) identify gender difference in the returns to job mobility as the main source of gender earnings growth differentials on a sample of private sector employees in Italy. Hirsch, and Schnabel (2012) show that lower female wage-elasticity and gender differences in the transition probability are both important for explaining the gender wage gap in German employer/employee matched data.

The remaining of the paper is organized as follows. Section 2 describes our data set and key variables. Section 3 discusses our estimation strategy. Finally, the main findings of our analysis are presented in Section 4.

2. Data and Definition of Key Variables

Our analysis relies on a unique combination of the Longitudinal Employer-Household Dynamics (LEHD) database and the 2000 Decennial Census of Population (one in six long form). Both datasets are confidential and housed by the U.S. Census Bureau in the Research Data Centers (RDC). As the current combination of these two restricted access data sets has barely ever been used in previous empirical literature, this section will provide a detailed summary of the construction of our data platform.

The LEHD is based on quarterly, worker-level, filings by private-sector U.S. firms in the context of the administration of state unemployment insurance (UI) benefit programs. The data identify all employees of an establishment and their quarterly compensation on a month-to-month basis. UI earnings include wages, salary and taxable bonuses and are not top-coded.[14] The state UI system covers about 95% of private sector employment. Thus our analysis is fully representative of private firms within the geographical areas we study (see Hyatt, McEntarfer, McKinney, Tibbets, and Walton, 2014; Stevens, 2007). The LEHD is longitudinally linked at both the firm and employee levels, making it possible to analyze how firm employment and

[14] See Abowd, Stephens, Vilhuber, Andersson, McKinney, Roemer, and Woodcock.(2002) for an in-depth discussion of the benefits and shortcomings of this data.

employee earnings evolve over time, within and across all establishments. The LEHD vintage used in this paper includes 23 states with varying initial dates of coverage, starting from 1991, and runs through 2008.

To manage the enormous number of person and firm fixed effects required to estimate our models, we focus on the largest PMSAs in the U.S. in terms of population as of 1991. Of the 50 largest U.S. PMSAs, 26 were located in 18 of the 23 LEHD covered states available to us. Specifically, these PMSAs are located in CA, CO, GA, FL, HI, ID, IL, MD, NC, NJ, NM, OR, RI, SC, TX, UT, VA and WA. We further reduce our analysis sample by using annual data from 1995 to 2008 and selecting workers who worked more than two quarters per year and earned at least $2,000 per quarter, on average, during the year. The last restriction removes from the sample very short and sporadic employment relationships as well as any short-term contractor type arrangements, and directs our study towards the more permanent work arrangements. All dollar values are inflated to 2008 values using the all-urban-consumers-CPI published by the BLS. Finally, we focus on individuals in their prime working age. That is, for each individual, we only use observations when the person is aged 25-44.

The LEHD records limited information about workers in the snapshot individual characteristics file (ICF). This includes age, gender, race, place of birth, and citizenship status. Through the employment history files (EHF), we can also discern their earnings and job-by-job employment histories. Moreover, using the unique person identifiers (PIKs), we are able to match people in the LEHD to the individual-level records contained in the long-form responses of the 2000 Decennial Census of Population.[15] The long-form was given to a random sample of 1-in-6 households and is nationally representative. This process allows us to match almost exactly 1-in-6 of our LEHD workers with added Census details from the Person File. The LEHD-Census match thus includes more detailed and comprehensive information about each individual in our sample (e.g., level of education, occupation, marital status, class of worker, etc.) and their respective families (e.g., family composition, detailed characteristics of their spouse, and household income by source). In the current study we mainly extract individual-level characteristics, that is, educational attainment, marital status and race. It is worth emphasizing that while the LEHD longitudinally follows the same individuals over time across jobs, the 2000

[15] The Census Bureau has created the unique person identifiers (PIKs) based on Social Security Numbers (SSNs). These PIKs allow the linking of individuals across demographic surveys, censuses and administrative records.

Census is obviously just a snapshot. To the extent that the person's marital status, education or occupation changes, either before or after 2000, we will not be able to capture that.

Another possible caveat with our data is attrition from people moving out of the 26 PMSAs. This would pose a problem for us if the movements out of the PMSA were differentially selected across genders. Since our key results are obtained conditional on fixed individual and establishment effects, heterogeneity in terms of individual or establishment earnings levels is controlled for in the analysis. However, attrition bias could still affect our gender comparisons if there is differential selection in residual earnings growth between men and women. Although this concern cannot be confronted directly based on our data, we note that the bias could go either away. We show below that our results are driven mainly by married individuals. If married women in our sample of PMSAs are disproportionately tied stayers, this could lead to finding lower wage growth for women. But low (residual) wage growth women may as likely be tied movers, women who follow their husband as they take better job opportunities, which would bias our findings in the opposite direction.

A few final details about the Census RDC data sets are worth noting. First, all observation counts in the paper are disguised and rounded to the nearest 100 according to Census Bureau disclosure restrictions. Second, we generally use the establishment ID (based on the State Tax ID and the establishment number) to identify work establishments and to track them over time. The LEHD also includes firm identifiers, but unlike establishment IDs those are not fully consistent over time within a given firm. For example, if another firm acquires an establishment, the firm ID will change, even though the workers within that establishment would all continue their employment with the company. Due to the sheer size and scope of these data it would be practically impossible to try to follow each of the firms over time while taking into account all merger activity and other corporate restructuring. Moreover, we believe that the establishment level tracking is more relevant for the current purpose because the type of job-to-job moves that is the focus of this paper may involve changes between establishments within a firm as well.

The dependent variable in our models is the natural logarithm of earnings, where earnings are measured as the average quarterly earnings during the year (over the quarters that the person was working). Another key variable is the establishment size, where the size corresponds to the LEHD reported number of employees minus the sample mean. We also include a squared-term in

age, where the age refers to the person's age during the year of observation minus 35. Since the regression specification includes establishment and person fixed effects, most of the other time-invariant person and establishment characteristics are absorbed by those fixed effects. However, our cross-sectional model for the person fixed effect includes time-invariant individual characteristics such as age, years of education (minus 12), and race dummies.

3. Methodology

Our aim is to compare the age-earnings profiles of men and women, both within and between employers. Consider first the following earnings equation for individual *i* at time *t* in establishment *j*:

$$(1) \qquad lnw_{it} = \beta_0 + \beta_1 Age_{it} + \beta_2 Age^2{}_{it} + \beta_3 lnSize_{j(i,t)t} + \psi_{ij(i,t)} + \gamma_t + \varepsilon_{it}$$

where $\psi_{ij(i,t)} = \alpha_i + \varphi_{j(i,t)} + \xi_{ij(i,t)}$ is a job-specific effect that is further decomposed into an individual effect, α_i, an establishment effect, $\varphi_{j(i,t)}$, and an orthogonal match effect $\xi_{ij(i,t)}$, where *j(i,t)* identifies the establishment *j* where individual *i* is employed at time *t*. A job is defined as a match between an individual and an establishment. Note that even if $\xi_{ij(i,t)}$ is defined orthogonal to α_i and $\varphi_{j(i,t)}$ it can be correlated with the covariates in (1) that vary over time within a job. γ_t is a year fixed effect, and ε_{it} is an error term, assumed to be orthogonal to the other variables.

The *within employer age-earnings profile* describes the earnings profile over time for an individual who stays in the same job, conditional on the firm size, and is defined by the $\beta_1$and β_2 coefficients of equation (1). We estimate the earnings equation separately by region and educational group.

In addition to the age-earnings profile within jobs, an individual may experience earnings growth from job changes. Different jobs may involve different establishment effects, $\varphi_{j(i,t)}$, and different earnings-size premiums, $\beta_3 lnSize_{j(i,t)t}$. Establishment size may vary either within the same establishment over time, or as the individual changes establishment. We define the *establishment earnings premium* of individual i at time t as:

$$(4) \qquad \chi_{j(i,t)t} = \beta_3 lnSize_{j(i,t)\,t} + \varphi_{j(i,t)}$$

consisting of the time varying size term (defined throughout as deviation from the sample mean), and the unobserved establishment fixed effect.

We assess the importance of the establishment component of earnings growth over a worker's career by estimating, on the full panel of individuals and by gender, the auxiliary regression of the establishment specific earnings premium as a function of age and age squared:

$$(5) \qquad \chi_{j(i,t)} = b_1 Age_{it} + b_1 Age^2{}_{it} + u_{it}$$

where we allow the residual term, u_{it}, to include a fixed individual effect to account for heterogeneity across individuals in terms of establishment affiliation, for instance due to cohort effects. Equation (5) describes the average career during the observation period of our panel in terms of the establishment earnings premium of individuals over time. It represents the combined average effect of changing earnings premiums as firms grow or decline, and as workers move across establishments that differ by establishment specific earnings premiums.

For simplicity we drop the index *(i,t)* on *j* in the following, identifying the establishment of individual *i* at time *t* as establishment *j*.

3.1 Identification

Cohort effects, time effects, and age profiles within jobs

Consider the within employer earnings profiles first. We have excellent panel data where we can follow workers over time, both within and across employers, with the caveat that workers remain in a private sector firm located in one of the 26 PMSA's[16]. However, we still face the standard problem of disentangling the linear trends in age, time, and cohort effects. The identification of age, time and cohort effects in panel models with fixed individual and establishment effects is not trivial.

Our identification strategy is first to assume identical time effects for men and women within the same education group and the same locality defined by PMSA. The time effects thus represent all local variations in the supply and demand for each educational group. With this assumption, we may identify the difference between the linear part of the age effect directly from a "within job" equation, using the difference in earnings growth between men and

[16] See the data section for a brief discussion of potential problems due to attrition from movers out of the PMSA's.

women for individuals in a given job. Next, we may identify the linear seniority profile by comparing different jobs by the same individual in our panel. Finally, we use an assumption of common cohort effects by decade for men to identify the linear term in the men's age profile, to which we may add the difference between men and women estimated in stage one, to obtain the female linear age effect. Since this is a key part of our endeavor, we elaborate our modeling strategy in some detail.

Let $\gamma_t = dt + \tilde{\gamma}_t$, t = 0,..,10 be the linear projection of the time dummies on t (conveniently set to zero at the start of our panel), plus deviations from the linear trend, $\tilde{\gamma}_t$. Note that within the same job we have $\left(Age_{ijt} - \overline{Age}_{ij.}\right) = t - \overline{t_{ij.}}$, and we are thus not able to identify β_1 and *d* separately from within job variation. A strategy for identification is thus to omit the linear term for Age from equation (1) and estimate[17]:

(1') $lnw_{it} = \tilde{\beta}_0 + \beta_2 Age^2{}_{it} + \beta_3 lnSize_{jt} + \tilde{\psi}_{ji} + (\beta_1 + d)t + \tilde{\gamma}_t + \varepsilon_{it}$,

where $\tilde{\beta}_0 = \tilde{\gamma}_0 + \beta_0$,

(2) $\tilde{\psi}_{ji} = \tilde{\alpha}_i + \varphi_j + \chi_{ij}$

and

(3) $\tilde{\alpha}_i = \beta_1 Age_{i0} + c_i + c_\tau$

where c_τ and c_i represent a decomposition of the individual effect, α_i, into one effect reflecting worker *i*'s cohort and the other the worker's fixed effect within his cohort.

Different earnings profiles by gender

Allowing the parameters of the earnings equation to vary across genders, we have:

(1'') $lnw_{it} = \beta_0 + \left(\beta_1 + \beta^w{}_1 G\right) Age_{it} + \left(\beta_2 + \beta^w{}_2 G\right) Age^2{}_{it} + \left(\beta_3 + \beta^w{}_3 G\right) lnSize_{jt} + \psi^G{}_{ji} + dt + \tilde{\gamma}_t + \varepsilon_{it}$

[17] The introduction of the linear term *t* is done for expositional reasons. In practice we implement this estimation using year dummies only. This does not change the argument in any way, and the linear term of the year dummies may be recovered from the dummies.

Where G is a dummy variable taking the value 1 for women. Note that all parameters except for the time effects are allowed to vary by gender. We still have $\left(Age_{ijt} - \overline{Age}_{ij.}\right) = (t - \overline{t_{ij}})$, but since $\left(Age_{ijt} - \overline{Age}_{ij.}\right)G$ is not collinear with $t - \overline{t_{ij}}$, we are now able to identify ${\beta^w}_1$directly by adding the interaction term to the within job equation. We may thus estimate:

(1''') $$lnw_{it} = \tilde{\beta}_0 + {\beta^w}_1 G Age_{it} + \left(\beta_2 + {\beta^w}_2 G\right) Age^2{}_{it} + \left(\beta_3 + {\beta^w}_3 G\right)\ lnSize_{jt} + {\tilde{\psi}^G}_{ji} + (\beta_1 + d)t\ + \tilde{\gamma}_t + \varepsilon_{it}$$

where $\tilde{\beta}_0 = \tilde{\gamma}_0 + \beta_0$,

(2') ${\tilde{\psi}^G}_{ji} = \tilde{\alpha_\iota} + {\varphi^G}_j + \chi_{ij}$

and

(3') $\tilde{\alpha}_i = \beta_1 Age_{i0} + c_i + {c^G}_\tau$

Where Age_{i0} is age at the beginning of our panel (t=0), and where both the establishment fixed effect and the cohort effects can vary by gender. We implement this by estimating (1''') on the full sample, retrieve the job fixed effects, next estimate (2') by gender, retrieve the individual fixed effects and then estimate (3') by gender to obtain β_1 and the gender specific cohort effects.

We estimate the parameters of this model by PMSA and report average estimators over all PMSAs. We estimate all parameters separately for each education group, gender and PMSA, with the exception of the time effects that are assumed to be equal across gender within each education/PMSA cell, and establishment fixed effects that are assumed to be equal for each education group, but allowed to vary across gender (and PMSA, of course).

Seniority-earnings profiles

Consider the possibility that there is an establishment specific earnings growth, in addition to the age profile that the individual obtains from (potentially) being in the labor market for one more year. Under this assumption the age earnings profiles can be decomposed into a seniority profile and a general age-earnings profile.

Empirically, it is difficult to identify the effect of seniority on earnings, in particular because a match entailing a positive earnings premium for the worker is likely to last longer than

matches with lower pay. Access to establishment data with many workers per establishment may solve this difficulty by identifying the effect comparing workers within the same employer only (Barth 1997). With panel data we may follow workers over time, and may control for individual fixed effects as well. However, in this setting we run into the difficulty that we cannot identify separate linear terms for age, seniority or time in the within job regression. In the following we outline how we identify separate age and seniority profiles for each gender. Again, we rely on the assumption of equal time effects for men and women with the same education in the same PMSA to tease out the difference in age profiles between men and women. Next, we rely on individuals with more than one job to identify the seniority profiles separately from the age profiles. In order to simplify the exposition, we ignore all variables that vary independently within each job, such as age squared and firm size. Consider the within job earnings equation:

$$(6) \qquad lnw_{it} = \beta_0 + (\beta_1 + \beta^w{}_1 G) Age_{it} + (\beta_2 + \beta^w{}_2 G) S_{ijt} + dt + \psi^G{}_{ji} + e_{it}$$

Where S is the number of years in current establishment. This time we have $(Age_{ijt} - \overline{Age}_{ij.}) = (S_{ijt} - \bar{S}_{ij.}) = (t - \overline{t_{ij}})$, and $(Age_{it} - \overline{Age}_{i.})G = (S_{ijt} - \bar{S}_{ij.})G$ as well. We may rewrite (6) in the following way:

$$(6') \; lnw_{it} = \beta_0 + (\beta_1 + \beta_2 + d)t + (\beta^w{}_1 + \beta^w{}_2) G Age_{it} + \beta_1 Age_{i0} + \beta_2 S_{i0} + \psi^G{}_{ji} + e_{it}$$

From which it is clear that we can identify $(\beta_1 + \beta_2 + d)$ and $(\beta^w{}_1 + \beta^w{}_2)$ only from the within job equation. Age_{i0} and S_{i0} are fixed characteristics of the job that are subsumed into the job fixed effect. Since we have individuals with more than one job, we may obtain β_2 and $\beta^w{}_2$ from estimating the gender specific equations

$$(7) \qquad \tilde{\psi}^G{}_{ji} = \tilde{\alpha}_i + \beta^G{}_2 S_{i0} + \varphi^G{}_j + \chi_{ij}$$

and β_1 from the remaining individual fixed effect

$$(8) \qquad \tilde{\alpha}_i = \beta_1 Age_{i0} + c_i + c^G{}_\tau$$

A complication is added since we only observe seniority from the beginning of our panel. This means that the Age_0 variable captures the effect of seniority at the beginning of the panel as well. We make a correction for this by estimating for each gender-education group how much seniority grows by age using survey data (CPS March 2000) containing information on seniority (job

tenure), and calculate β_1 from the equation $\hat{b}_1 = (\beta_1 + \widehat{\beta_2}\hat{\tau})$, where b is coefficient for Age_0 in (8), and τ is the coefficient for age in a regression of seniority on age from the survey[18].

We implement the identification strategy by estimating (6') on the full sample, where $\beta_1 Age_{i0} + \beta_2 S_{i0}$ is subsumed in the fixed job effects, retrieve the job fixed effects, and estimate (7) by gender to obtain β_2, retrieve the individual fixed effects and estimate (8) for males by education to obtain β_1 and the cohort effects as laid out above. The linear part of the age profile for women is then given by $(\beta_1 + \beta^w{}_1)$.

4. Results

I) A large part of the increasing earnings gap occurs within establishments

Figure 2 shows the predicted age-earnings profiles obtained from separate regressions with fixed individual and establishment effects as outlined above. The models include year effects as well. The figure illustrates the evolution of earnings over time for the same individual, keeping the contribution from the establishment component unchanged, relative to a 25 years old person of the same gender and educational group. Note that, given the large sample size, all coefficients are estimated very precisely. This is why we don't report standard errors in the figures and tables (see data section for details).

Again we find a much steeper profile for college-educated workers, in particular for men. An average college educated man improves his earnings by 57 log points going from age 25 to age 45, while a college educated woman improves her earnings only by 27 log points. The first takeaway of our analysis is thus that for college-educated workers, a considerable part of the growth in the gender earnings gap occurs within establishments.

For workers without a college degree, however, the within establishment earnings gap increases over the first 10 years but then narrows considerably over time as the earnings profile for men flattens out. By age 45 women without a college degree more than catch up to similarly

[18] The coefficient τ is estimated to be 0.31, 0.34, 0.41 and 0.41 for no-college women, college women, no-college men, and college men respectively. We use the CPS Job Tenure data for the March 2000 CPS supplement provided by the CEPR (http://ceprdata.org/cps-uniform-data-extracts/cps-job-tenure/cps-job-tenure-data/) and estimate the model for workers between 25 and 45 years of age.

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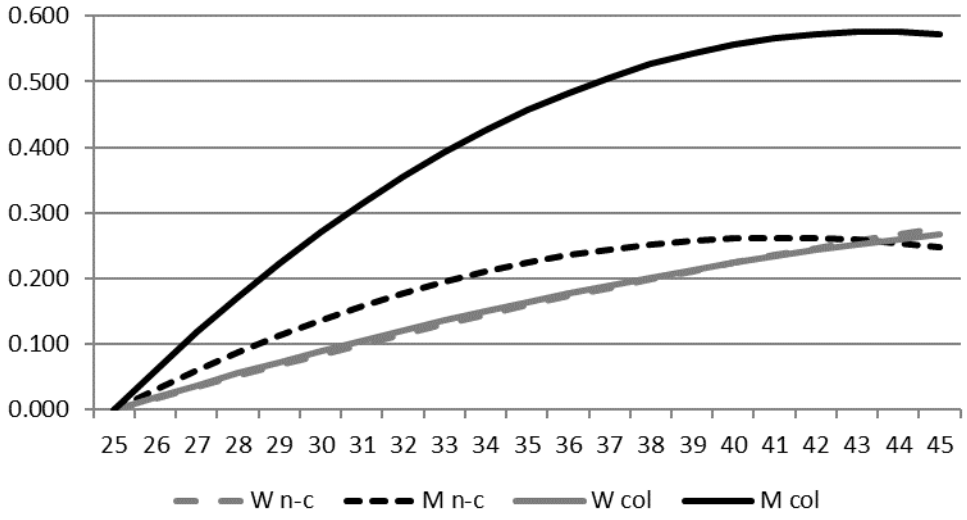
educated men. Their earnings grow by 28 log points over the 20 years period, while men's earnings increase only by 25 log points.

Figure 2 Within Establishment Earnings Profiles



Note: Predicted values from separate regressions by education (equation (1''')). The model also includes individual and establishment fixed effects and ln(establishment size) with gender interactions, see Section 3 for details. Average profiles calculated on the matched sample from 26 of the 50 largest PMSAs located in LEHD states.

Table 1 quantifies the change in the gender earnings gap within establishments for different age intervals. Among the non-college educated, we find that men have faster earnings growth within establishments until the age of 35, but women catch up in terms of earnings growth after that. By age 45 their accumulated earnings growth is 3 log points higher than men's. Among the college educated, men have faster earnings growth up to age 40, followed by some catching up by women between ages 40 and 45 as the male earnings profile flattens out. However, by age 45 college educated men have a 30 log points advantage in accumulated earnings growth relative to women in the same education group.

Table 1. Change in the within establishment gender pay gap by education and age intervals

Change in gender gap by age intervals	No college	College
25-30	0.052	0.181
30-35	0.013	0.111
35-40	-0.028	0.041
45-40	-0.067	-0.029
25-45	-0.030	0.304

Notes: Calculated from predicted values from separate regressions of ln earnings by education, see Figure 2.

II) Seniority and age profiles

Next we decompose the within establishment earnings growth into the component that is purely due to seniority within a firm, i.e. the part of earnings growth that is lost when a person changes jobs, and the component of within establishment earnings growth that is retained also when changing jobs. Table 2 displays the estimated returns to seniority, measured as the relative earnings gain from one year of additional tenure within the same establishment. We find that men have a higher return to seniority than women, particularly among the college educated.

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Table 2 Returns to seniority by gender and education

No college			College		
Women	Men	Difference	Women	Men	Difference
0.0139	0.0172	0.0033	0.0112	0.0213	0.0100

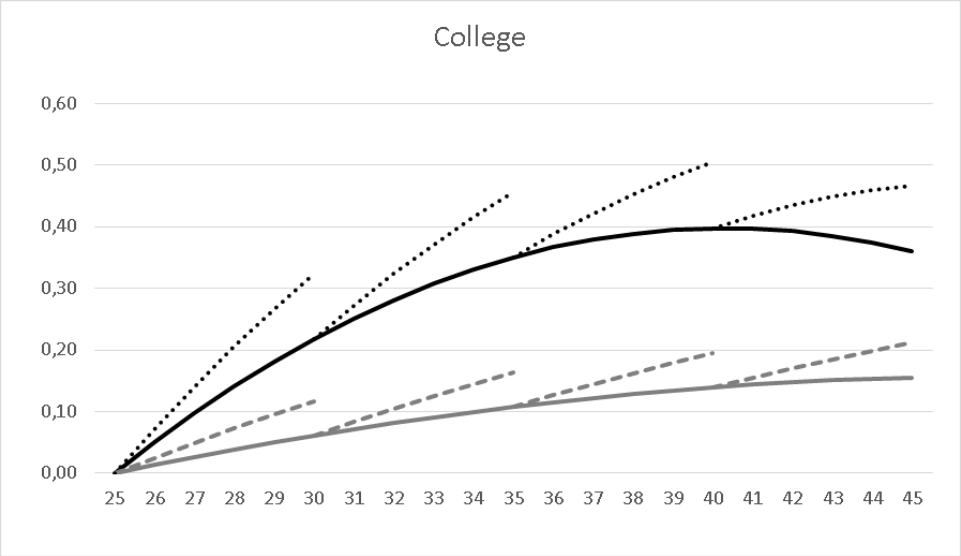
Note: Estimated coefficient for years of seniority in the full model specification estimated from job-effect equations (equation (7)).

The remaining part of the within establishment earnings growth by age, that is retained when changing jobs, is found by subtracting the average contribution from the return to seniority, calculated using average seniority by age, education and gender[19], from the overall within-establishment earnings profile as displayed in Figure 2. Conditional on seniority and the establishment fixed effect, the age profile measures the improvement in the relative earnings within the establishment that a person retains even when changing jobs. An example of a positive

[19] See the methodology section for details.

within-establishment earnings change would be a person low in the earnings hierarchy of one establishment who changes jobs to a position higher up in the earnings hierarchy of another establishment. Figure 3 illustrates how the within establishment seniority and age profiles interact for a person who changes job every fifth year, using college educated men and women as an example.

Figure 3. Log earnings by seniority and age. College educated workers.



Note: Calculated within establishment earnings profiles for men and women with a college degree who changes jobs every 5 years. Black: Men, Grey: Women. Solid lines show predicted age-earnings profiles, conditional on seniority, and dotted lines show the additional returns obtained in each new job. Average profiles calculated on the matched sample from the largest 26 PMSA's in the US.

Both the seniority and age profiles contribute to the widening of the within establishment earnings gap over time, particularly for the college educated workers. In table 3 we show the contribution to the development of the gender earnings gap over time from the within establishment age and seniority profiles separately. In the calculation we use an average development of seniority by age from each group separately[20]. The seniority wage contribution is constant over time as the returns to seniority only has a linear term, whereas the age term is allowed to change over time. Differential returns to seniority by gender contributes twice as

[20] See footnote 18 for details.

much to the widening of the pay gap among college educated as to the widening of the pay gap among non-college educated.

In the beginning of the career, the age profile is steeper for men than for women, and dominates as a source of increasing pay gap, particularly for the college educated workers. This means that men, in addition to having steeper earnings growth within establishments, also gain more in terms of relative earnings within establishments when they change jobs. As people age, the age profile in particular for men, dips to negative, and contributes to a narrowing of the gender earnings pay gap.

Table 3 Change in the within establishment gender pay gap by age interval. Contributions from seniority and age. By gender and education

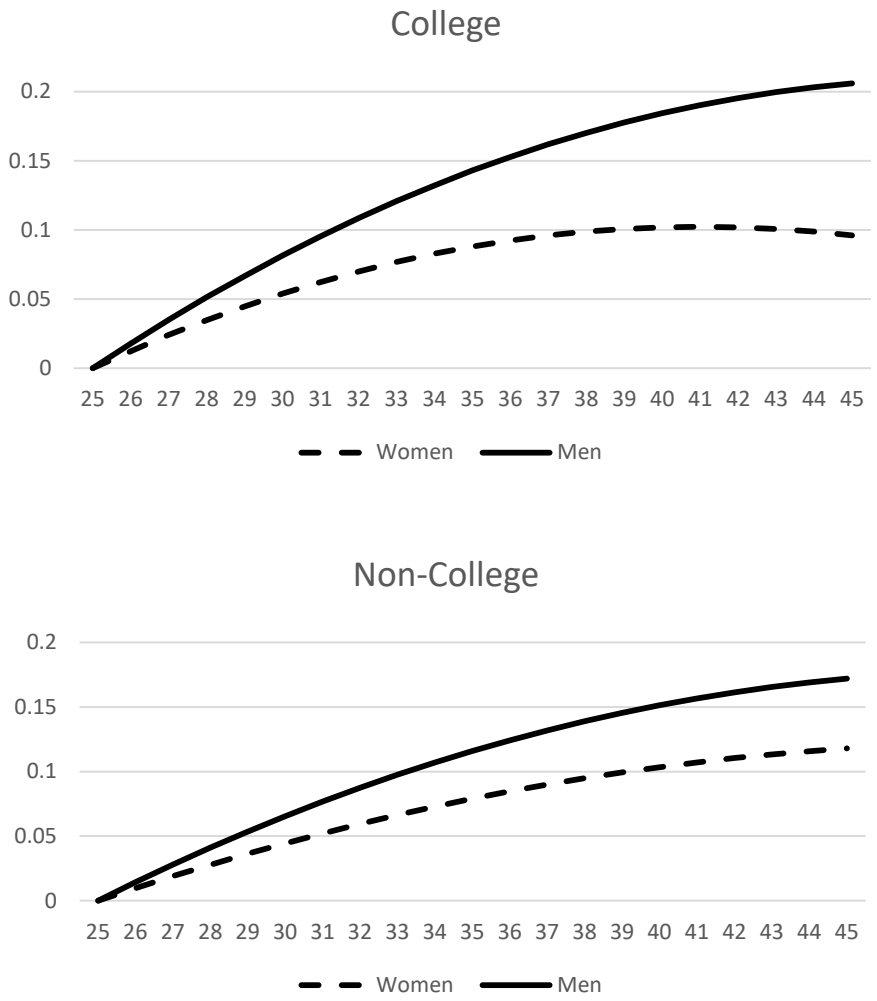
	No college		College	
	Age	Seniority	Age	Seniority
25-30	0.038	0.014	0.156	0.025
30-35	-0.002	0.014	0.086	0.025
35-40	-0.042	0.014	0.016	0.025
45-40	-0.082	0.014	-0.054	0.025
25-40	-0.086	0.056	0.205	0.099

Note: Change in gender earnings gap due to different returns to seniority and age within establishments. Calculated from equation (1’’’) and (6).

III) The gap between establishments increases with age

We label the sum of the coefficient of the fixed establishment effect and the component of earnings that is attributable to firm size, the “earnings premium” of the establishment. The earnings premium measures how much more (or less) the employer pays an individual worker over and above the average establishment in the economy. The widening of the gap in the establishment premium as individuals age represents a key finding in this paper: it shows the differential contribution for men and women coming from job-to-job changes during their prime working age years. Figure 4 shows the development of the establishment earnings premium over time, compared to a person of 25 years of age with the same gender and education.

Figure 4 Predicted Establishment Earnings Premium



Notes: Predicted establishment earnings premium – age profiles relative to a 25 years old with the same education and gender. Predicted values from separate regressions for each gender and educational level (equation 5 – model with seniority). The establishment earnings premium includes the fixed establishment effect and the earnings premium due to firm size. The model also includes individual fixed effects, see methods section for details on the estimation method. Average profiles calculated on the matched sample from the largest 26 PMSA's in the US.

We find a rising age-earnings profile across establishments for both college and non-college workers. An average college educated man gains 21 log points from age 25 to 45 in terms of the establishment earnings component, while a college educated women on average gains 10 log

points. Non-college men experience a growth of 17 log points, whereas the number for women is 12 log points.

Table 4 Change in the between-establishment gender earnings gap by age and education

	No College	College
25-30	0.021	0.028
30-35	0.016	0.027
35-40	0.011	0.028
45-40	0.006	0.027
25-45	0.054	0.110

Notes: Calculated from predicted values from separate regressions of ln earnings by education, see Figure 4.

Table 4 shows the contribution to the widening gender earnings gap that comes from the shifting distribution of pay across establishments. For non-college educated workers, the establishment contribution is largest in the beginning, suggesting that men disproportionately move into higher paying establishments early in their career. For college educated workers, the difference is larger and more evenly spread across age intervals. The gender gap in the average establishment earnings premium increases by 5 log points going from age 25 to age 45 for non-college workers and 11 log points for college workers.

Next we quantify the contribution of between- and within-establishment component to the widening of the gender gap. Table 5 reports the total change in the gender earnings gap by age (column 1 and 3) and the share attributable to the between-establishment component (column 2 and 4). Among workers without a college degree, the total earnings gap widens from age 25 to 30, and from age 30 to age 35. The share arising from an increasing between-establishment wage premium is 28 and 57 percent, respectively. For college workers, the total gender earnings gap increases in all age intervals up to 40 years of age. The share of between establishment contribution increases from 13 percent during the first 5 years to 41 percent between age 35 and 40.

Up to the age 40, about 56 percent of the accumulated gender gap in earnings growth for non-college educated workers, and about 20 percent of the accumulated gender gap for the

college-educated is due to differential growth in the establishment component of pay. The remaining parts are due to differential earnings growth within establishments.

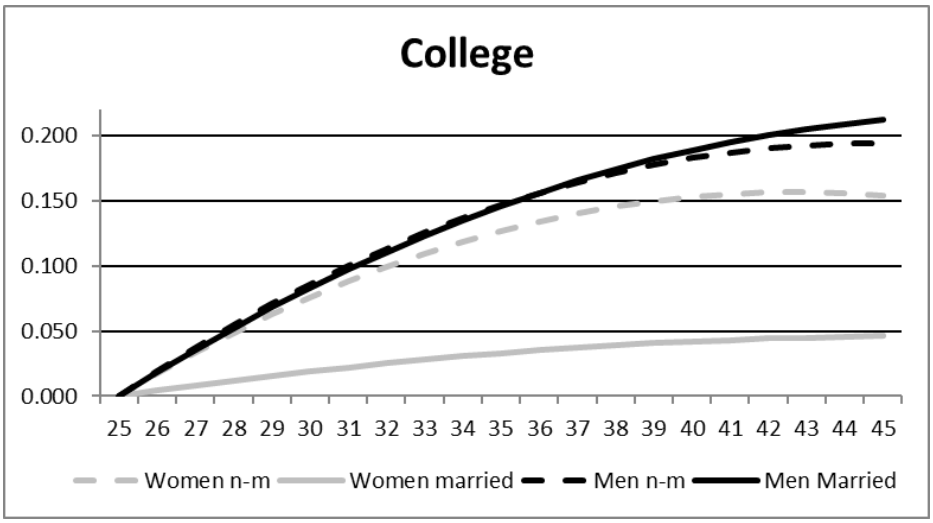
Table 5 Share of growth in pay gap due to establishment earnings premium by age interval

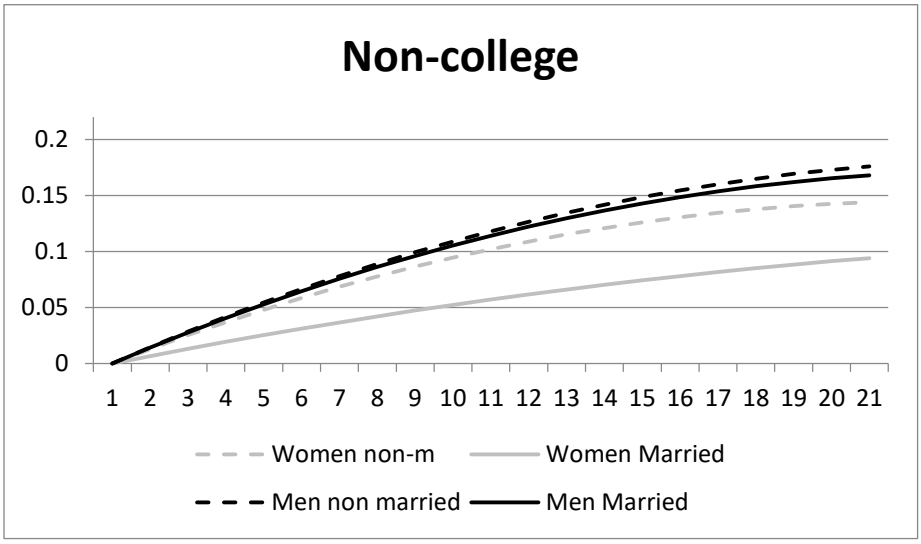
	Non-college		College	
Age interval:	Total change	% Between	Total change	% Between
25-30	0.074	28 %	0.209	13 %
30-35	0.028	57 %	0.138	20 %
35-40	-0.016		0.069	41 %
45-40	-0.062		-0.002	.
25-45	0.024	225%	0.414	27 %

Notes: The change in the gender gap is obtained as the sum of the age/education specific entries from tables 1 and 4. % between is obtained as the ratio of the between-establishment component (in table 4) to the total.

We further investigate the role of marital status in explaining the widening of the gender earnings gap arising from earnings differentials across establishments. Figure 5 displays the predicted establishment earnings premium by age for married and never married (as of 2000) men and women. Interestingly, although not surprisingly, the bulk of the increase in the establishment earnings gap over the life cycle is driven by the behavior of married men and women. Consider college educated workers first. The earnings path for married and non-married men is very similar, but so is also the earnings path of non-married women. The difference in the growth of the establishment component of pay seems to be entirely driven by the lower growth among married women. For non-college workers, the pattern is similar, but less pronounced. Again, the dominant part of the difference between men and women arises from lower growth among married women.

Figure 5. Changes in predicted establishment earnings premiums by age, gender, education and marital status





Notes: Predicted values from separate regressions for each gender and educational level. Dependent variable: Establishment earnings premium. Average profiles calculated on the matched sample from the largest 26 PMSA's in the US, see data section for details.

5. Discussion and Conclusions

The gender earnings gap widens considerably during the first two decades of working life. This widening is much stronger among college-educated workers than among workers without a college degree. Controlling for cohort effects, the earnings growth (from age 25 to 45) of men with a college is 41 log points higher than that of college women. In comparison, the difference between the earnings growth of men and women without a college degree is minimal, only 2.4 log points over the 20 years. In order to assess the extent to which this widening is associated

with the organization of firms and advancements in job ladders within firms, or with different earnings distributions and job-to-job mobility patterns across establishments, we decomposed it into a *within*- and a *between-establishment component.*

Over time, an individual may improve his or her position *within* establishment by climbing the corporate ladder. When changing employer, this improvement may be transferred over to the new employer or even enhanced, or it may be lost as in a game of chutes and ladders. The seniority profile signifies the earnings growth within a job that is lost when changing employer, while the within establishment age profile, conditional on seniority, signifies the within establishment earnings growth that is maintained even when changing employer. In terms of earnings growth within establishments, college educated men stand out with a significantly higher earnings growth than all the other groups. Relative to women, men have both steeper seniority profiles, on average longer seniority, and experience a steeper age-earnings profile within establishments, conditional on seniority. Men's within establishment advantage is particularly large during the early career; after 10 years the earnings gap has widened by 29 log points. From 40 to 45 women catch up some of the advantage, amounting to 5.4 log points.

The allocation of workers *between* establishments and its change over time also adds significantly to the widening of the gender earnings gap, especially for the college educated. Men climb the establishment ladder faster than women. From 25 to 45 years of age, the establishment earnings component grows by 21 log points among college educated men, and by 10 log points for college educated women. This part of the increase of the gender earnings gap is entirely different from the within establishment component. While the within establishment component originates from the combination of the management determined job structure and workers competition to climb the ladder, the between establishment component originates from the combination of options that arise in the marketplace and workers job mobility patterns. The gender difference in the growth of the establishment component arises from two sources: Differences in the probability of job-to-job transitions, and differences in the earnings gain associated with such job changes. A voluntary job move is likely to be associated with earnings gains, whereas involuntary or "tied" moves are more likely to be associated with an earnings loss. What we have accounted for in this paper is the combined result of such differences.

We find that almost all the difference in the growth of the establishment component of pay across genders is due to differences by marital status. Whereas the difference between men and women in the growth of the establishment component is small among non-married employees, there is a large widening of the gender gap for the married. This pattern is particularly strong among college educated workers: At 45 years of age, a married college educated man has gained more than 20 log points of earnings, whereas a married college educated woman gains on average less than 5 log points. These results suggest that among married couples, the household division of labor tend to limit women's career choices with respect to job-to-job changes and this is an important determinant of the widening of the gender earnings gap, especially for college educated women who are more likely to be in occupations with steep age-earnings profiles. Evidence based on the publicly available 2000 Census (not reported) suggests that this is linked to the arrival of children, which is especially costly for couples where both partners are college educated. Our linked employer employee data allow further exploration and (potentially) identification of the underlying mechanisms because unlike, other linked data, we know (as of 2000) who is married to whom, demographic characteristics of both spouses and presence and age of children. Because of limitations in data access we are currently unable to investigate this further, but plan to do that in future work.

References

Abowd, John, Francis Kramarz, and David Margolis (1999) “High Earnings Workers and High Earnings Firms” *Econometrica* 67(2): 251-333.

Abowd, John M., Bryce E. Stephens & Lars Vilhuber & Fredrik Andersson & Kevin L. McKinney & Marc Roemer & Simon Woodcock, (2002). "The LEHD Infrastructure Files and the Creation of the Quarterly Workforce Indicators," Longitudinal Employer-Household Dynamics Technical Papers 2002-05, Center for Economic Studies, U.S. Census Bureau

Abowd, John M., Robert H. Creecy, and Francis Kramarz (2002) "Computing Person and Firm Effects Using Linked Longitudinal Employer-Employee Data," Longitudinal Employer-Household Dynamics Technical Papers 2002-06, Center for Economic Studies, U.S. Census Bureau.

Albanesi, Stefania and Claudia Olivetti, (2009) “Home Production, Market Production and the Gender Earnings Gap: Incentives and Expectations,” *Review of Economic Dynamics*, vol. 12(1), 80-107, January.

Altonji, Joseph and Rebecca Blank. 1999. “Race and Gender in the Labor Market.” In Orley Ashenfelter and David Card (editors), *Handbook of Labor Economics* Vol. IIIc. Amsterdam: Elsevier, pp. 3143-3259.

Amuedo-Dorantes, Catalina, and Sara De la Rica. "The role of segregation and pay structure on the gender wage gap: evidence from matched employer-employee data for Spain." The *BE Journal of Economic Analysis & Policy* 5.1 (2006).

Bayard, Kimberley, Judith Hellerstein, David Neumark, and Kenneth Troske, (2003) "New Evidence on Sex Segregation and Sex Differences in Wages from Matched Employee-Employer Data," *Journal of Labor Economics* vol. 21(4), pages 887-922, October.

Barth, Erling, Alex Bryson, James C. Davis, and Richard B. Freeman (2016) “It's Where You Work: Increases in Earnings Dispersion across Establishments and Individuals in the U.S.”, *Journal of Labor Economics* 34 (S2, Part 2): 67-97.

Barth, Erling and Arne Mastekaasa (1996) “Decomposing the Male/Female Earnings Gap: Within and Between Establishment Differences”. *Labour*, 10: 339–356. doi: 10.1111/j.1467-9914.1996.tb00088

Barth, Erling and Harald Dale-Olsen (2009) “Monopsonistic Discrimination, Worker Turnover and the Gender Wage Gap*” Labour Economics* 16:589-597

Barth, Erling, Bernt Bratsberg and Oddbjørn Raaum, (2012) "Immigrant earnings profiles within and between establishments," *Labour Economics*, Elsevier, vol. 19(4), pages 541-556.

Bayard, Kimberly, Judith Hellerstein, David Neumark and Kenneth Troske, (2003) "New Evidence on Sex Segregation and Sex Differences in Earningss from Matched Employee-Employer Data," *Journal of Labor Economics*, vol. 21(4), pages 887-922, October.

Becker, Gary S. (1975) *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education",* Second Edition NBER Books, National Bureau of Economic Research, Inc.

Black, Dan A. (1995) "Discrimination in an Equilibrium Search Model" *Journal of Labor Economics* Vol 13, pp 309–34.

Blau, Francine D. and Lawrence M. Kahn (1981). "Race and sex differences in quits by young workers," *Industrial and Labor Relations Review, ILR Review*, Cornell University, ILR School, vol. 34(4), pages 563-577, July.

Blau, Francine D. and Lawrence M. Kahn (2000). Gender Differences in Pay. *Journal of Economic Perspectives* 14(4): 75-99.

Blau, Francine D., and Lawrence M. Kahn (2006). "The U.S. Gender Pay Gap in the 1990s: Slowing Convergence." *Industrial and Labor Relations Review* 60 (1): 45–66.

Blau, Francine D. and Jed DeVaro. "New Evidence on Gender Differences in Promotion Rates: An Empirical Analysis of a Sample of New Hires." *Industrial Relations* (July 2007).

Blau F. and L. Kahn (2016) "The Gender Wage Gap: Extent, Trends, and Sources," *Journal of Economic Literature* (forthcoming). Available as NBER WP 21913.

Booth, Alison L., Marco Francesconi, and Jeff Frank. 2003. "A Sticky Floors Model of Promotion, Pay, and Gender." *European Economic Review,* 47:295-322.

Bowlus, Audra J. (1997). "A Search Interpretation of Male-Female Earnings Differentials," *Journal of Labor Economics*, vol. 15(4) (October): 625-657.

Bowlus, Audra J. and Zvi Eckstein (2002) "Discrimination and Skill Differences in an Equilibrium Search Model," *International Economic Review*, vol. 43(4), pp 1309-1345.

Bosworth, Barry, Gary Burtless and C. Eugene Steuerle (1999) "Lifetime earnings patterns, the distribution of future social security benefits, and the impact of pension reform" CRR WP 1999-06. Boston College.

Card, David, Ana Rute Cardoso and Patrick Kline (2016). “Bargaining, Sorting, and the Gender Wage Gap: Quantifying the Impact of Firms on the Relative Pay of Women.” *Quarterly Journal of Economics* 131 (2): 633-86.

Card, David , Jörg Heining and Patrick Kline (2013), "Workplace Heterogeneity and the Rise of West German Wage Inequality," *The Quarterly Journal of Economics*, Oxford University Press, vol. 128(3), pages 967-1015.

Datta Gupta, Nabanita and Donna S. Rothstein, (2005) "The Impact of Worker and Establishment-level Characteristics on Male-Female Wage Differentials: Evidence from Danish Matched Employee-Employer Data," *LABOUR*, CEIS, vol. 19(1), pages 1-34, 03.

Del Bono, Emilia, and Daniela Vuri. "Job mobility and the gender wage gap in Italy." Labour Economics 18.1 (2011): 130-142.

Félix, Sónia and Portugal, Pedro (2016), "Labor Market Imperfections and the Firm's Wage Setting Policy," IZA Discussion Papers 10241, Institute for the Study of Labor (IZA).

Flabbi, Luca, (2010) "Gender Discrimination Estimation In A Search Model With Matching And Bargaining," *International Economic Review*, vol. 51(3), pages 745-783, 08.

Francois, Patrick (1998). Gender Discrimination without Gender Difference: Theory and Policy Responses. *Journal of Public Economics*, Vol. 68, No.1, 1-32.

Francois, Patrick and Jan van Ours (2000). Gender Earnings Differentials in a Competitive Labor Market: The Household Interaction Effect. IZA Discussion Papers 202, Institute for the Study of Labor (IZA).

Goldin, Claudia (2014). “A Grand Convergence: Its Last Chapter,” *American Economic Review*, 104(4): 1–30.

Goldin, Claudia, Sari Kerr, Claudia Olivetti and Erling Barth (2017) “The Expanding Gender Earnings Gap: Evidence from the LEHD-2000 Census,” Forthcoming in American Economic Review P&P (May).

Green, Francis, Stephen, Machin and Alan Manning, (1996) “The Employer Size-Earnings Effect: Can Dynamic Monopsony Provide an Explanation?” *Oxford Economic Papers*, Oxford University Press, vol. 48(3), pages 433-55, July.

Groshen, Erica L. (1988). "Why do earningss vary among employers?" *Economic Review*, Federal Reserve Bank of Cleveland, issue Q I, pages 19-38.

Heinze, Anja and Wolf, Elke, (2010), The intra-firm gender wage gap: a new view on wage differentials based on linked employer–employee data, *Journal of Population Economics*, 23, issue 3, p. 851-879.

Hirsch, Boris, and Claus Schnabel. "Women move differently: Job separations and gender." *Journal of Labor Research* 33.4 (2012): 417-442.

Hyatt, Henry, Erika McEntarfer, Kevin McKinney, Stephen Tibbets, Doug Walton, (2014) "JOB-TO-JOB (J2J) Flows: New Labor Market Statistics From Linked Employer-Employee Data," Working Papers 14-34, Center for Economic Studies, U.S. Census Bureau.

Korkeamäki, Ossi, and Tomi Kyyrä. "A gender wage gap decomposition for matched employer–employee data." *Labour Economics* 13.5 (2006): 611-638.

Lazear, Edward P, (1981) "Agency, Earnings Profiles, Productivity, and Hours Restrictions," *American Economic Review*, American Economic Association, vol. 71(4), pages 606-620.

Lazear, Edward P. and Sherwin Rosen (1990). "Male-Female Earnings Differentials in Job Ladders," *Journal of Labor Economics* 8:1, Part 2: Essays in Honor of Albert Rees. (January): S106-S123.

Light, Audrey and Manuelita Ureta (1995) "Early-Career Work Experience and Gender Earnings Differentials," *Journal of Labor Economics* 13 (January): 121-54

Light, Audrey and Manuelita Ureta (1990) "Gender Differences in Earningss and Job Turnover Among Continuously Employed Workers" *American Economic Review* 80 (May 1990): 293-97.

Loprest, Pamela J, (1992), "Gender Differences in Wage Growth and Job Mobility", *American Economic Review*, 82, issue 2, p. 526-32.

Manning, Alan. 2003. *Monopsony in Motion*. Princeton: Princeton University Press.

Manning, Alan, and Joanna Swaffield (2008). "The Gender Gap in Early-Career Earnings Growth." *Economic Journal* 118 **(**530**)**: 983–1024.
McCue, Kristin, (1996) "Promotions and Wage Growth," *Journal of Labor Economics*, vol. 14(2), pages 175-209.

Meng, Xin. "Gender Earnings Gap: the Role of Firm Specific Effects." *Labour Economics* 11 (2004): 555-573.

Royalty, Anne Beeson, (1998) "Job-to-Job and Job-to-Nonemployment Turnover by Gender and Education Level," *Journal of Labor Economics*, vol. 16(2), pages 392-443.

Simón, Hipólito. "The gender gap in earnings: an international comparison with European matched employer–employee data." *Applied Economics* 44.15 (2012): 1985-1999.

Song, Jae, David J. Price, Fatih Guvenen, Nicholas Bloom, and Till von Wachter. 2015. "Firming Up Inequality" NBER Working Papers 21199, National Bureau of Economic Research, Inc.