

# The Lifecycle Wage Growth of Men and Women: Explaining Gender Differences in Wage Trajectories

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## Abstract

Why do women’s wages grow more slowly than men’s? Theory indicates that wages grow both as workers progress up an internal “career ladder,” and as they switch firms and move up the “job ladder” to higher-paying firms. In this paper, we use employer-employee linked data from Sweden to decompose cumulative wage growth of men and women at each age into wage gains associated with (1) firm changes, (2) large discrete wage gains relative to one’s co-workers – which we call promotions – and (3) interim (non-promotion) growth. While women switch firms at almost identical rates as men over the lifecycle, they have substantially lower promotion rates at all ages, even controlling for firm, major, and occupation. Though relatively rare, promotions are the largest driver of wage growth by 45 for both men and women. Gender differences in promotion-related growth account for around 73 to 83% of the differences in lifecycle wage growth of college-educated men and women from ages 25 to 45. Differences in wage growth associated with firm changes account for 28%, while interim, non-promotion growth is slightly higher for women. Gender differences in sorting across firms with steeper vs. flatter wage structures explain only about 10% of differences in promotion probability. Lastly, we study hours worked and the evolution of the promotion gap with time to first birth. We use our findings to explain why childbirth penalties for women are so large, immediate and persistent; why gender wage differentials vary across professions; and what contributes to gender differences in estimated firm wage premiums.

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# 1 Introduction

Men and women have significantly different lifecycle labor market outcomes, as a sizable literature has documented (e.g., Bertrand et al. (2010), Goldin (2014), Adda et al. (2017)). While college-educated men and women start out with similar wages, by age 45 women’s wages are about 30% lower than men’s (Figure 1). This is true not only in countries such as the U.S., where job interruptions and the associated wage penalties for women are common (Bronson (2015)), but also in countries like Sweden, where generous parental leave and job protections provide job continuity and encourage almost universal employment among college-educated women.

While a number of studies have shown that the dynamic effects of childbirth are an important explanation for these lifecycle patterns, the underlying mechanisms behind these dynamic effects are still not well understood.<sup>1</sup> For example, do women experience lower wage growth because they switch to lower-paying firms?<sup>2</sup> Do they become part-time workers with low or flat earnings at otherwise high-paying firms? Or alternatively, do women and men with similar qualifications and hours worked systematically experience different upward trajectories – including probability of promotion – even when they work at the same firm? Quantitatively, how much do these explanations matter? In this paper, we seek to answer these questions.

Questions about men’s and women’s within- and across-firm movements require data connecting men and women with their firms and co-workers; covering a large portion of the lifecycle; and, additionally, providing relevant demographic information, such as detailed educational background and, ideally, the number and timing of births. As a result, we lack detailed evidence describing such moves, and the associated wage changes. By linking several Swedish administrative registers that incorporate all of these features, we help fill this gap in the literature. Sweden also provides a useful setting for our study. College-educated Swedish men and women, our population of interest, have virtually identical labor force participation rates of 95% and 96%, respectively, reducing concerns about sample selection or changes in composition of workers with time, common in lifecycle analyses.

We begin our study of wage dynamics by characterizing the patterns of men’s and women’s lifecycle wage *growth*. This is an obvious approach for analyzing lifecycle wage trajectories, but surprisingly one that has not been frequently employed in the literature. First, we document that for the cohort we follow (born 1960 to 1970), women’s lower wage levels by age 45 are not driven by cumulative effects of marginally lower wage growth relative to men over many years, but rather by women’s lower

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<sup>1</sup>See, for example, Waldfogel (1998), Lundberg and Rose (2000), Bertrand et al. (2010), Goldin (2014), Angelov et al. (2016), Adda et al. (2017), and Kleven et al. (2017).

<sup>2</sup>Gender segregation across firms has been documented in several studies. See Hellerstein et al. (2008), Card et al. (2016), Albrecht et al. (2017), and Barth et al. (2017).

likelihood of realizing a year of very high real wage growth, e.g. of 15% or more. Theory indicates that such large wage increases are likely associated either with moves up the “job ladder” as workers switch to higher-paying firms; or with promotions, as individuals progress up an internal “career ladder.”<sup>3</sup> To investigate this feature of the data further, we decompose lifecycle real wage growth into three components which we define as follows: (1) growth related to wage gains in the year that an individual switches firms; (2) growth related to what we call internal “promotions,” i.e. instances of large (e.g., 10% or higher) wage gains relative to mean or median annual wage growth of one’s co-workers; and, (3) internal wage growth in the periods when a promotion does not occur.

This classification, which compares men’s and women’s wage growth with that of their co-workers’, is an innovation made possible by the employer-employee linked nature of our data. Its benefit is twofold. First, it identifies instances of large upward movements of individuals within a firm. Indeed, “promotions” as defined above on average move workers 17 percentiles higher in the firm’s wage distribution. Second, it distinguishes naturally between periods of typically low real wage growth, often less than two percent annually, and periods in which individuals see substantial increases in their wages. We emphasize that we use “promotions” as a short-hand to signify large, discrete wage jumps relative one’s educated co-workers at the same firm. Our classification does not require that a promotion be associated with a change in job assignment. However, in the final part of the paper we provide evidence that changes in job assignment are a prominent feature of the large discrete wage jumps relative to one’s co-workers that we observe in the data.

Our decomposition indicates that promotions, as defined above, typically occur only two or three times over the lifecycle. However, they account for the largest share of wage growth between ages 25 and 45 for both men and women, around 40-45%. Second, we show that differences in the probability of promotion account for nearly 80% of the lifecycle wage differences between men and women in our cohort. In fact, missing just one promotion over the lifecycle implies an average wage loss of around 19%. While women’s lower rates of promotion should not be surprising, the central role of this factor in explaining differences in men’s and women’s wage trajectories, is to the best of our knowledge, new.

Next, we study whether the gender difference in probability of promotion is driven by differences in the types of firms at which men and women work. In particular, are women more likely to work at firms with fewer opportunities for promotion? Or,

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<sup>3</sup>See the classic paper on search and job ladders by Burdett (1978), and the review by Rogerson, Shimer, and Wright (2005). For a review of theory and evidence on career ladders and internal advancement, see Gibbons and Waldman (1999). Of course, some large internal wage increases or promotions may associated with matches to outside offer arrivals, as in Burdett and Mortensen (1998).

alternatively, do women get promoted less than men even at firms with identical opportunities for upward movement? We show that while women are more likely to work at flatter firms, quantitatively the second factor – differences in promotion rates within the same firm, rather than across firms – is far more important, accounting for 75-90% of the gender differences in promotion probability. This is true even when controlling for specific educational background, such as years of college and choice of major, occupation, and years of experience.

Third, we examine how hours worked and incidence of childbirth affect promotion probability of men and women. We first show that gender differences in part-time work play a relatively limited role, as women have a lower promotion probability than men at all hours worked. Next, we study promotion dynamics for men and women by time relative to first birth. The largest disparities in promotion probability occur in the year of and immediately following childbirth, when women in Sweden are most likely to be on parental leave. About 29% of the gender promotion gap is associated with “missed promotions” in the year of and following childbirth. We find no evidence that women who continue to work full-time on average “make up” for the promotions missed in the parental leave years. This finding provides the clearest explanation yet for why wage penalties incurred by women at the time of first birth are so immediate, large, and surprisingly persistent (e.g., Kleven et al. (2017)).<sup>4</sup>

Next, we quantify that women’s higher rate of part-time work after childbirth explains another 21% of the gender promotion gap. Finally, we provide evidence that women’s promotion probability is already substantially lower prior to first birth, and is lower also for women who never have children. In fact, our findings indicate that just under 50% of the gender gap in promotion probability is attributable directly to what the literature identifies as the effect of motherhood (e.g., Kleven et al. (2017) and Angelov et al. (2016)), while the remainder is a penalty that appears to be associated only with being a woman. We discuss the policy implications of these findings, which raise questions about trade-offs relating to generous family friendly policies.

We conclude by using our framework to interpret the findings of Card et al. (2016), who in a recent paper document that the firm fixed effects implied by an AKM (Abowd, Kramarz, and Margolis (1999)) model are lower for women than they are for men. We estimate the same AKM model on our data and show that this gender difference is strongly associated with gender differences in promotion rates at firms. Lastly, we note an implication of our findings for studies of gender wage gaps across occupations: in professions where promotions constitute an important source lifecycle wage growth, one should observe higher overall gender wage gaps. Using field of study as a proxy for profession, we show that this is precisely what we observe in the data. Indeed,

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<sup>4</sup>Note that unlike wage penalties, earnings penalties associated with childbirth are relatively easier to explain, since they are mechanically driven down by reductions in hours worked.

promotions are likely to be one common source of non-linearities between wages and hours worked documented for high wage gap professions (Goldin (2014)).

Our paper builds on the empirical literature on the role of firms in wage dynamics (e.g., Card, Heining, and Kline (2013), Haltiwanger et al. (2017), Barth et al. (2016)) and the literature on gender wage differentials (Altonji and Blank (1999), Bertrand (2011), Blau and Kahn (2017)). The two studies closest to ours are Card et al. (2016) and Barth et al. (2017), which analyze the effects of gender differences in sorting and firm-specific premiums on pay differentials by age in Portugal and the U.S., respectively. Notably, results from Portugal and the U.S., as well as our results from Sweden, all suggest that differences in sorting and firm premiums explain at best around 30% of gender wage differentials.<sup>5</sup>

Our study also contributes the literature on internal “career ladders” (Gibbons and Waldman (1999)). In particular, existing empirical evidence about gender differences in movement up career ladders and in promotion-related wage growth is limited and quite mixed, with effects even of opposite sign, as reviewed in Blau and DeVaro (2007).<sup>6</sup> The variation in findings about gender differences in promotions across studies is likely explained in large part by differences in the definition of promotion. In practice, defining a promotion is not straightforward, even when detailed occupation or job title codes are available.<sup>7</sup> Indeed, an important advantage of the measure we use to study internal advancement is that it is transparent and replicable across all countries in which employer-employee matched wage data is available.

The rest of the paper is organized as follows. Section 2 describes the data and the Swedish institutional context. Section 3 presents the main empirical findings about the drivers of gender differences in lifecycle wage growth. Section 4 analyzes the role of hours worked and childbirth in affecting the promotion gap documented in Section 3. Sections 5 and 6 analyze further implications of our findings and sensitivity of our results to alternative measures of promotions. Section 7 concludes.

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<sup>5</sup>Barth et al. (2017) only have data on earnings, which combine hours worked and wage. Thus, their results are somewhat more difficult to interpret. Nevertheless, they find similar magnitudes.

<sup>6</sup>Both the promotion probabilities and associated wage gains documented for men and women differ substantially across studies. See, for example, McCue (1996), Booth et al. (2003), Javdani and McGee (2015), Johnston and Lee (2012), and especially the discussion in Blau and DeVaro (2007).

<sup>7</sup>See Blau and DeVaro (2007). Promotions may be defined using changes in occupation or job titles, or using self-reported survey data, which may ask employers or employees directly about promotions, or about any change in positions at the current firm. Often classifications employed by researchers additionally require that a promotion have an associated positive wage change. The reason for this is that even when detailed occupation or job title codes are available, it is often unclear what code change constitutes a “promotion.”

## 2 Data Description and Institutional Context

Throughout the paper, we rely on data from several administrative registers from Statistics Sweden, covering the years 1985-2013. Our baseline dataset is the LOUISE register, which covers the entire population of Sweden aged 16-75. It includes demographic variables, such as age, gender, household composition, years of post-secondary education, age at graduation, and field of major. It also provides information about parental leave pay and annual labor income, including zero income. We link this dataset with three other registers using personal and firm identifiers. The first is Wage Structure Statistics register, which provides information on a worker's contracted hours and contracted wages, measured as full-time equivalent monthly earnings. The second is the multi-generational register, which provides details about the dates of all births and hence, the number of children. Finally, the third is the employer register, which provides personal identifiers of all employees, as well as certain firm characteristics, such as size, industry, and whether the establishment is in the public or private sector. Using these linked registers, we can analyze firm-specific wage distributions and other firm characteristics by gender or education.

An important advantage of our administrative data is that it records wage, not just earnings. This allows us to distinguish changes in wages from changes in hours over the lifecycle. This is often impossible using tax or social security records, which generally only record earnings, or employer-employee linked survey data such as Longitudinal Employer-Household Dynamics, e.g. used by Barth et al. (2017). Our wage measure – full-time equivalent monthly earnings, from the Wage Structure Statistics – is collected once yearly for employees with positive hours in the survey month. This wage data is collected for all public-sector employees and all workers at firms with at least 500 employees. Firms with fewer than 500 employees are sampled each year, and sample weights are provided.<sup>8</sup>

In order to analyze lifecycle dynamics, we focus on college-educated individuals from the cohorts born between 1960 to 1970. These years correspond to the youngest set of cohorts that we are able follow from age 25 in 1985 until age 45 in 2013 (age 43 for the 1970 cohort). We begin following individuals from age 25 or the year after they graduate with their terminal degree, whichever comes later. We focus specifically on college-educated individuals for two main reasons. First, the average labor force participation rate of college-educated women ages 25 to 45 is 95%, nearly as high as

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<sup>8</sup>Results are not dependent on weighting. Individuals who work at firms for which wage data is collected, but are on parental leave in the survey month, do appear not in the Wage Structure Statistics. For these individuals, we interpolate wages during the parental leave year in three ways. The first method, which we use when we report results, averages the wage from the prior and subsequent year. The second and third methods assign just the prior year's wage, or just the subsequent year's wage, respectively. None of our results are sensitive to the choice of interpolation.

that of men, alleviating concerns about sample selection or changes in composition of workers over the lifecycle. Second, the increase in lifecycle gender wage differentials is more pronounced among the higher-educated, especially toward the top of the income distribution, making this a particularly interesting group to study. Correspondingly, whenever we construct firm-level variables, such as employee wages at different percentiles or average wage growth of an individual’s co-workers at the firm, we also restrict our analysis only to college-educated employees at the firm.

Finally, since our focus is on the role of firms, and how wages change as individuals move within and across them, we restrict our sample to individuals with degrees that are not associated almost exclusively with public sector employment in Sweden. This means that we exclude individuals with degrees related to teaching, medicine, and social work in the main analysis, as more than 85% of these workers work in the public sector. In the final part of the paper, we document results when we re-incorporate these primarily public sector majors. In the paper, whenever we refer to “firms,” we refer to all private sector and public sector employers.

Table 1 records summary statistics for the population of workers that we follow throughout the analysis. As Table 1 shows, women and men have similarly high labor force participation rates, exceeding 95% at all ages, although women are more likely to work part-time. Women are less likely than men to attain additional education after a bachelor’s degree. More than 75% of individuals in our sample have had a child by age 45, and mean age at first birth is relatively high, at about 31.7 years for women, and 33.0 for men. About 36% of women work in the public sector, compared to 22% of men. This share does not change significantly with age for college-educated workers. Finally, on average women work at larger firms, and mean wage of college educated workers at the firms where women work is about 5% lower than at the firms where men work.

Relative to other countries, the Swedish labor market is characterized by high female labor force participation and relatively low gender wage differentials. In 2015 the gender difference in median wages for all full-time workers in Sweden was 13.1 percent, compared to 17.9 in the U.S.<sup>9</sup> Sweden is characterized by strong job protections for new parents and generous parental leave. New parents are entitled to 390 paid days of family leave at a 80% replacement rate (up to a cap), with an additional 90 days paid at a flat rate. While 60 days of leave are reserved for each parent, the remainder can be transferred freely between parents. Additionally, during the period under study in this paper, individuals have the right to work part-time (75% of full time), until the child turns eight. Prior to childbirth, part-time work is rare in Sweden, with about 3% of men and 6% of women working part-time.

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<sup>9</sup>See <https://data.oecd.org/earnwage/gender-wage-gap.htm>.

### 3 Gender Differences in Lifecycle Wage Growth

Figure 1 shows that college-educated women in Sweden have lower wage growth than men. The figure confirms the standard finding that while women and men start their careers with similar wages, a substantial gender wage gap is observed by age 45. To show what accounts for this, in this section we characterize key features of annual wage growth for individuals in the 1960-1970 birth cohort.

#### 3.1 Motivation: Distribution of Real Annual Wage Growth

We begin our analysis of gender differences in wage growth with this simple motivation: while average wage-age profiles such as those in Figure 1 are smooth, individual wage profiles are not. In practice, individual wage growth is episodic, as demonstrated in Figure 2 for a sample individual in our data, for whom we observe wage in all years. For this individual – a male business major with somewhat above average income for his cohort – wage growth can be characterized by many periods of relatively low or even non-positive real wage growth, punctuated by large, discrete jumps in wage. The wage changes in just three years account for about 60% of his wage growth between ages 25 and 45.

The worker featured in Figure 2 is not atypical. In Figure 3, we characterize the full distribution of real annual wage growth, across all individuals in our sample and all years that we observe them. For the majority of individuals and years, real annual wage growth is low, typically below 2.5% – even in our relatively young sample of high-skilled individuals. By contrast, annual wage growth exceeding 15% accounts for only about one-fifth of observations, but around 50% of total real wage growth from age 25 to 45. In fact, about 80% of individuals achieve half of their wage growth between ages 25 and 45 in just three (not necessarily consecutive) years, as Table 2 shows.

Figure 3 also documents that the incidence of periods of high wage growth differs substantially for men and women. Men are about 1.4 times as likely to experience a wage increase of 20% or more, and about 1.2 times as likely to see their wages grow by 15-19% in a year. For women, this is offset by a greater number of periods with growth below 5%. This pattern constitutes the major gender difference in Figure 3, indicating that it is a key driver of the divergence in men’s and women’s lifecycle wages. Men’s higher probability of experiencing wage gains between 7.5-15% also contribute to the divergence, but by comparison play a much smaller role.

Large wage gains such as those documented in Figure 3 are commonly associated with firm changes (e.g., Burdett (1978), Topel and Ward (1992), Abowd et al. (1999)). Firm changes account for about 26% of the observed wage increases exceeding 15% in Figure 3 for men, and about 28% for women. The remaining wage increases occur

during a workers’ firm tenure, rather than during a firm switch, on average moving workers 17 percentiles higher in their firm’s wage distribution.<sup>10</sup> Such substantial upward within-firm moves are typically associated with internal promotion (e.g., Gibbons and Waldman (1999)).

### 3.2 Decomposing Wage Growth: Firm Switches, Promotions, and Interim Wage Growth

The stylized facts documented above point to two factors – gender differences in probability of possible promotions and in the frequency of and return to firm switches – as important drivers of gender differences in wage growth. In this section, we seek to better understand the incidence of these factors over the lifecycle, as well as their contribution to lifecycle wage growth for men and women.

We begin our analysis by classifying real annual wage growth into three categories that we define as follows: (1) wage growth that is associated with switching firms, in the year that the switch occurs; (2) wage growth that is associated with a large increase in one’s wage *relative* to one’s co-workers, which we call an internal “promotion;” and (3) internal wage growth that is not associated with a promotion, which we call “non-promotion” or “interim” wage growth. These categories are mutually exclusive and exhaustive.

To construct a measure of internal promotion, we exploit the employer-employee linked structure of our data and compare men’s and women’s wage growth with that of their co-workers. First, we identify all college-educated employees working at the same firm, and construct average wage growth statistics by firm and year. We then classify someone as having received a “promotion” if he or she realized wage gains that are  $n$  percentage points higher than the average wage growth of his or her college-educated co-workers that year. If an employed individual did not receive a promotion according to this definition and did not switch firms, by construction they are assigned to the third category. Throughout the main analysis, we present results using a fairly conservative threshold, where we set  $n$  equal to 10, which focuses the analysis on relatively “large” movements within the firm. In Section 6, we consider results for a wide range of values for  $n$ , and alternative definitions of promotion.<sup>11</sup>

Our definition of promotion specifically signifies years of high wage increases relative to one’s co-workers. This need not be associated with a change in job assignment to more complex tasks (e.g., Gibbons and Waldman (1999)), but could instead represent

<sup>10</sup>While there are firms where the majority of employees experience annual real wage gains of 15% or more, such firms are rare in our data, and account for less than 1% of observed wage increases exceeding 15%.

<sup>11</sup>Our results are qualitatively similar when using any of these alternative definitions, and quantitatively similar for a large range of values of  $n$ .

a match of an outside offer (e.g., Burdett and Mortensen (1998)), or both simultaneously. We discuss the interpretation of our promotion measure more fully in Section 6. For the moment, we are agnostic about what generates large discrete wage increases relative to one’s co-workers, as our objective is to document gender differences in the incidence of large within-firm moves, relative to interim or incremental annual growth, as transparently as possible. That said, individuals who experience a promotion under our definition are about 1.8 times more likely to experience a change in occupational code compared to those who were not promoted, indicating that a change in job assignment is a common feature of promotions under our measure.<sup>12</sup>

Table 3 provides summary statistics about the wage growth associated with firm switches, promotions, and interim periods, as well as the the probabilities with they occur, by age group. As expected, promotions are relatively rare, especially after age 35, but are associated with high wage growth. The wage gains following promotion exceed 18 log points (19.7%) at all ages, and are about 1-1.5% higher for men. By contrast, both men and women experience average wage growth below 3.3% in interim, non-promotion years, and this declines to 1.1-1.6% by ages 41 to 45. The wage gain from switching firms is highest in the youngest age group at around 8.4 log points for women and 9.5 for men (8.8% and 9.9%), and then declines to 4.1-4.8% later in the lifecycle. The gender gap in annual wage growth favoring men declines and in fact reverses around age 40 for both firm switches and interim wage growth.

Figure 4 documents that both firm switches and promotions are most likely to occur at young ages. Men and women switch firms at nearly identical rates over the lifecycle. By contrast, women have significantly lower promotion rates, especially at younger ages. At the ages when promotions are most common, ages 26 to 30, women have a 17.3% probability of experiencing a promotion in a given year, compared to 21.5% for men, about a 20% difference (Table 3). Figure 4 also documents that differences in promotion probability are not easily explained by the presence of children, as patterns are similar for women who delay childbirth until after age 35 or who never have children.

To quantify the contribution of these three sources to cumulative lifecycle wage growth for men and women, we next conduct a simple decomposition. We begin with the following identity governing average cumulative wage growth in log points by age  $a$ :

$$\sum_{t=26}^a \Delta W_t^k = \sum_{t=26}^a \sum_{j=1}^3 P_t^k(j) \Delta w_t^k(j), \quad k = m, f. \quad (1)$$

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<sup>12</sup>Alternatively, we could use changes in occupational codes directly to define promotions. This would be more aligned with the traditional notion of promotion, but is problematic for two reasons. First, using changes in occupational codes, it is often difficult to distinguish between lateral and vertical moves. For example, it is unclear whether a move from business specialist to finance specialist should be classified as a promotion. Second, even detailed, four-digit codes are not sufficiently fine-grained to capture many promotions, e.g., from project manager to division leader, CFO to CEO, or assistant to associate professor.

Here,  $j$  corresponds to one of the three possible sources of wage growth: the immediate wage growth associated with switching firms; internal growth due to promotions; and interim (non-promotion) growth.  $P_t(j)$  is the probability with which  $j$  occurs at age  $t$ , and  $\Delta w_t(j)$  is the average wage growth associated with  $j$ , where growth is measured as the difference in log wages between  $t$  and  $t - 1$ . In Figure 5, we then graph the average share  $S_j^a$  of cumulative wage growth by age  $a$  attributable to  $j$ :

$$S_j^{a,k} = \frac{\sum_{t=26}^a P_t^k(j) \Delta w_t^k(j)}{\sum_{t=26}^a \Delta W_t^k}, \quad k = m, f \quad (2)$$

where  $\sum_{j=1}^3 S_j^{a,k} = 1$  at all  $a$  for men and for women.

Figure 5 graphs the result of the decomposition. For both men and women, promotions account for the largest share of cumulative wage growth, at all  $a$ . Though promotions are less common at older ages, they continue to constitute an important source of cumulative lifecycle wage growth, since even relatively rare promotions generate a large amount of wage growth. By contrast, the contribution of growth related to firm switches declines over time.

Second, Figure 5 documents that promotions explain a larger share of wage growth for men, about 45%, compared to about 40% for women. Therefore, periods of smaller, non-promotion growth contribute more towards women's cumulative wage growth, in line with the motivating evidence in Figure 3. In Table 4, we confirm that a more standard wage variance decomposition (in wage levels) yields the same result. Specifically, we regress log wage on individual and time fixed effects, years of experience interacted with field of major, and a set of indicators corresponding to an individual's cumulative number of promotions and firm switches each period.<sup>13</sup> Table 4 documents that promotions explain about 44-46% of the total variation in lifecycle wages that is not captured by fixed differences across individuals. This is close to the magnitudes documented in Figure 5, for promotions' share of wage growth in each year relative to individual starting wage.

To quantify how much gender differences in firm switches, promotions and interim growth contribute to the increase in lifecycle gender wage differentials, we conduct a related decomposition, again using the identity in equation (1). Consider gender differences in cumulative lifecycle wage growth by age  $a$ ,

$$G^a = \sum_{t=26}^a \Delta W_t^m - \sum_{t=26}^a \Delta W_t^f.$$

Note that the total gender wage gap in log points at any given age  $a$  is the starting

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<sup>13</sup>Note that *cumulative* number of promotions should be used in such a regression, since the outcome variable is wage level, not wage growth.

gender wage gap at age 25 plus  $G^a$ , the difference in men’s and women’s total wage growth, also measured in log points. The part of the gender wage gap  $G^a$  that is attributable to each of the three sources of wage growth  $j$  can be expressed as

$$g_j^a = \sum_{t=26}^a P_t^m(j) \Delta w_t^m(j) - \sum_{t=26}^a P_t^f(j) \Delta w_t^f(j), \quad (3)$$

where  $\sum_{j=1}^3 g_j^a = G^a$ .

Figure 6 graphs the outcome of decomposition (3). The main finding in Figure 6 is that of the three sources of wage growth, differences in promotion-related growth are the dominant driver of the increasing lifecycle gender wage gap. At all ages, these differences in promotion-related growth are of the first order, and averaged over all ages account for a remarkable 78% of the differences in wage growth. Differences in growth associated with switching firms account for about 28% of the increase in the wage gap. Non-promotion growth contributes negatively (-6%), as years without promotions are more common for women, and the growth associated with non-promotions is marginally higher for women than for men after age 39.

Combining the findings in Figure 6 with those in Table 3, it is possible to establish several additional facts about the lifecycle wage growth of men and women. First, since men and women switch firms at very similar rates over the lifecycle (Table 3 and Figure 4), the gender difference in growth associated with switching firms in Figure 6 is generated primarily by differences in wage growth conditional on switching, rather than by differences in the frequency with which men and women switch firms.<sup>14</sup> Second, the fact that the probability of switching firms is similar – in fact, marginally higher for men – also indicates that women’s lower promotion-related growth is not driven mechanically by their lower tenure at firms, which could make them less eligible for promotion. Indeed, average firm tenure for men and women in our sample is nearly identical, at 4.2 years for men and 4.3 years for women.

Finally, Table 3 shows that the wage gains upon being promoted are of a similar magnitude for men and women, close to 20 log points. In fact, equalizing wage gains conditional on promotion only reduces the share of the wage gap increase attributable to differences in promotion to 73%. This implies that the “promotion gap” – the gender difference in the probability of receiving a promotion, and therefore the large gains associated with it – is the predominant driver of the observed gender differences in lifecycle wage growth.

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<sup>14</sup>This difference in wage growth conditional on switching is driven by two factors: that women and men switch to firms with different pay, and that they receive different starting wages at the same firm, conditional on switching. Card et al. (2016) study this dimension in detail using Portuguese data and find that about two-thirds of the difference is driven by differences in the wage premiums of firms where men and women work, and about one-third is driven by differences in how much they receive conditional on switching firms.

The decomposition exercise above is purposefully simple and conducted without imposing structure or making parametric assumptions.<sup>15</sup> In particular, we do not place restrictions on how a firm change can affect immediate wage growth. This is important, since a large literature has emphasized the importance of movement up job ladders through firm changes, but does not necessarily agree on the mechanisms determining the wage gains associated with firm-to-firm movements.<sup>16</sup> For this reason, analyses that put restrictions on how firm moves can affect immediate wage gains may incorrectly estimate the importance of this dimension. In section 5, we explicitly compare our findings to a recent study of firm-to-firm movements by Card et al. (2016) that takes such a fully parametric approach. An important take-away from our analysis in this section is that gender differences in immediate wage growth associated with firm changes matter, but are decidedly secondary relative to what happens to wage growth during men’s and women’s firm tenure in subsequent years. In particular, they are secondary to the role that large within-firm wage movements (promotions) play. Of course, it is still possible that gender differences in the types of firms men and women switch to over the lifecycle generate gender differences in promotion, an issue we investigate further in the next section.

### 3.3 Gender Differences in Probability of Promotion

Since our analysis finds that differences in probability of promotion account for the majority of gender differences in lifecycle wage growth, we next focus our attention on what drives this gap in promotion probability. In the remainder of this section, we study the role of gender differences in firm characteristics, human capital and occupation. In Section 4, we focus our attention on the effects of hours worked.

#### 3.3.1 Differences in Promotion Across Vs. Within Firms

While differences in wage growth associated with across-firm movements play a secondary role in explaining lifecycle gender wage differentials, gender differences in firm characteristics may still be an important driver of observed gender differences in promotion. Therefore, in this subsection we document the main stylized facts around promotion opportunities at firms where men and women work. Specifically, do women work at firms with fewer opportunities for promotion? Or are they promoted less often than their male co-workers at the same firm?

Analyzing these questions requires constructing a variable measuring promotion

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<sup>15</sup>Our only restriction is definitional, about how a promotion is categorized, and we analyze sensitivity to this definition in Section 6.

<sup>16</sup>See, for example, Topel and Ward (1992), Burdett and Mortensen (1998), Postel-Vinay and Robin (2002), Lentz and Roys (2015), and the review by Rogerson, Shimer, and Wright (2005).

opportunities at the firm that is consistent with the previous analysis. To do this, we calculate the average share of high-skilled employees who are promoted annually at each firm, using the same definition of promotion as in section 3.2.<sup>17</sup> In Figures 7 and 8, we order firms by this measure on the x-axis.

Figure 7 plots the share female across firms with different promotion opportunities. For reference, it also plots the distribution of high-skill workers across these firms, since high-promotion firms are less common. Figure 7 shows that women on average work at firms with fewer opportunities for upward movement, both in our cohort and among high-skill workers overall. In firms with fewer opportunities for upward movement, women and men represent a roughly equal share of workers. However, at firms that are in the upper half of the distribution for the yearly share of workers promoted, women represent a lower share of the firm’s high-skilled employees, around 35-43%. These differences can be interpreted as gender differences in “sorting” across firms.

In Figure 8, we examine differences in the probability of being promoted for men and women in our cohort, conditional on the promotion opportunities at their firm. We focus on ages below 35, when the majority of promotions occur. Figure 8 documents that women have a lower probability of being promoted across all firm types, with more pronounced gender differences at firms with more promotion opportunities. On average, women each year are about 3.9 p.p. (20.9%) less likely to get promoted. However, at firms where at least 15% of workers are promoted each year, women in our cohort are on average about 6.2 p.p. (21.5%) less likely than men to get promoted. These differences can be interpreted as the “within-firm” differences in promotion probability.

To quantify the importance of sorting vs. within-firm gender differences in promotion, we use two approaches. The first approach is to conduct a simple decomposition exercise, without any controls, that considers the following two counterfactuals. The first counterfactual asks what the implied gender gap in promotion rates would be if men and women worked at the same firms (no sorting). The second asks what the implied gap in promotion rates would be if men and women had identical probabilities of promotion at their current firms. As Table 5 shows, assigning men’s distribution across firms to women only reduces the gap in promotion rates from 3.9 p.p. to 3.1 p.p. By contrast, assigning men’s probability of promotion to women at their current firms reduces the gap in promotion rates by 75%, to 1.0 p.p.

Our second method compares the gender gap in promotion probability in regressions with and without firm fixed effects, which control for systematic differences across firms in the probability of promotion. In these regressions, we also add human capital

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<sup>17</sup>Alternatively, one could calculate the average share of high-skilled male employees who are promoted annually at each firm. If women on average have lower promotion rates, firms with a higher share female will by construction have lower promotion rates. Using this alternative definition of promotion opportunities at the firm does not change the findings in this section.

controls, including field of study. The latter, which is closely related to occupation, differs on average for men and women, and may therefore affect men’s and women’s relative promotion probability. In the regression below, the outcome variable  $y_{ift}$  is an indicator corresponding to whether or not individual  $i$  at firm  $f$  received a promotion in year  $t$ :

$$y_{ift} = \alpha \cdot \text{female}_i + \beta X_{it} + \pi_t + \gamma_f + \varepsilon_{ift} \quad (4)$$

Control variables  $X_{it}$  include indicators for years of post-secondary education and field of major, and a quadratic in years of experience. The coefficient  $\alpha$  corresponds to the gender difference in promotion rates, and  $\pi_t$  and  $\gamma_f$  are year and firm fixed effects.

Table 6 documents that in the baseline regression, with human capital controls but without firm fixed effects, the coefficient  $\alpha$  implies a promotion gap of around 4.4 p.p., in fact larger than the raw promotion gap of 3.9 p.p. The coefficient increases when we control for field of major because men are more likely have science or engineering degrees, which have lower promotion rates compared to business or law, which are more common fields among women.<sup>18</sup>

Secondly, Table 6 documents that adding firm fixed effects only reduces the coefficient on female by about 10%, from 4.4 p.p. to 4.0 p.p. Note that the addition of firm fixed effects also controls for fixed firm characteristics such as industry, implying that possible gender differences in industry are not an important driver of the promotion gap. Overall, the regression results in Table 6 show that gender differences in promotion rates of men and women at the *same* firm – rather than differences in sorting across firms – are the primary driver of gender differences in promotion probability.

### 3.3.2 Promotions and Occupation

In the regressions in the previous section, and in those throughout most of the paper, we do not add controls for occupation. The obvious reason for this is that many differences in occupation – e.g., manager vs. analyst – are outcomes of promotions. Adding controls for occupation would therefore complicate the interpretation of our results, and potentially control away part of the effect we are seeking to capture. On the other hand, it is possible that women, even when they have the same major as men, are more likely to choose a low-paying occupation not related to their major, possibly one without substantial opportunities for upward movement but, for example, with more flexible hours arrangements. In this case, controls for occupation would be desirable, since they would capture possible differences in chosen career tracks.

In Figure A.1, we document differences in the distribution of men and women across occupations in our sample, using two-digit occupation codes. Appendix A.1

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<sup>18</sup>In science or engineering, about 15% of men below 35 are promoted annually, compared to 22% of men in business or law.

provides details about the specific occupations that fall into each of the two-digit categories. Figure A.1 shows that women are indeed more likely than men to work in clerical or administrative support positions, which are typically associated with fewer opportunities for upward movement. However, the effect of other gender differences in occupation on probability of promotion are not clear-cut. Overall, women are relatively more likely than men to work in occupations related to business and law, in line with their major choices, and less likely to work in occupations related the physical sciences and engineering.

To understand whether differences in occupation – that are not already captured by controls for field of major – explain a large share of the promotion gap, we add occupational controls to equation (4). We present the results in Table 7. In column (1), we add controls for whether or not an individual works in a clerical or administrative support occupation. The addition of this control has almost no effect, which is not surprising since only a small share of individuals in our sample work in such occupations. In column (2) and (3), we add two-digit and three-digit occupation codes, respectively. As expected, this reduces the coefficient on female, but only slightly to 3.9 p.p., which is not statistically different from the baseline coefficient of 4.0 without occupation controls. Thus, our results indicate that even conditional on years of college, field of major, years of experience, specific firm, and occupation, women experience about 20% lower promotion rates than their male colleagues.

## 4 Promotions, Hours Worked, and The Role of Children

In the previous section, we documented that most of the gender differences in wage growth among college-educated individuals in Sweden can be attributed to differences in the rate of internal promotion of women relative to their male co-workers, i.e. in the probability that they experience a large wage increase relative to their co-workers. In this section, we try to understand how much of this difference in promotion probability is driven by two, often related factors: (1) differences in hours worked, and (2) gender differences in how childbirth affects promotion over the lifecycle. This approach is motivated by three insights from the literature. First, women on average work fewer hours than men (e.g., Goldin (2014)). Second, hours worked, in as far as they correlate with on-the-job learning or performance, are likely to affect promotion probability (Gibbons and Waldman (1999)). And third, a number of recent papers document a large and immediate wage penalty associated with childbirth for mothers (e.g., Kleven et al. (2017), Angelov et al. (2016)).

## 4.1 Measures of Hours Worked

Before we describe the relationship between hours worked and promotions in our data, it is useful to discuss the measures of hours available to us.

In our data, we have two such potential measures. One is contracted hours, an administrative measure. It records full-time vs. part-time employment on a scale from 1 to 100 (e.g. 50% FTE, 75% FTE, etc.). The benefit of this measure is that it reliably identifies part-time workers, and allows us to track part-time work history. However, the drawback of this measure is that most of the observations are concentrated at “full time” (100% FTE), and do not exceed this threshold, making it impossible to study variation in hours worked at the upper end of the hours distribution.

Alternatively, it is possible to construct a proxy measure for hours worked, by dividing annual labor income by contracted wage. The drawback of this measure in turn is that annual labor income can also include bonus or incentive pay, which need not reflect higher hours worked. However, the advantage of the measure is that it provides more variation in hours worked for those employed full-time. Moreover, annual labor income does not include sick leave (personal or for care of sick family members) or parental leave pay. Therefore, the hours proxy captures hours reductions due to such family-related leave as well. To avoid introducing a mechanical correlation with our promotion measure, we use a lagged version of the hours proxy. We provide further details about its construction in Appendix A.2.

## 4.2 Gender Differences in Hours Worked and Promotion

In Table A.1, we summarize hours worked, by age. Part-time work (35 hours or less) is quite common among women in their late thirties, with about 23% working part-time, and less common at younger ages. Over all age groups, the average gender difference in weekly hours worked using the detailed proxy measure is about 5.4 hours.

Table 8 documents that the relationship between promotion probability and hours worked in the prior period, using our proxy measure, is indeed positive. However, the promotion rate is relatively flat across different weekly hours for individuals working fewer than 41 hours, at around 14.7-16.4%. The annual promotion rate then increases to about 19.9% for individuals who worked 42-48 hours per week, and to about 24.4% for individuals who worked 48 hours per week or more, the category with the lowest share of women.

In Table 9, we analyze the effect of hours worked on the the estimated promotion gap, again for ages below 35. Relative to the baseline gap (column (1)), controlling for part-time work and for part-time history in column (2) has only a small effect. However, controlling further for hours worked in the prior period using the lagged

proxy measure reduces the promotion gap to 3.2 p.p. (column (3)), about a 20% reduction in the coefficient. Next, in column (4) we add an indicator for whether or not the worker had a child in the current or prior period, interacted with an indicator for being female. Since neither the part-time measure nor the proxy measure, which is lagged, fully capture reductions in labor supply taken during these years due to parental leave, this control corrects for such additional reductions in labor supply. Indeed, the years of and immediately following childbirth appear to play an important role for explaining the promotion gap, reducing the coefficient further to about 2.1 percentage points. However, even the addition of these controls only reduces the promotion gap under age 35 by about half.

Table 10 provides evidence for why gender differences in hours worked explain part but not all of the gap in promotions. It shows that for *all* ranges of hours worked in the prior year, we observe a substantial gender difference in current period promotion rates, of about 3 percentage points. In other words, even men who work part-time have a higher probability of promotion than women who work part-time, and the same is true for men and women who work full-time, more than full-time, etc. Next, adding a control for the year of or following childbirth interacted with female in column (2) reduces the promotion gap, but the effect is concentrated at the top of the hours distribution. However, at the most common weekly hours (39 to 41), and at slightly reduced hours (32 to 39), the promotion gap remains high with this added control, at about 2.0 to 3.2 p.p. These estimates virtually do not change when one restricts the sample only to childless individuals (column (3)).

To summarize, gender differences in part-time work, part-time history, and hours worked in the prior period together account for 0.8 percentage points, or about one-fifth of the promotion gap from below age 35 (Table 9). The negative effects of children on promotion are particularly prominent around the time of birth, with the years of and immediately following childbirth accounting for another 1.1 percentage points of the promotion gap. In the next section, we explore these findings further by focusing specifically on the dynamic effects of childbirth on probability of promotion.

### 4.3 Dynamic Effects of Childbirth

At the time of first birth, Swedish women’s labor supply patterns change substantially, similarly as in other countries. From graduation until first childbirth, 90% of all future mothers in our sample are employed and working full-time, compared to 91% of future fathers. However, after childbirth virtually all women take at least six months of parental leave, and many take a full year, although overall employment rates remain high in those years, with about 95% of women in our sample either working or on parental leave. After first birth, a substantial share of women switch to part-time

work, on average about 28% in the five years following first childbirth, compared to 6% of men.

Correspondingly, wage differentials increase after childbirth. Even in our relatively homogenous sample, with additional controls for years of college, major, and years of labor market experience, the gender wage gap increases from about 3% five years prior to childbirth to about 6% already in the year prior childbirth, for individuals who ever have children. Over the next 5 years, this gap rapidly expands to 13%, and 10 years after childbirth it increases to about 19%.

In this section, we ask two questions. First, how do the dynamic effects of childbirth affect promotion probability over the lifecycle, and correspondingly, wage differentials? Second, how much of the promotion gap can be attributed specifically to the effect of motherhood? Throughout this section, we employ an event-study approach to answer these questions, with first childbirth as the main event of interest, following other studies of the effect of motherhood on wage earnings differentials (e.g. Kleven et al. (2017), Angelov et al. (2016)).

#### 4.3.1 Probability of Promotion, by Time to First Birth

We begin by documenting how the probability of receiving a promotion in a given year changes with time relative to first birth  $k$ , where  $k = -5, -4, \dots, 10$ . To make the specification as flexible as possible, we run a separate regression for each year relative to first birth  $k$ :

$$y_{it} = \beta_1^k \cdot \text{female}_i + \beta_2^k X_{it} + \pi_t^k + \varepsilon_{it} \quad (5)$$

Figure 9 plots the coefficients  $\beta_1^k$  on the indicator variable for whether individual  $i$  is female. The year of first birth corresponds to  $k = 0$ . The sample for this regression includes only men and women who have ever had children, or about 75% of our original sample. In the baseline specification, we include calendar year fixed effects  $\pi_t^k$  and human capital controls  $X_{it}$ , which include indicators for years of post-secondary education, field of major, and a quadratic term in years of experience. In the second specification, also plotted in Figure 9, we add controls for part-time status and part-time history. The third specification additionally controls for detailed hours worked using the hours proxy variable.

Figure 9 features three main findings. First and foremost, women’s probability of receiving a promotion drops dramatically in the year of and immediately following first birth. In each of those two years, women are 8.4-9.0 p.p., or about 53% less likely than men to receive a promotion, as documented in Table 11. These years coincide with parental leave for many women in Sweden. When controlling for part-time status, part-time history, and our proxy measure for prior hours worked, the result is the same.

Second, even before first birth, women have a 2.2-3.8 p.p. (about 16%) lower annual

probability of promotion than men. Accounting for part-time work does not affect these estimates. Accounting additionally for hours worked using our proxy variable, which better captures variation in hours worked above the full-time threshold, reduces the estimates on average by 0.8 percentage points in Figure 9, although the differences are statistically significant only in one of the years.

Finally, the third main pattern documented in Figure 9 is that after first birth women continue to have lower promotion rates than men, even when controlling for part-time work history and hours worked. However, the gap is somewhat smaller than before first birth, especially when adding controls for hours on the intensive margin. Part of the explanation for the promotion gap in the 2-5 years after first birth is the incidence of second birth, as the modal number of children per couple in Sweden is two. As Figure 10 shows, second birth is associated with another large reduction in promotion probability of about 5 p.p. for women, equivalent again to about a 50% lower likelihood relative to men.<sup>19</sup> Interestingly, just two years after second birth the promotion gap decreases dramatically and remains low.

#### 4.3.2 Probability of Promotion and the Motherhood Penalty

In light of studies documenting no penalty associated with motherhood prior to first birth (e.g., Kleven et al. (2017)), the fact that we find a pre-birth promotion gap in the figures above is perhaps surprising. However, the coefficients  $\beta_1^k$  on *female* presented in Figure 11, from equation (5), combine two effects: a motherhood penalty, associated specifically with the effect of childbirth on promotions, as well as any other penalties women incur before and after childbirth, associated simply with being female. To isolate just the effect of motherhood, we run the regression below, following the literature that focuses on estimating such effects (e.g. Angelov et al. (2016), Kleven et al. (2017)):

$$y_{it} = \sum_{k \neq -1} a_k D_{it}^k + \sum_j \beta_j Age_{it}^j + \pi_t + \gamma X_i + \varepsilon_{it}. \quad (6)$$

$D^k$  are a set of time-to-birth dummies, equal to one if an individual is  $k$  years from first birth, where  $k$  varies from -5 to 10.<sup>20</sup>  $Age^j$  are indicators for being  $j$  years old, and  $\pi_t$  are a set of year fixed effects. We use the same specification as Kleven et al. (2017), and run the regression – separately, as they do – for men and women who have ever had children. The only difference in our specification is that we add controls for years of college and field of major,  $X_i$ . The  $\beta_j$  and  $\pi_t$  coefficients capture

<sup>19</sup>Promotion rates, in absolute terms, decrease with age. Correspondingly, the gender differences in absolute terms also decrease with age. This explains why the promotion gap at second birth is not lower in relative terms than at first birth, but is lower in absolute terms.

<sup>20</sup>Observations corresponding to more than five years before first birth are assigned to the  $k = -5$  category. Observations more than 10 after first birth are assigned to the  $k = 10$  category.

all lifecycle and time effects on the outcome variable. The coefficients  $a_k$  therefore capture the additional effects of motherhood or fatherhood, with effects in each year  $k$  scaled relative to the year before first birth, since  $k = -1$  constitutes the omitted category. The “motherhood penalty” refers to the differences in the parenthood effects  $a_k$  that are estimated for men and those that are estimated for women.

An important difference between the regressions associated with equation (6) and those with equation (5), is that regression (6) is run separately for men and women. As a result, returns to experience and year effects can differ for men and women. The coefficients  $a_k$  in equation (6) isolate the effects associated specifically with time relative to first birth for men and women, or fatherhood and motherhood. Of course, women may still incur other gender penalties relative to men, that are not related to the timing to childbirth – for example, if employers discriminate against all women of childbearing age. Such gender differences would be captured in the estimates of  $\beta_j$  or  $\pi_t$ . Therefore, it is important to note that lack of an estimated motherhood penalty in wages or promotions in some years, using the specification in equation (6), does not imply that there is no gender gap in those years.

Figure 11-A plots the estimates of  $a_k$  from equation (6) for men and women, with promotion in a given year as the outcome variable. The figure shows that prior to first birth, neither motherhood nor fatherhood is associated with a negative effect. If anything, the anticipatory effect of parenthood for men and especially women is slightly positive. This implies that all of the male-female promotion difference prior to birth documented in Figure 9 is a penalty for being female that is not directly related to the time to first birth. Indeed, the penalty does not even appear to be associated with motherhood, as future mothers, on average, have somewhat higher promotion rates prior to first birth than women who never have children (Table 13).

Next, Figure 11-A documents a similar drop for women in the probability of promotion in the year of and following childbirth, as in Figure 9. Interestingly, for men the probability of promotion drops as well, but this decline occurs slightly later, about one to two years after childbirth. This corresponds roughly to the time when women in Sweden usually finish their leave and men begin theirs. The effect is smaller for men, as fathers in this cohort on average take less than one-fourth of the total parental leave allocated per child. Nevertheless, at about two percentage points, this effect is not negligible. Several years after first birth, a parenthood effect persists for both women and men, at about three percentage points for mothers, and one percentage point for fathers.

Finally, in Panel B of Figure 11 we plot the motherhood penalty, which is the difference between the motherhood effects and the fatherhood effects graphed in Panel A. Alongside this penalty, we also graph the total male-female promotion gap,

from Figure 9. A comparison between the two series shows that while the motherhood penalty explains a significant share of the gender promotion gap, especially in the year of and following first birth, only about half of the total gender gap is directly associated with motherhood. Overall, the total male-female promotion gap from five years prior to first birth to the 10 years after first birth amounts to a total of 0.587 promotions. The motherhood penalty, which corresponds to 0.292 promotions over these years, explains 49.7% of the total gap. The remainder of the gap, associated with being female rather than with the motherhood penalty, is in large part incurred prior to childbirth, but continues to play a role until about six years after first birth.

Lastly, we quantify how much of the motherhood penalty is explained specifically by women switching to part-time work, sometimes referred to as the “mommy track.” When controlling for part-time work and part-time history, the total gender difference in number of promotions experienced from five years before childbirth to ten years after birth declines from 0.59 to about 0.47. This implies that differences in part-time work explain about about 21% of the total promotion gap. The remaining motherhood penalty is mostly explained by the large promotion differences in the year of and immediately following first, second, etc., childbirth, and is equal to 0.17, or about 29% of the promotion gap.

Our findings in this section reveal two insights about the mechanisms through which childbirth affects gender wage differentials. First, the sizable drop in probability of promotion for women in the years of and immediately following childbirth explains why childbirth is associated with such immediate and substantial average wage losses relative to men. Indeed, each promotion missed in these years corresponds to forgone wage gains of 17.5 log points. Second, we do not observe an uptick in promotion probability for women two or more years after childbirth, relative to men. This suggests that on average women partially or fully forfeit “missed promotions.” This pattern likely explains why previously documented wage losses associated with childbirth are so persistent (e.g., Kleven et al. (2017)). An interesting question for future research, requiring evidence from other countries, is whether the length of parental leave benefits exacerbates this pattern.

Relatedly, our finding that women in Sweden have lower promotion rates prior to first birth, that cannot be explained by hours worked, employer, or observable differences in human capital, also has implications for optimal design of parental leave policy. Given the available data, we can only speculate about what drives this gender difference in promotion probability that is unrelated to motherhood. One obvious possibility is that employers anticipate – on average, correctly – that female employees are more likely to take up parental leave or exercise their right to work part-time after childbirth, and are more reluctant to promote women. Indeed, the fact that

a promotion gap is also observed for women who never have children, and that the gap narrows after women have their second, typically terminal child, supports this interpretation. How much generosity of parental leave affects promotion probability – positively or negatively – in the years before and after childbirth is an important question for future empirical work and for optimal design of maternity and paternity leave policies.

## 5 Promotions, Firm Effects, and Wage Gaps Across Professions

In this section, we relate our findings to two recent areas of research on gender wage differences. One uses AKM (Abowd, Kramarz, and Margolis (1999)) two-way fixed effects regressions to study how much of the gender wage gap can be explained by gender differences in sorting and returns to higher-paying firms (Card et al. (2016)). The second area of research studies the drivers of differences in gender wage gaps across professions, especially as they relate to hours worked (e.g., Goldin and Katz (2011), Goldin (2014)).

### 5.1 Comparison with AKM Decompositions

Both our study and Card, Cardoso, and Kline (2016) use employer-employee matched data to analyze within- and across-firm effects on men’s and women’s wages. Thus, it is a useful exercise to try to compare our findings and theirs. Using data from Portugal, Card, Cardoso, and Kline (CCK) estimate that overall about 20% of the gender wage gap can be explained by gender differences in firm effects. Specifically, they estimate separate regressions for men and women with two-way firm and individual fixed effects in the style of Abowd, Kramarz, and Margolis (1999). They find that women work at firms with lower fixed effects than men, reflecting differences in “sorting,” and accounting for about 13% of the cross-sectional wage gap. Second, conditional on being at the same firm, the estimated firm fixed effect is smaller on average for women than for men, reflecting what CCK interpret as differences in “bargaining” for a share of firm-specific rents, and accounting for another 7% of the cross-sectional wage gap.

In our study, the unit of analysis is wage growth – focusing either on log differences in wages or on promotion – rather than wage levels or the cross-sectional wage gap, as in CCK. As a result, the mapping between the results in our paper and theirs is not direct.<sup>21</sup> Nevertheless, some comparisons can be made. CCK’s results show that at age

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<sup>21</sup>Additionally, there are differences between the samples used in the two papers, since we focus on college-educated workers in Sweden, while CCK focus on Portuguese workers of all education levels.

25 or earlier, gender differences in firm-specific effects explain more than a third of the wage gap, about 3 log points out of a 8 log point wage gap. At age 45, the wage gap documented by CCK increases more than fourfold to about 33 log points, but gender differences in firm-specific effects increase to only about 6 to 7 log points at that age.<sup>22</sup> This implies that the increase in gender differences in firm-specific effects accounts for about 14% of the growth in the total gender wage gap between ages 25 and 45. One question that naturally follows is what explains the remainder of the gender wage gap in CCK’s population, and in particular its dramatic expansion. Since our results speak precisely to this question, we view our findings about the role of within-firm wage growth through promotions as complementary to those in CCK. In particular, the magnitude of our results – that close to 80% of the increase in the gender wage gap is attributable to promotions – is in line with and complementary to their findings, that changes in firm-specific effects account for about 14% of the increase in the gap.<sup>23</sup>

Finally, it is useful to note that the regressions in CCK allow for heterogeneity across firms in wage levels, but not in wage growth. However, our findings from section 3 document heterogeneity across firms in opportunities for upward movement – ranging from less than 1% to more than 20% promoted – raising an interesting question about how such cross-firm heterogeneity in wage growth affects estimates of fixed effects in an AKM regression.<sup>24</sup> Firm fixed effects are likely to absorb some of this variation,

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<sup>22</sup>See the results summarized in Figure VI in Card, Cardoso, and Kline (2017).

<sup>23</sup>Indeed, our own decomposition results imply that the corresponding effects of firm changes, as reflected by the immediate wage gains at the time of hire, are as high as 28%. It is not surprising that our estimates are higher than CCK’s. Note that our decomposition focused on the total change in wages associated with firm changes, and did not make parametric assumptions about what generates this change. In CCK’s model, log wage is a linear function of individual and firm fixed effects,  $\alpha_i$  and  $\theta_{ijt}$ , time-varying covariates  $X_{it}$ , and a residual term  $\varepsilon_{it}$ . Thus, the average difference in log wage over all individuals who switch firms in a given period corresponds to

$$(\bar{y}_t^k - \bar{y}_{t-1}^k) | \theta_{ijt}^k \neq \theta_{ijt-1}^k = \beta^k(\bar{X}_t^k - \bar{X}_{t-1}^k) + (\bar{\theta}_t^k - \bar{\theta}_{t-1}^k) | \theta_{ijt}^k \neq \theta_{ijt-1}^k \quad k = \text{male, female}$$

$$\text{or} \quad \Delta \bar{y}_t^k | \theta_{ijt}^k \neq \theta_{ijt-1}^k = \beta^k(\Delta \bar{X}_t^k) + \Delta \bar{\theta}_t^k | \theta_{ijt}^k \neq \theta_{ijt-1}^k.$$

The object of interest for immediate wage gains associated with firm changes in an AKM estimation would be  $\Delta \bar{\theta}_t^m - \Delta \bar{\theta}_t^f$  in the period that a switch occurs. By contrast, we focus on total gender differences in wage gains  $\Delta \bar{y}_t^m - \Delta \bar{y}_t^f$  in periods when a switch occurs, remaining agnostic about what generates this difference. If the AKM model correctly captures the true wage generating process (see, however, the discussion in Postel-Vinay and Robin (2002, 2006)), our estimates of gender differences in wage gains capture both  $\Delta \bar{\theta}_t^m - \Delta \bar{\theta}_t^f$ , as well as the additional component,  $\beta^m(\Delta \bar{X}_t^m) - \beta^f(\Delta \bar{X}_t^f)$ , associated simply with “regular” wage growth, i.e. with the increase in one year of experience. It is not clear what constitutes “regular” wage growth in the year that a switch occurs. Recall that our findings indicate that  $\beta^m(\Delta \bar{X}_t^m) - \beta^f(\Delta \bar{X}_t^f)$  are either close to zero (in the case of non-promotion growth) or positive (in case of promotion-related growth). Thus, our estimate of wage growth associated with firm switches would either correspond approximately to the firm effect estimated by AKM, or alternatively characterize an upper bound for it.

<sup>24</sup>Note that in principle one can add firm-specific tenure effects to partly capture such differences, as in Abowd, Kramarz, and Margolis (1999). However, since promotion-related wage growth is concentrated early on in the lifecycle, firm-specific tenure effects should be interacted with age or age group to properly capture this variation. CCK do not include tenure effects in their model.

since individuals who switch to high-growth firms would, on average, experience a large increase in their wage while at the firm. Since men on average benefit more from promotion opportunities at a firm, estimated gender differences in firm effects in CCK would also be affected, with larger estimates of gender differences at firms with more opportunities for upward movement. Thus, rather than just capturing differences in wage changes upon hire (“bargaining”), the gender gap in firm fixed effects likely also reflects men’s and women’s upward movement at the firm – including the differences in promotion rates related to such factors as childbirth. In Appendix A.3, we conduct a set of AKM regressions following CCK’s specification and implementation, and show that this is precisely the case: there is a significant positive relationship between estimated gender differences in firm fixed effects and overall promotion rates at the firm, as well as the gender gap in promotions at the firm.

## 5.2 Differences in Wage Gaps By Profession

Recent studies document substantially higher wage gaps in some professions than in others, emphasizing non-linearities in the relationship between wages and hours in some professions as an important explanatory factor (Goldin and Katz (2011, 2012), Goldin (2014)). Our findings address this literature, as they have the following implication: fields in which promotions are more common should have more sizable gender wage gaps.

To test the relationship between annual promotion rates and the gender wage gap by profession, we proxy profession with two-digit major codes. As the measure of promotion rates in a given profession, we use men’s average annual promotion probability from ages 26 to 35, the age range when promotions are the most common. We then compare this measure with the log difference between women’s and men’s wages at ages 35 to 45. We graph the results in Figure 12. As the figure shows, there is a significant positive correlation, in line with our prediction. The more common promotions are in a field early on in the lifecycle, the larger the observed gender wage gap at ages 35 to 45. Additionally, in Section 4 we document a correlation between promotion probability and hours worked. Promotions therefore are likely to constitute one prominent form of the previously documented non-linearities between hours worked and wages in fields with high gender wage gaps (Goldin, 2014).

## 6 Sensitivity Analysis and Extensions

In this section, we discuss the sensitivity of our results to alternative measures of promotions, and to the inclusion of primarily public sector-related professions. We also discuss the interpretation of our promotion measure.

## 6.1 Alternative Measures of Promotions

In Section 3, we classify an individual as having received a “promotion” if he or she did not switch firms and realized an annual wage gain that is  $n$  percentage points higher than the average wage growth of his or her college-educated co-workers that year. Throughout the paper, we set  $n$  equal to 10, focusing the analysis on relatively “large” movements within the firm. In Appendix A.4, we analyze how sensitive our results are to alternative choices of  $n$ . Additionally, we consider a promotion measure based on median (instead of mean) wage growth of college-educated co-workers at the firm. Finally, since our existing measures may miss promotions at firms where the majority of workers are promoted every year, we show for reference how the results are affected if one classifies any internal wage gain above  $n$  as a promotion.

We present the results in Table A.3. By construction, as the threshold for  $n$  increases, the share promoted declines. The share of lifecycle wage differentials explained are fairly similar as one varies  $n$  from 7.5 to 12.5, ranging from 83% to 73%. Setting  $n$  to 15 reduces the promotion rate to just 0.11 in the years when promotions are most common, ages 26 to 35. Nevertheless, the share of lifecycle gender wage differentials explained is still quite high, at 0.64. The results are very similar to baseline results when one constructs the promotion measure based on median wage growth of co-workers at the firm, rather than average wage growth. Finally, if one were to classify any internal wage gain above 10% as a “promotion,” more instances of wage growth are classified a promotion, as expected. Overall, however, all definitions in Table A.3 yield similar results, for values of  $n$  within a reasonable range.

## 6.2 Changes in Job Assignment vs. Offer Matching

Given that we construct our measure of promotion entirely based on relative wage growth within the firm, it is useful to discuss whether these large relative wage increases correspond to changes in job assignment, traditionally associated with “promotions,” or are simply responses to outside job offers whenever workers receive them (e.g., Burdett and Mortensen (1998), Postel-Vinay and Robin (2002)). Distinguishing between these two potential reasons for internal wage increases is not necessary for our analysis, nor would it affect any of the results. Moreover, the two factors may often be indistinguishable, since some changes in job assignment may be a result of the arrival of an outside offer. Nevertheless, a brief discussion of what is likely to drive promotions in our analysis is useful, since it affects the interpretation of the results and hints at possible mechanisms driving the gender difference in promotions, and therefore lifecycle wage growth. Four patterns in the data suggest that the promotions we identify are most likely associated with the more traditional definition, related to job assignment.

First, as discussed in Section 3.2, individuals who experience a promotion under our definition are also likely to experience a change in occupational code. Specifically, they are about 1.8 times as likely to experience a change in occupational classification, compared to individuals who do not experience a promotion. Second, public sector establishments have regulated wage schedules and limited flexibility to match wage offers. However, one still observes a large promotion gap of about 3.7 percentage points for public sector workers.

Third, we find that the promotions captured by our measure occur primarily early on in the lifecycle, whereas the literature suggests that increases in wages attributable to matching offers received from other firms play a prominent role primarily later on in the lifecycle (e.g. Bagger et al. (2014)). Finally, the rate of firm switching is almost identical for men and women in our sample. Though one would need data about outside offer arrivals to say something definitive, this suggests that men and women have similar search behaviors and similar probabilities of receiving outside offers.

For these reasons, we suspect that the majority of promotions captured by our measure, especially early in the lifecycle, are associated with the more traditional definition of promotions.

### 6.3 Public Sector Majors

To focus our attention on the role of firms, and how wages change as individuals move within and across them, we restricted our original population of college-educated individuals to those with degrees that are not associated almost exclusively with public sector employment in Sweden. For completeness, in Appendix A.5, we consider the results when all majors are included. The omitted public sector majors, of which women make up a large share (e.g., teaching and nursing), are characterized both by lower promotion rates than in the baseline population, as well as by substantially lower growth in non-promotion years. As a result, the share of gender differences in lifecycle wage growth explained by promotions in the full population declines moderately, to 62%. Instead, male-female differences in non-promotion growth, which were close to zero at most ages and even negative in the baseline sample, now play a larger role. However, even in the omitted group the estimated promotion gap is quite high, at 3.0 p.p. As Table A.4 shows, for the full population of college graduates, the estimated promotion gap under age 35 is about 3.7 p.p., compared to 4.0 p.p. in the baseline population.

## 7 Conclusion

In this paper, we characterize and quantify drivers of lifecycle wage growth of college-educated men and women. Our analysis of Swedish employer-employee matched data finds that differences in growth related to promotions – instances of high wage growth relative to co-workers at one’s firm – account for around 73-83% of the differences in the wage growth of men and women between ages 25 and 45. By contrast, growth associated with firm switches accounts for 28% of gender differences in wage growth, and interim, non-promotion growth is slightly higher for women. Since the wage gains associated with being promoted are only marginally higher for men, the majority of the difference in promotion-related growth is explained simply by women’s lower probability of receiving a promotion.

Next, we analyze whether women are more likely to work at firms with fewer promotion opportunities, or are simply promoted less than their male co-workers, conditional on working at the same firm. While our findings indicate that women do sort on average into firms with flatter wage structures, such gender differences in sorting explain only 10% of gender differences in promotion probability in our cohort. Indeed, 90% of the difference in promotion rates is a gender difference within the same firm, for individuals with the same years of education, field of major, years of experience, and occupation.

Third, we show that a large share of the promotion gap (29%) is incurred in the year of and immediately after childbirth, when women are typically on parental leave. In these years, women’s probability of promotion drops dramatically, even for women who work high (48+) hours prior to childbirth. Additionally, another 21% of the promotion gap between ages 25 and 45 is accounted for by part-time work, sometimes referred to as the “mommy-track.” Employing the event-study approach used in the literature studying effects of motherhood on labor market outcomes, we show that about half of the overall promotion gap is associated with being female, but not with motherhood, and is concentrated early in the lifecycle, before childbirth.

Sweden’s generous leave and part-time work policies – which women take up at a higher rate than men – have been remarkably successful in providing job continuity and encouraging almost universal employment among college-educated women. Nevertheless, Swedish college-educated women fall behind men over the lifecycle, a pattern explained predominantly by their lower promotion rates, as our findings indicate. Whether or not this gender difference in promotion rates is more prominent in countries with generous leave policies, like Sweden, is an important question for future research and for the design of parental leave and family friendly policies.

# Appendices

## A Appendix

### A.1 Classification of Occupations

The two-digit occupation codes used in the paper consist of the following three-digit occupations.

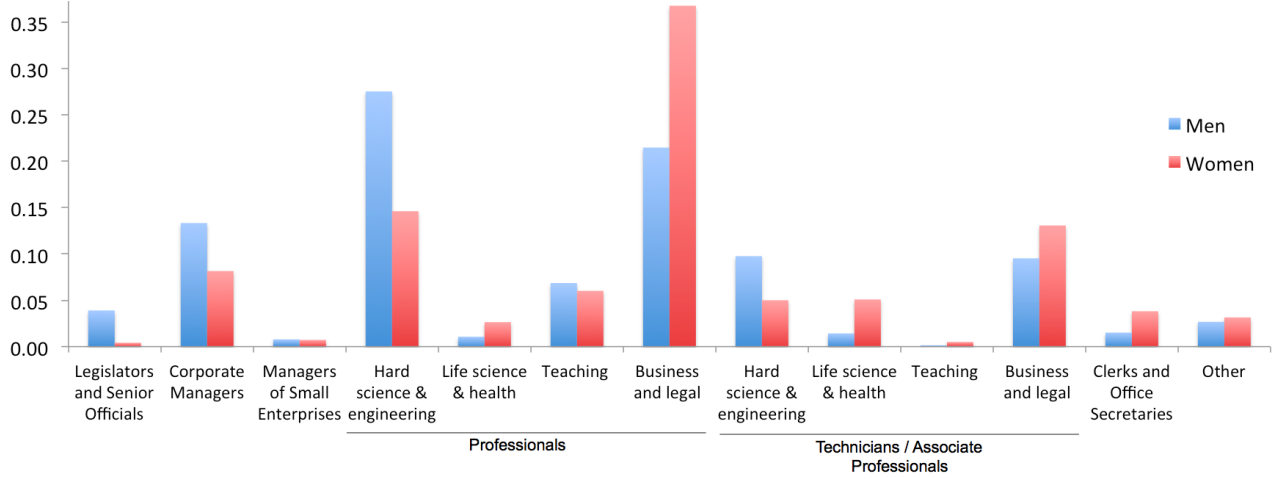
*Legislators and senior officials:* Legislators and senior government officials; Senior officials of special-interest organizations. *Corporate managers:* Directors and chief executives; Production and operations managers; Other specialist managers. *Managers of small enterprises:* Managers of small enterprises.

*Physical, mathematical and engineering science professionals:* Physicists, chemists and related professionals; Mathematicians and statisticians; Mathematicians; Computing professionals; Architects, engineers and related professionals. *Life science and health professionals:* Life science professionals; Health professionals (except nursing); Nursing and midwifery professionals. *Teaching professionals:* College, university and higher education teaching professionals; Secondary education teaching professionals; Primary education teaching professionals; Special education teaching professionals; Other teaching professionals. *Business, Legal, and Other professionals:* Business professionals; Legal professionals; Archivists, librarians and related information professionals; Social science and linguistics professionals (except social work professionals); Writers and creative or performing artists Religious professionals; Public service administrative professionals; Administrative professionals of special-interest organizations; Psychologists, social work and related professionals.

*Physical and engineering science associate professionals:* Physical and engineering science technicians; Computer associate professionals; Optical and electronic equipment operators; Ship and aircraft controllers and technicians; Safety and quality inspectors. *Life science and health associate professionals:* Agronomy and forestry technicians; Health associate professionals (except nursing); Nursing associate professionals; Life science technicians. *Teaching associate professionals:* Pre-primary education teaching associate professionals; Other teaching associate professionals. *Business, Legal, and Other associate professionals:* Finance and sales associate professionals; Business services agents and trade brokers; Administrative associate professionals; Customs, tax and related government associate professionals; Police officers and detectives; Social work associate professionals; Artistic, entertainment and sports associate professionals; Religious associate professionals. *Office clerks:* Office secretaries and data entry operators; Numerical clerks; Stores and transport clerks; Library and filing clerks; Mail carriers and sorting clerks; Other office clerks. *Customer services clerks:* Cashiers, tellers and related clerks; Client information clerks.

All other two-digit categories represent a small share of college-educated workers. The include the following two-digit occupations: *Personal and protective services workers;* *Models, salespersons and demonstrators;* *Skilled agricultural and fishery workers;* *Extraction and building trades workers;* *Metal, machinery and related trades workers;* *Precision, handicraft, craft printing and related trades workers;* *Other craft and related trades workers;* *Machine operators and assemblers;* *Drivers and mobile-plant operators;* *Sales and services elementary occupations;* *Agricultural and fishery laborers;* *Laborers in mining, construction, manufacturing and transport;* *Armed forces.*

**Figure A.1:** Occupational Distribution of Men and Women, Ages 25-45



## A.2 Construction of Proxy Hours Measure

We construct our proxy measure of hours worked by dividing annual labor income, which we observe for the calendar year, by contracted wage, which we observe in the yearly survey month, typically September. The contracted wage measure is also used to construct the promotion variable, which compares wages in Septembers of consecutive years. One issue with using the constructed hours variable to analyze the relationship between current year hours and current year promotions is that one will, on average, underestimate the relationship between the two variables. The reason is that if a promotion occurred, for example, in August of the current year, then total annual labor income will reflect lower wages from January to July, and higher income only from August to December. Dividing this annual income by the high wage recorded in September will lead us to infer that hours worked were lower in the current year than they truly were. This would be true for all individuals promoted after January of the current year.

One alternative is to use hours worked from the previous period. In fact, conceptually this is desirable, as the personnel economics literature suggest that promotions are awarded for past effort and on-the-job learning (Gibbons and Waldman (1999)). However, this has a similar, although opposite problem. Suppose a promotion occurred in October 2000, which would be recorded as a promotion only in 2001, when we observe it in September of that year. In this case, dividing year 2000 annual labor income – which will already partially reflect the promotion – by the wage from September 2000 would lead us to infer that hours worked were higher than they truly were. In this case, we would overestimate the true relationship between hours worked and promotion.

To avoid introducing a mechanical correlation between promotion in year  $t$  and hours worked in year  $t$  or  $t - 1$ , we therefore use a twice lagged measure of hours

worked whenever we rely on the proxy hours measure, i.e. hours in year  $t-2$ . Whenever we use the proxy hours measure, we therefore restrict the sample to individuals who have at least two full years of tenure on the job, to ensure that our measure captures hours worked at the current firm, not a previous firm. Whether or not we impose this restriction, however, does not affect any of the results.

In Table A.1, we summarize this measure of hours worked, by age, and compare it to the contracted hours measure. The contracted hours measure and the proxy measure capture similar patterns. As expected, the proxy hours measure is somewhat higher for men than contracted hours, since contracted hours do not exceed 100% FTE (40 hours per week). For women, the hours proxy measure combines both the effect of hours worked above full-time, as well as time away for parental leave, and therefore is lower in most periods. Since the hours proxy measure captures relevant additional variation in hours worked, we rely on it whenever we analyze specific hours worked.

**Table A.1:** Share Working Part Time and Average Weekly Hours Worked, By Age

|            | Part-Time |       | Hours (Contracted) |       | Hours (Proxy) |       |
|------------|-----------|-------|--------------------|-------|---------------|-------|
|            | Men       | Women | Men                | Women | Men           | Women |
| Ages 26-30 | 0.04      | 0.11  | 39.1               | 38.0  | 41.9          | 38.6  |
| Ages 31-35 | 0.04      | 0.19  | 39.2               | 37.1  | 41.9          | 34.9  |
| Ages 36-40 | 0.05      | 0.23  | 39.1               | 36.7  | 40.5          | 33.7  |
| Ages 41-45 | 0.04      | 0.18  | 39.2               | 37.2  | 40.6          | 36.0  |

### A.3 Interpreting Gender Differences in Estimated Firm Fixed Effects

In this appendix, we implement the test discussed in Section 5.1. We first estimate two-way individual and firm fixed effects regressions on men and women separately in our sample, exactly following the specification and implementation in Card, Cardoso, and Kline (2016). We then calculate the gender differences in estimated firm fixed effects, and group firms into low, medium, and high gap firms based on the size of these calculated gender differences. Note that since we analyze *relative* differences in the gender gaps in firm fixed effects, we avoid having to impose any normalization to make the absolute size of firm fixed effects from the separate AKM regressions for men and women comparable. Finally, we analyze overall promotion rates, as well as the gender difference in promotion rates, at firms with low, medium, and high gender differences in firm fixed effects.

We present the results in Table A.2. In Panel A, we first document the share of variation in wages explained by firm and person fixed effects in our sample. As is common in wage variance decompositions with two-way fixed effects, individual fixed

**Table A.2:** Gender Differences: AKM Firm Fixed Effects and Promotions

| Panel A: Decomposition Results |      |       |
|--------------------------------|------|-------|
| Share of variance due to:      | Men  | Women |
| Person Effects                 | 0.43 | 0.44  |
| Firm Effects                   | 0.08 | 0.09  |
| Covariates                     | 0.40 | 0.37  |
| Residuals                      | 0.09 | 0.10  |

| Panel B: Gender Differences in Firm Effects and Promotions |                    |                                           |
|------------------------------------------------------------|--------------------|-------------------------------------------|
| Gender Difference in Estimated Firm Fixed Effects (M-F)    | Promotion Rate (M) | Gender Difference in Promotion Rate (M-F) |
| Bottom Third of Firms (Smallest Difference)                | 0.120<br>(0.001)   | 0.012<br>(0.000)                          |
| Middle Third                                               | 0.133<br>(0.000)   | 0.028<br>(0.000)                          |
| Top Third (Largest Difference)                             | 0.169<br>(0.000)   | 0.036<br>(0.000)                          |

Notes: Following Card et al. (2016), regression models include individual and firm fixed effects, year fixed effects interacted with indicators for years of education, and quadratic and cubic terms in age interacted with years of education.

effects explain the largest share of the total variance in wages. Since our data follows individuals for more than 20 years, the time-varying covariates such as experience capture more of the total variance in wages than in previous studies, such as in AKM or CCK. Correspondingly, the share of variance explained by firms is slightly lower than in CCK. Overall, however, the results of the decomposition are quite standard.

Next, in Panel B we document the relationship between the three variables of interest. The table shows that firms with a larger gender gap in estimated firm fixed effects tend to be firms with high overall promotion rates and, correspondingly, firms with a larger gender gap in promotion rates. Moving from the bottom to the top third of firms, the promotion rate increases from 0.12 to 0.169, and the gender difference in promotion rates increases from 0.01 to 0.04. These differences are statistically significant at the 0.01% level.

## A.4 Alternative Definitions of Promotions

According to our definition, a promotion occurs when the wage growth of a worker is  $n$  percentage points higher than the average annual wage growth of college-educated co-workers at the firm in the same year. In the table below, we consider alternative thresholds for  $n$ , setting  $n$  equal to 7.5, 12.5, and 15. We compare this to our baseline results, when  $n = 10$ . Additionally, we construct the promotion measure using median

**Table A.3:** Main Results Using Alternative Measures Promotion

|                                      | Promotion<br>Gap     | Promotion<br>Rate (M) | Wage Gain<br>M | Wage Gain<br>F | % Explained<br>by Promotion |
|--------------------------------------|----------------------|-----------------------|----------------|----------------|-----------------------------|
| n = 7.5                              | -0.047***<br>(0.002) | 0.28                  | 0.18           | 0.17           | 0.83                        |
| n = 10                               | -0.040***<br>(0.002) | 0.20                  | 0.21           | 0.20           | 0.78                        |
| n = 12.5                             | -0.032***<br>(0.002) | 0.15                  | 0.24           | 0.22           | 0.73                        |
| n = 15                               | -0.026***<br>(0.002) | 0.11                  | 0.26           | 0.25           | 0.64                        |
| Median-based,<br>n = 10              | -0.042***<br>(0.002) | 0.22                  | 0.21           | 0.20           | 0.80                        |
| Absolute wage growth,<br>10+ percent | -0.047***<br>(0.002) | 0.29                  | 0.19           | 0.18           | 0.87                        |

In the first column, controls include indicators for year, age, years of higher education, field of major, a quadratic in years of experience, and firm fixed effects. The sample for the regression in column (1) and for the promotion rate calculation in figure (2) consists of individuals ages 26 to 35 in years when a firm switch did not occur. In columns (3) and (4) the wage gain is the annual wage growth associated with a promotion. Column (5) calculates the share of the gender differences in lifecycle wage growth explained by promotion-related growth, using the decomposition from equation 2.

(instead of mean) wage growth of college-educated co-workers, again setting  $n$  equal to 10. Finally, for reference, we also define promotion as any real wage gain that exceeds 10%. Table A.3 summarizes the results, showing that both qualitatively and quantitatively, the main results are similar for a relatively wide range of values for  $n$ .

## A.5 Public Sector Majors

In Table A.4, we consider results for the full population of college graduates in the 1960-1970 cohort. The full population of graduates includes the baseline population analyzed throughout the paper, as well individuals with major associated almost entirely with public sector employment, omitted in the analysis. These include all majors related to teaching, medicine and social work. Column (1) in Panel A shows summary results for the baseline population. Column (2) shows results for just the omitted population, and column (3) provides results for all graduates from the 1960-1970 cohorts. As Panel A shows, even among individuals with predominantly public sector majors, the total wage gap by ages 40-45 is quite large, at 0.24, compared to 0.25 in the baseline population. The overall gender wage difference for all graduates when the two groups are combined is even higher than in the baseline group, at 0.26. The reason for this is that average wages in the omitted group, which has more women, are significantly lower than in the baseline group.

**Table A.4:** Summary Results: Baseline vs. Full Population

| Panel A: Summary Statistics    |                        |                      |                      |
|--------------------------------|------------------------|----------------------|----------------------|
|                                | Baseline<br>Population | Omitted<br>Majors    | All<br>Graduates     |
| Promotion Gap                  | 0.040***<br>(0.002)    | -0.033***<br>(0.002) | -0.037***<br>(0.001) |
| Mean Wage (Men), Ages 40 to 45 | 10.54                  | 10.35                | 10.46                |
| Mean Wage Gap, Ages 40 to 45   | 0.25                   | 0.24                 | 0.26                 |
| Men                            | 60,353                 | 12,398               | 72,751               |
| Women                          | 42,602                 | 33,839               | 76,441               |

| Panel B: Decomposition Results |                                                     |            |                      |
|--------------------------------|-----------------------------------------------------|------------|----------------------|
|                                | % of Gender Difference in Wage Growth Explained by: |            |                      |
|                                | Firm Switches                                       | Promotions | Non-Promotion Growth |
| Baseline Population            | 0.28                                                | 0.78       | -0.06                |
| Full Population                | 0.31                                                | 0.62       | 0.07                 |

In Panel A, estimates of the promotion gap control for indicators for year, age, years of higher education, field of major, firm, and include a quadratic in years of experience. The sample for estimates of the promotion gap consists of individuals ages 26 to 35 in years when a firm switch did not occur. All other estimates are for the full sample.

Next, Panel B compares decomposition results for the baseline vs. full population. The share of gender differences in lifecycle wage growth explained by firm switches is approximately similar in the two groups. However, the importance of gender differences in non-promotion growth increases in the full population. A combination of two factors accounts for this pattern. First, wage growth in non-promotion periods is lower in the omitted majors than in the baseline population. Second, women make up a larger share of the omitted majors. Correspondingly, the share of gender differences in wage growth explained by differences promotion-related growth decreases moderately, to 62%.

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# Tables And Figures

**Table 1:** Summary Statistics, 1960-1970 Cohort

|                                                         | Men        | Women      |
|---------------------------------------------------------|------------|------------|
| Labor Force Participation:                              |            |            |
| Ages 25-29                                              | 0.97       | 0.97       |
| Ages 30-34                                              | 0.96       | 0.95       |
| Ages 35-44                                              | 0.96       | 0.95       |
| Ages 40-45                                              | 0.95       | 0.95       |
| Employed Part-Time                                      | 0.04       | 0.18       |
| Educational Attainment:                                 |            |            |
| Bachelor's                                              | 0.43       | 0.54       |
| Master's, Ph.D., or Professional                        | 0.57       | 0.46       |
| Children and Fertility                                  |            |            |
| Mean Age at First Birth                                 | 32.95      | 31.72      |
| Had a child by 45                                       | 0.75       | 0.81       |
| Mean # of Children, Conditional on Having Children      | 2.25       | 2.19       |
| Workplace Characteristics                               |            |            |
| Share in Public Sector, Ages 25-30                      | 0.23       | 0.36       |
| Share in Public Sector, Ages 40-45                      | 0.21       | 0.37       |
| Average Log Firm Size                                   | 6.07       | 6.45       |
| Average Log Wage at Firm                                | 10.18      | 10.13      |
| Individuals                                             | 60,353     | 42,602     |
| Individual-Year Observations                            | 958,322    | 686,917    |
| Individual-Year Obs., incl. Educated Co-Workers at Firm | 39,193,218 | 39,037,944 |

Notes: All gender differences in means are statistically significant at the 1% level for all variables.

**Table 2:** Concentration of Lifecycle Wage Growth

|                                                                               |      |
|-------------------------------------------------------------------------------|------|
| Share of individuals who achieved, during three yrs. of greatest wage growth: |      |
| 50% of lifecycle wage growth                                                  | 0.80 |
| 60% of lifecycle wage growth                                                  | 0.55 |
| 70% of lifecycle wage growth                                                  | 0.34 |
| 50% of lifecycle wage growth (excluding first three years after graduation)   | 0.81 |

Notes: In the calculations above, the three years of greatest wage growth need not be consecutive. Sample includes only the 21,222 individuals for whom we observe wages in all years after graduation.

**Table 3:** Probability and Size of Wage Growth, By Type

|                           | Firm Switch |       | Promotion |       | Non-Promotion |       |
|---------------------------|-------------|-------|-----------|-------|---------------|-------|
|                           | Men         | Women | Men       | Women | Men           | Women |
| <i>Annual Probability</i> |             |       |           |       |               |       |
| Ages 26-30                | 0.295       | 0.291 | 0.215     | 0.173 | 0.490         | 0.535 |
| Ages 31-35                | 0.247       | 0.234 | 0.160     | 0.131 | 0.593         | 0.635 |
| Ages 36-40                | 0.192       | 0.186 | 0.108     | 0.093 | 0.701         | 0.721 |
| Ages 41-45                | 0.145       | 0.147 | 0.075     | 0.069 | 0.780         | 0.785 |
| <i>Annual Wage Growth</i> |             |       |           |       |               |       |
| Ages 26-30                | 0.095       | 0.084 | 0.199     | 0.186 | 0.033         | 0.031 |
| Ages 31-35                | 0.091       | 0.083 | 0.215     | 0.203 | 0.034         | 0.031 |
| Ages 36-40                | 0.065       | 0.059 | 0.211     | 0.195 | 0.020         | 0.022 |
| Ages 41-45                | 0.041       | 0.047 | 0.200     | 0.182 | 0.011         | 0.016 |

Notes: A promotion is defined as a large, discrete wage jump relative to one's co-workers at the same firm, in a year when an individual did not switch employers. See text for details.

**Table 4:** Summary of Individual Fixed Effect Model With Promotions

| Share of variance of log wages due to: | Men  | Women |
|----------------------------------------|------|-------|
| Individual effects                     | 0.25 | 0.25  |
| Of remaining variance, share due to:   |      |       |
| Cumulative number of promotions        | 0.46 | 0.44  |
| All other covariates                   | 0.40 | 0.47  |
| Residual                               | 0.14 | 0.09  |

Notes: The wage variance decomposition above is for a regression of log wages on individual and time fixed effects, years of experience interacted with field of major, and a set of indicators corresponding to the cumulative number of promotions and firm switches experienced by each age. A promotion is defined as a large, discrete wage jump relative to one's co-workers. See text for details.

**Table 5:** Importance of Cross-Firm vs. Within-Firm Differences, Ages 26 to 35

|                                                  | Gap  | Share of Gap Explained |
|--------------------------------------------------|------|------------------------|
| Gender Gap In Promotion Rates                    | 3.88 | -                      |
| Counterfactual: Same Distribution Across Firms   | 3.05 | 0.214                  |
| Counterfactual: Same Promotion Rate Within Firms | 0.97 | 0.749                  |

Notes: Calculations are for all individuals ages 26 to 35. In the first counterfactual, women are re-assigned to have the same distribution across firms as men. In the second counterfactual, women are assigned the same average promotion rate as men at their firm. A promotion is defined as a large, discrete wage jump relative to one's co-workers. See text for details. N = 190,404.

**Table 6:** Probability of Promotion Ages 26 to 35, With and Without Firm Fixed Effects

| Dependent Variable: Probability of Promotion | (1)                  | (2)                  |
|----------------------------------------------|----------------------|----------------------|
| Female                                       | -0.044***<br>(0.002) | -0.040***<br>(0.002) |
| Baseline Controls                            | Yes                  | Yes                  |
| Firm Fixed Effects                           | No                   | Yes                  |
| N                                            | 190,404              | 190,404              |

\*\*\* Significant at 1% level. Notes: Baseline controls include indicators for year, age, years of higher education, field of major, as well as a quadratic in years of experience. Sample includes all individuals ages 26 to 35 in years when a firm switch did not occur. In this and all subsequent tables, a promotion is defined as a large, discrete wage jump relative to one's co-workers. See text for details.

**Table 7:** Probability of Promotion Ages 26 to 35, With Controls for Occupation

| Dep. Variable: Probability of Promotion | (1)                  | (2)                  | (3)                  |
|-----------------------------------------|----------------------|----------------------|----------------------|
| Female                                  | -0.041***<br>(0.002) | -.0398***<br>(0.002) | -.0388***<br>(0.002) |
| Baseline Controls                       | Yes                  | Yes                  | Yes                  |
| Firm Fixed Effects                      | Yes                  | Yes                  | Yes                  |
| N                                       | 190,404              | 190,404              | 190,404              |

\*\*\* Significant at 1% level. Notes: Baseline controls include indicators for year, age, years of higher education, field of major, as well as a quadratic in years of experience. Column 1 controls for being in a clerical or administrative support occupation. Columns 2 and 3 control for two- and three-digit occupation codes, respectively. Sample includes all individuals ages 26 to 35 in years when a firm switch did not occur.

**Table 8:** Probability of Promotion Ages 26 to 35, By Average Weekly Hours Worked

| Weekly hours: | Avg. Hours | Promotion Rate | Share of Men | Share of Women |
|---------------|------------|----------------|--------------|----------------|
| 20 to 32      | 26.9       | 0.147          | 0.051        | 0.140          |
| 32 to 39      | 35.6       | 0.164          | 0.123        | 0.139          |
| 39 to 41      | 40.2       | 0.159          | 0.341        | 0.339          |
| 41 to 48      | 44.4       | 0.199          | 0.321        | 0.212          |
| 48 or more    | 53.9       | 0.244          | 0.145        | 0.053          |

The promotion rate is calculated for men, and is conditional on not having switched firms in the observation year. All hours calculations use the proxy hours measure. See text for details.

**Table 9:** Probability of Promotion Ages 26 to 35, With Controls for Hours Worked

| Dep. Variable: Probability of Promotion | (1)                  | (2)                  | (3)                  | (4)                  |
|-----------------------------------------|----------------------|----------------------|----------------------|----------------------|
| Female                                  | -0.040***<br>(0.002) | -0.038***<br>(0.002) | -0.032***<br>(0.003) | -0.021***<br>(0.003) |
| Baseline Controls & Firm Fixed Effects  | Yes                  | Yes                  | Yes                  | Yes                  |
| Controls for Part-Time History          | No                   | Yes                  | Yes                  | Yes                  |
| Controls for Hours Worked               | No                   | No                   | Yes                  | Yes                  |
| Controls for Year of Birth              | No                   | No                   | No                   | Yes                  |
| N                                       | 190,404              | 190,404              | 190,404              | 190,404              |

\*\*\* Significant at 1% level. Notes: All regressions include controls for year, age, years of higher education, field of major, a quadratic in years of experience, as well as controls for part-time history and specific hours worked within the ranges provided. Sample includes all individuals ages 26 to 35 in years when a firm switch did not occur.

**Table 10:** Promotion Gap Ages 26 to 35, By Average Weekly Hours Worked

| Promotion gap, by weekly hours worked: | (1)                  | (2)                  | (3)                  |
|----------------------------------------|----------------------|----------------------|----------------------|
| 20 to 32                               | -0.027***<br>(0.008) | -0.009<br>(0.015)    | -0.022***<br>(0.008) |
| 32 to 39                               | -0.036***<br>(0.006) | -0.032***<br>(0.010) | -0.032***<br>(0.006) |
| 39 to 41                               | -0.032***<br>(0.004) | -0.020***<br>(0.005) | -0.024***<br>(0.004) |
| 41 to 48                               | -0.031***<br>(0.005) | -0.015***<br>(0.006) | -0.019***<br>(0.005) |
| 48 or more                             | -0.031***<br>(0.009) | -0.008<br>(0.011)    | -0.014<br>(0.010)    |

\*\*\* Significant at 1% level. Notes: Each coefficient is the outcome of a separate regression. Controls include indicators for year, age, years of higher education, field of major, as well as a quadratic in years of experience. Sample includes all individuals ages 26 to 35 in years when a firm switch did not occur.

**Table 11:** Promotion Rate and Promotion Gap, by Years Relative to First Birth

|                                 | Promotion Gap<br>(1) | Promotion Rate<br>(2) | % Difference<br>(3) |
|---------------------------------|----------------------|-----------------------|---------------------|
| 5 to 1 years before first birth | -0.032               | 0.198                 | -16%                |
| Year of and first year after    | -0.087               | 0.163                 | -53%                |
| 2 to 10 years after first birth | -0.015               | 0.124                 | -12%                |

Notes: Calculations above are for individuals who ever had children, in years when a firm switch did not occur.

**Table 12:** Probability of Promotion, by Time to Birth

| Years to First Birth: | (1)                  | (2)                  | (3)                  | (4)                  | (5)                  |
|-----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| -5                    | -0.038<br>(0.009)*** | -0.033<br>(0.010)*** | -0.020<br>(0.011)*   | 0.018<br>(0.004)***  | -0.001<br>(0.004)    |
| -4                    | -0.022<br>(0.008)*** | -0.023<br>(0.008)*** | 0.000<br>(0.010)     | 0.018<br>(0.006)***  | 0.002<br>(0.005)     |
| -3                    | -0.038<br>(0.007)*** | -0.037<br>(0.008)*** | -0.029<br>(0.009)*** | 0.009<br>(0.005)*    | 0.007<br>(0.005)     |
| -2                    | -0.036<br>(0.006)*** | -0.037<br>(0.007)*** | -0.027<br>(0.008)*** | 0.007<br>(0.005)     | 0.008<br>(0.005)***  |
| -1                    | -0.033<br>(0.006)*** | -0.031<br>(0.006)*** | -0.032<br>(0.007)*** | 0.000<br>(0.000)     | 0.000<br>(0.000)     |
| 0                     | -0.089<br>(0.005)*** | -0.090<br>(0.005)*** | -0.086<br>(0.005)*** | -0.065<br>(0.005)*** | 0.000<br>(0.004)     |
| 1                     | -0.086<br>(0.004)*** | -0.084<br>(0.005)*** | -0.077<br>(0.005)*** | -0.076<br>(0.005)*** | -0.010<br>(0.004)*** |
| 2                     | -0.033<br>(0.004)*** | -0.018<br>(0.005)*** | -0.006<br>(0.007)    | -0.035<br>(0.004)*** | -0.019<br>(0.004)*** |
| 3                     | -0.039<br>(0.004)*** | -0.029<br>(0.005)*** | -0.007<br>(0.006)    | -0.038<br>(0.004)*** | -0.011<br>(0.004)*** |
| 4                     | -0.035<br>(0.004)*** | -0.024<br>(0.005)*** | -0.020<br>(0.005)*** | -0.038<br>(0.004)*** | -0.012<br>(0.004)*** |
| 5                     | -0.026<br>(0.004)*** | -0.017<br>(0.004)*** | -0.014<br>(0.005)*** | -0.030<br>(0.004)*** | -0.011<br>(0.004)*** |
| 6                     | -0.021<br>(0.004)*** | -0.009<br>(0.004)*** | -0.001<br>(0.005)    | -0.030<br>(0.004)*** | -0.012<br>(0.004)*** |
| 7                     | -0.020<br>(0.004)*** | -0.008<br>(0.004)*** | -0.003<br>(0.005)    | -0.032<br>(0.004)*** | -0.012<br>(0.004)*** |
| 8                     | -0.024<br>(0.004)*** | -0.014<br>(0.004)*** | -0.005<br>(0.005)    | -0.026<br>(0.004)*** | -0.003<br>(0.004)    |
| 9                     | -0.021<br>(0.004)*** | -0.013<br>(0.004)*** | -0.008<br>(0.005)*   | -0.028<br>(0.005)*** | -0.005<br>(0.004)    |
| 10                    | -0.010<br>(0.004)*** | 0.000<br>(0.004)     | 0.003<br>(0.005)*    | -0.032<br>(0.004)*** | -0.006<br>(0.004)*   |

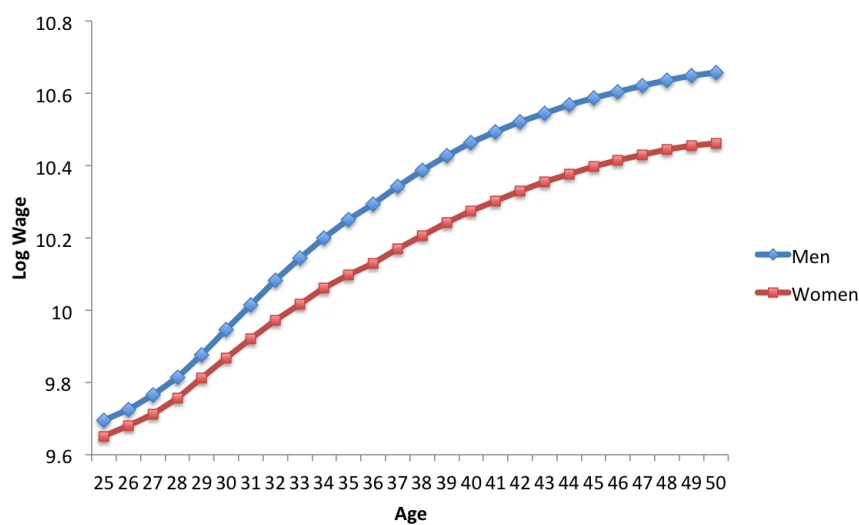
\* Significant at 10% level. \*\*\* Significant at 1% level. Notes: Columns (1) to (3) provide point estimates and standard errors for the three series in Figure 9. Column (1) refers to the baseline results. Column (2) adds controls for part-time work and part-time history. Column (3) adds controls for hours worked using the proxy variable. Columns (4) and (5) provide point estimates and standard errors for the three series in Figure 11. Column (4) refers to the motherhood gap and column (5) refers to the fatherhood gap.

**Table 13:** Share Promoted, By Lifetime Fertility

|               | Never Have Children |       | Ever Have Children |       |
|---------------|---------------------|-------|--------------------|-------|
|               | Men                 | Women | Men                | Women |
| Ages 26 to 35 | 0.164               | 0.136 | 0.183              | 0.153 |
| Ages 36 to 45 | 0.087               | 0.078 | 0.094              | 0.082 |

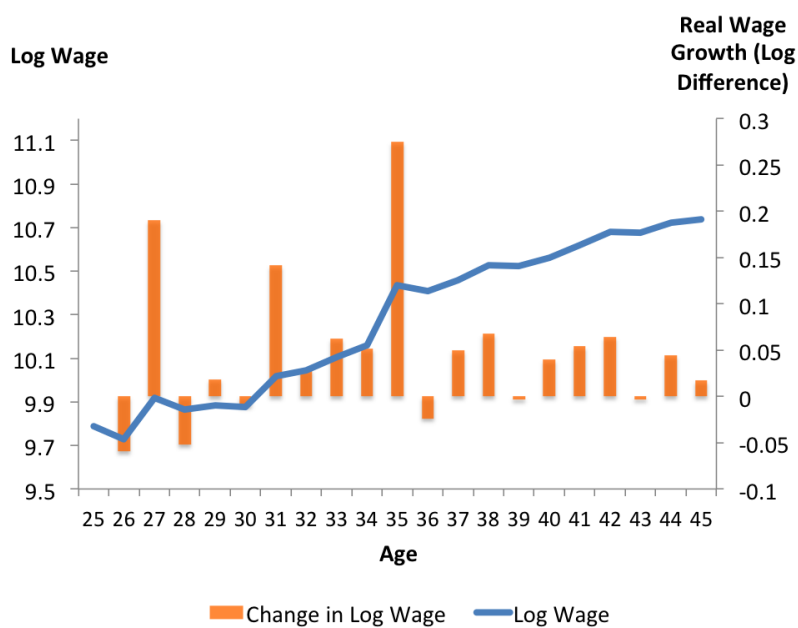
Notes: All gender differences statistically significant at 1% level.

**Figure 1:** Lifecycle Wage Profiles, Men and Women with College Education

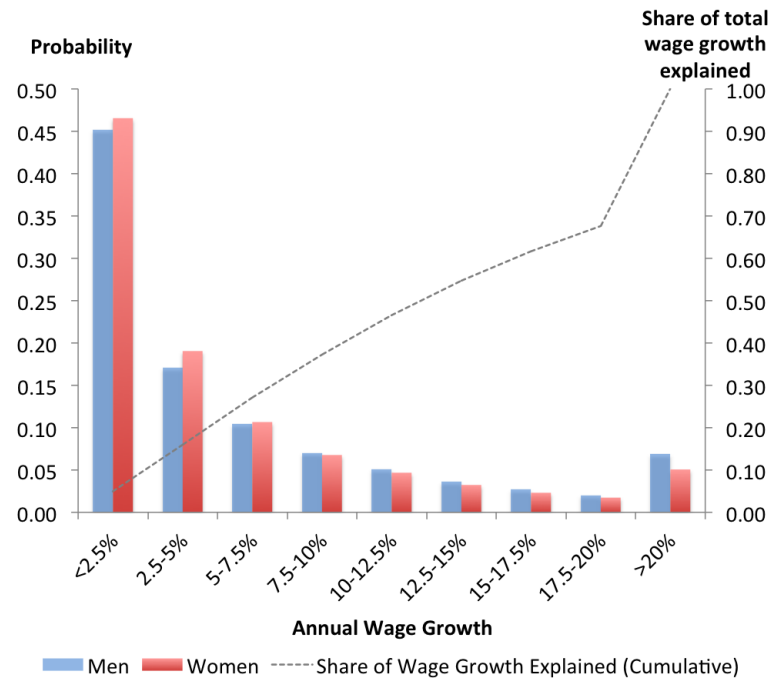


Notes: Graph follows college-educated individuals from the 1960-1970 birth cohorts in Sweden. For sample details, see Section 2. Source: Statistics Sweden.

**Figure 2:** Example of Individual's Lifecycle Wage Growth

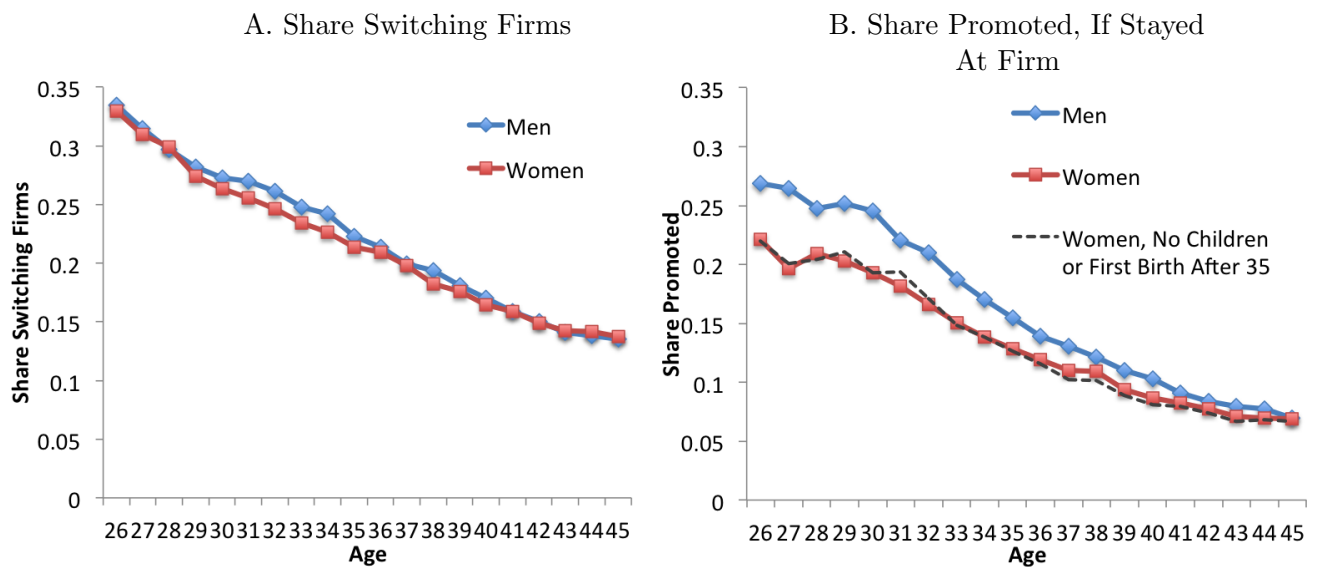


**Figure 3:** Distribution of Annual Wage Growth, Ages 25 to 45



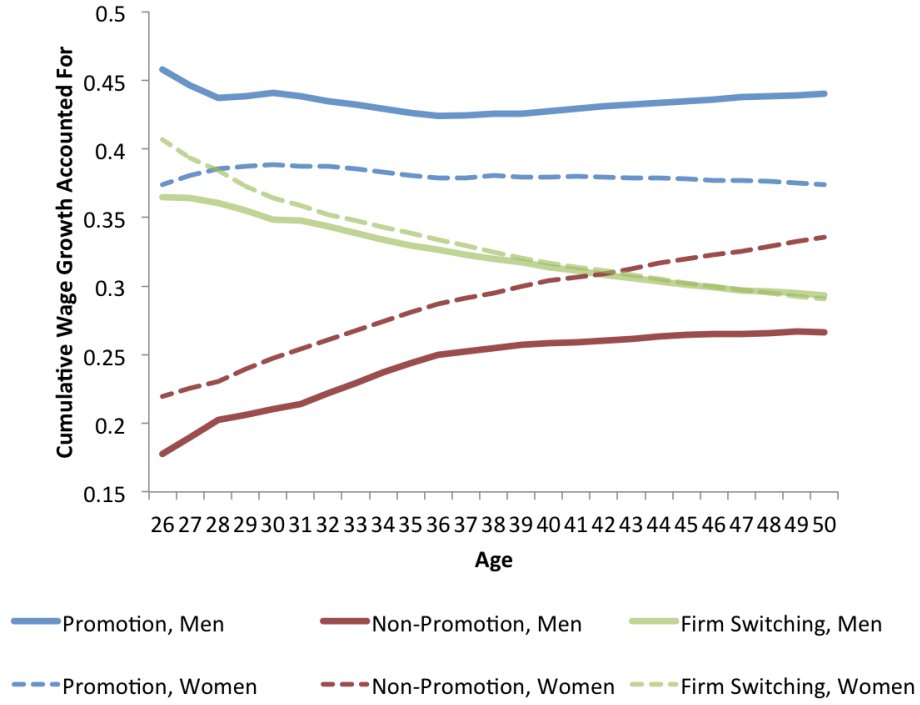
Notes: The histogram above tabulates individual-year level observations of real annual wage growth.

**Figure 4:** Share Switching Firms and Share Promoted, by Age



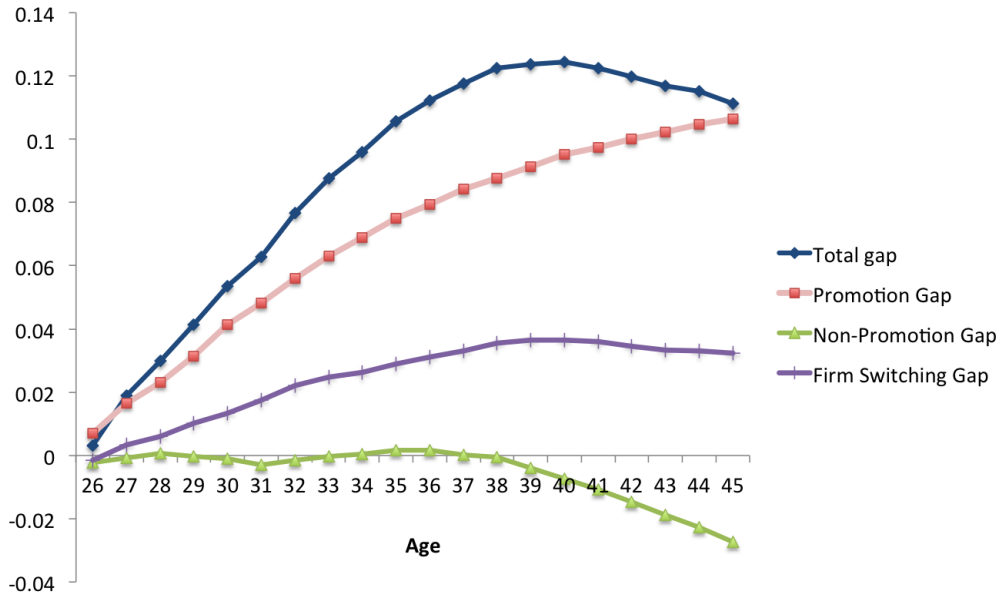
Notes: Panel A graphs the share switching firms out of all workers. Panel B graphs the conditional share promoted, out of those who did not switch firms in the current period. A promotion is defined as a large, discrete wage jump relative to one's co-workers at the same firm. See text for details.

**Figure 5:** Decomposition of Lifecycle Wage Growth



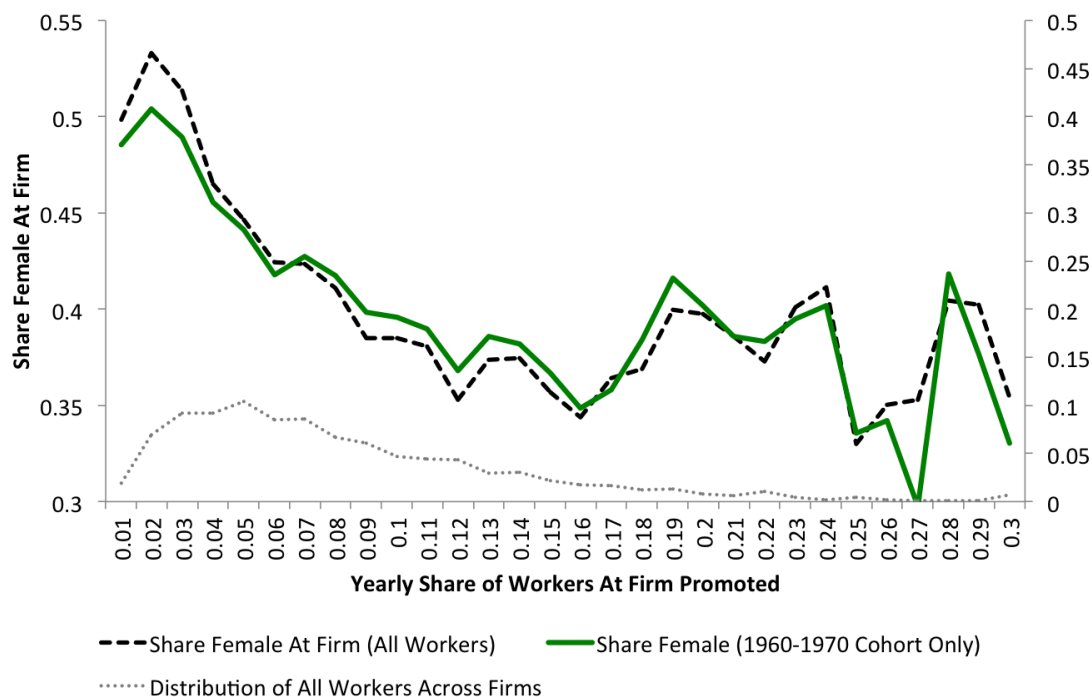
Notes: A promotion is defined as a large, discrete wage jump relative to one's co-workers at the same firm, in a year when an individual did not switch employers. See text for details.

**Figure 6:** Decomposition of the Growth in the Gender Wage Gap

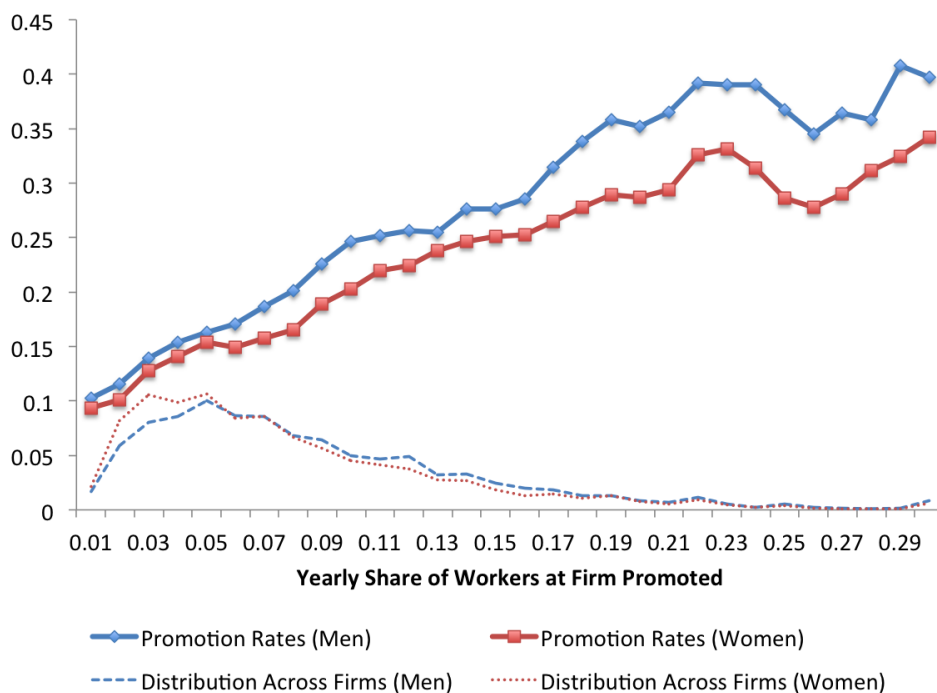


Notes: A promotion is defined as a large, discrete wage jump relative to one's co-workers at the same firm, in a year when an individual did not switch employers. See text for details. The promotion gap refers to gender differences in wage growth due to promotions. The firm-switching gap refers to gender differences in growth due firm switches. The non-promotion gap refers to gender differences in growth due to years associated with interim, non-promotion wage growth. The total gap refers to the total gender difference in wage growth since age 25.

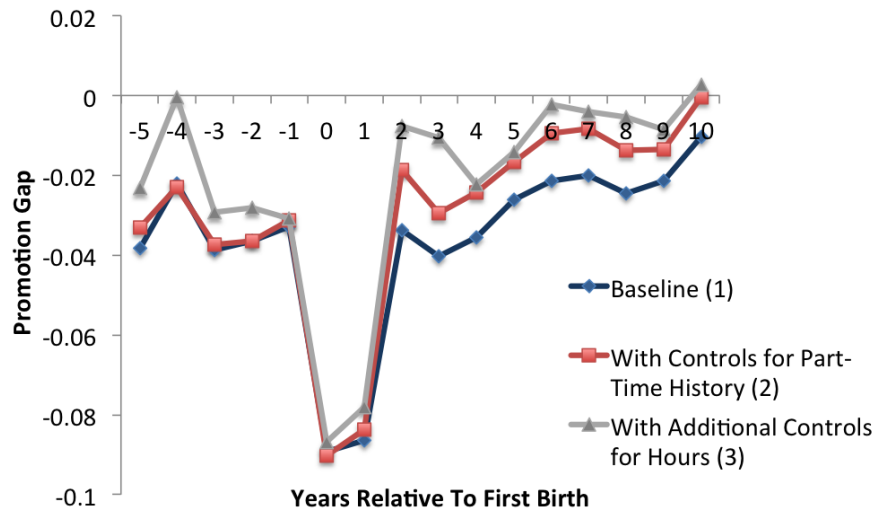
**Figure 7:** Share Female At Firm, By Opportunities for Upward Movement at Firm



**Figure 8:** Share of 1960-1970 Cohort Ages 26 to 35 Promoted At Firm, By Opportunities for Upward Movement at Firm

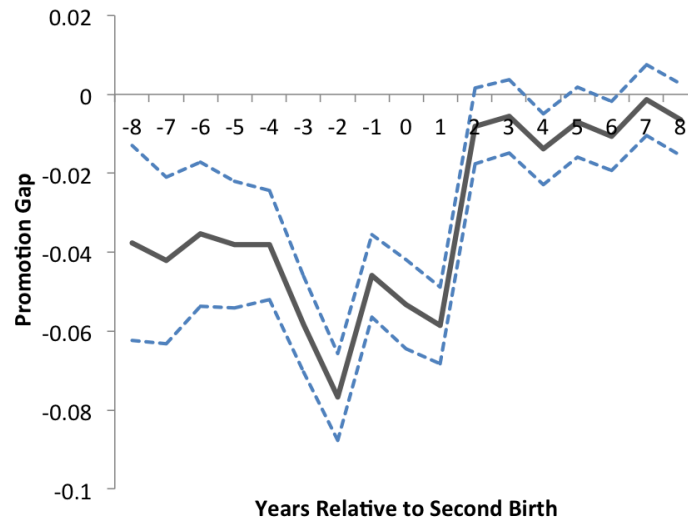


**Figure 9:** Gender Gap in Promotions, by Years Relative to First Birth



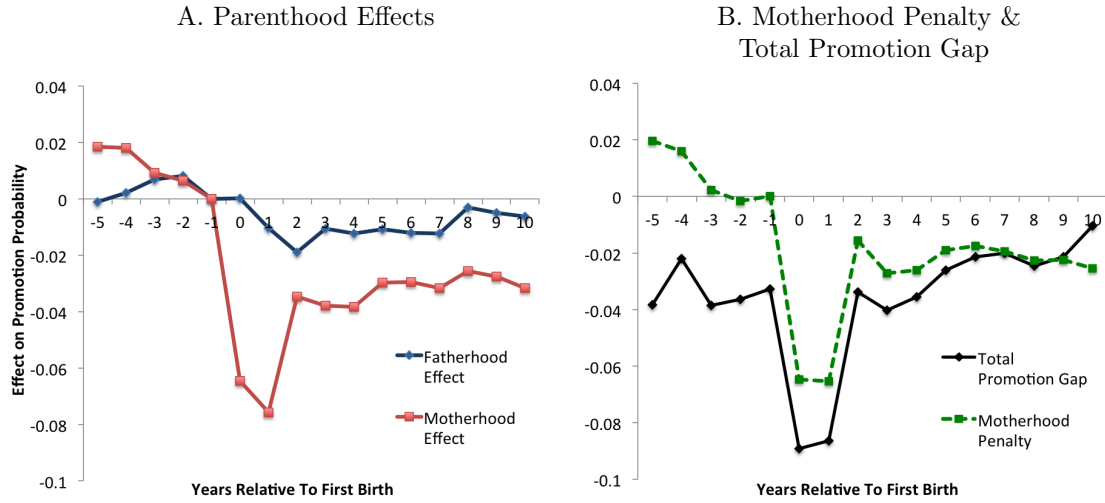
Notes: Confidence intervals omitted for clarity. See Table 12 for standard errors for all coefficients. All regressions include baseline controls for year, age, years of higher education, field of major, and a quadratic in years of experience. The promotion gap represents the coefficient on “female,” or the gender difference in promotion probability.

**Figure 10:** Gender Gap in Promotions, by Years Relative to Second Birth



Notes: The dashed series graph the 95% confidence interval. Regressions are restricted to only individuals who ever have two or more children, and include all baseline controls for year, age, years of higher education, field of major, a quadratic in years of experience, as well as controls for part-time work and part-time history. The promotion gap represents the coefficient on “female,” or the gender difference in promotion probability.

**Figure 11:** Parenthood Effects, Motherhood Penalty, and Total Promotion Gap by Years Relative to First Birth



Notes: The “motherhood penalty” in Panel B is equal to the difference between the motherhood and fatherhood effects, graphed in Panel A. The “total promotion gap” plots the estimates for the full promotion gap from Table 9. Confidence intervals omitted for clarity. See Table 12 for standard errors. All regressions include baseline controls for year, age, years of higher education, field of major, and a quadratic in years of experience.

**Figure 12:** Importance of Promotions and Size of Wage Gap, by Profession

