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A Grand Gender Convergence: Its Last Chapter

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ABSTRACT: The converging roles of men and women are among the grandest advances in society and the economy in the last century. These aspects of the grand gender convergence are figurative chapters in a history of gender roles. But what must the “last” chapter contain for there to be equality in the labor market? The answer may come as a surprise. The solution does not (necessarily) have to involve government intervention and it need not make men more responsible in the home (although that wouldn’t hurt). But it must involve changes in the labor market, in particular how jobs are structured and remunerated to enhance temporal flexibility. The gender gap in pay would be considerably reduced and might vanish altogether if firms did not have an incentive to disproportionately reward individuals who labored long hours and worked particular hours. Such change has taken off in various sectors, such as technology, science and health, but is less apparent in the corporate, financial and legal worlds.

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Converging Roles

Of the many advances in society and the economy in the last century the converging roles of men and women are among the grandest. A narrowing has occurred between men and women in labor force participation, paid hours of work, hours of work at home, life-time labor force experience, occupations, college majors and education, where there has been an overtaking by females.¹ And there has also been convergence in earnings, on which this essay will focus. Although my evidence is for the United States, the themes developed are more broadly applicable.

These parts of the grand gender convergence occupy various metaphorical chapters in the history of gender roles in the economy and society. But what must be in the “last” chapter for there to be real equality?

The answer may come as a surprise. The solution does not (necessarily) have to involve government intervention. It does not have to improve women’s bargaining skills and desire to compete. And it does not necessarily have to make men more responsible in the home (although that wouldn’t hurt). But it must involve alterations in the labor market, in particular changing how jobs are structured and remunerated to enhance temporal flexibility. The gender gap in pay would be considerably reduced and might even vanish if firms did not have an incentive to disproportionately reward individuals who worked long hours and who worked particular hours. Such change has already occurred in various sectors, but not in enough.

Before I discuss what is needed to close the gender gap and what must be in the last chapter, I should first discuss what is contained in the preceding figurative chapters. That will set the stage for the detective work necessary to uncover what the last chapter must contain.

The preceding metaphorical chapters unfolded across at least the last century. Narrowing occurred in a host of economic areas. Changes in labor force participation and the reasons for the changes were discussed in my Ely Lecture (Goldin 2006). A grand convergence occurred in labor force participation for adult women from the early twentieth century to more recently. But a plateau in participation has emerged for U.S. women in most age groups, even for college graduate women, ever since around the 1990s. The plateau may be related to the relative earnings issues that I will soon discuss. If certain women are disadvantaged in the labor market their participation will be stymied.²

Lifetime job experience rose along with labor force participation. Years of education for

¹ See Goldin, Katz and Kuziemko (2006) on women’s college education. In terms of years of schooling, U.S. women were ahead of men until the 1930s and then regained the lead (Goldin and Katz 2008a).

² The labor force participation plateau is also related to government policies regarding the length of family leave job protections. See Blau and Kahn (2013).

women increased more than it did for men and it changed in content for secondary and college education toward more investment-oriented and fewer consumption-oriented courses and concentrations. Professional and graduate program enrollment increased for women so that about half of all law and medical enrollments today are women, and women lead men in fields such as the biological sciences, pharmacy, optometry and veterinary medicine.

Women, particularly college graduates, increased their desire to attain “career and family.”³ Hours of work for women increased in the market and decreased in the home relative to those of men. Female earnings rose relative to males in an era that saw women “swimming against the tide” of generally rising income inequality.⁴ Thus the various metaphorical chapters that precede the “last” chapter explored here are those of a grand gender convergence.

Convergence in some economic outcomes has also occurred *within* various groups of women. Until the 1970s most non-employed adult women had not been in the workforce since they were first married or since having their first child. Currently employed women, however, had worked most years since school leaving.⁵ With increased labor market participation women were no longer divided as much along the lines of currently or not currently employed.

Gender Gaps in Earnings over the Life-Cycle and by Occupation

Even though there are many ways to measure the degree of gender equality in the economy, the one that stands out is earnings, particularly earnings per unit time or the wage. Because relative earnings often signify how individuals are valued socially and economically, earnings ratios between men and women have been banners for social movements. The mantra of the women’s movement in the 1970s was “59 cents on the dollar” and a more recent crusade for pay equality has adopted “77 cents on the dollar.”

The wage is also a summary statistic for an individual’s education, training, prior labor force experience and expected future participation. The gender gap in wages is a summary statistic for gender differences in work. For a long time the gender gap in wages has been viewed as summarizing human capital differences between men’s and women’s productivity as well as differential treatment of men and women in the labor market. As the grand gender convergence has proceeded, underlying differences between the human capital capabilities of women and men have been vastly reduced and in many cases eliminated.⁶

³ The history of the goal and achievement of career and family is discussed in Goldin (2004, 2006).

⁴ On trends in the gender pay gap, in particular the narrowing in the 1980s and 1990s, see Blau and Kahn (1997, 2000, 2006a).

⁵ Data on “heterogeneity” and “homogeneity” of labor force participation are in Goldin (1989). Wage inequality, however, has risen within the group of employed women since the 1980s as it has for men.

⁶ Altonji and Blank (1999) present a standard treatment and find (table 4) that the gender gap in CPS data

What do we know about how much of the difference between male and female wages is due to differential treatment in the labor market and how much to differences in productive characteristics? That question has been addressed by many and I will briefly summarize the findings and provide further comment.

Most of the gender wage gap studies have produced estimates of an “explained” and a “residual” portion.⁷ The “residual” is often termed “wage discrimination” since it is the difference in earnings between observationally identical males and females.

The explained portion of the gender wage gap decreased over time as human capital investments between men and women converged. Differences in years of education, in the content of college and in accumulated labor market experience narrowed. In consequence, the residual portion of the gap rose relatively.⁸

But what can explain the residual portion of the gap that now remains? There are many contenders. Some would claim that earnings differences for the same position are due to actual discrimination. To others it is due to women’s lower ability to bargain and their lesser desire to compete.⁹ And still others blame it on differential employer promotion standards due to gender differences in the probability of leaving.¹⁰

A better answer, I will demonstrate, can be found in an application of personnel economics.¹¹ The explanation will rely on labor market equilibrium with compensating differentials and endogenous job design.

As women have increased their productivity enhancing characteristics and as they “look” more like men, the human capital part of the wage difference has been squeezed out. What remains is largely how firms reward individuals who differ in their desire for various amenities. These amenities are various aspects of workplace flexibility. Workplace flexibility is a

for 1979 was larger than for 1995 and that a larger fraction was explained by human capital variables.

⁷ Estimates of the explained and residual portions can be found in Blau and Kahn (2006b) and O’Neill and Polachek (1993), who put considerable emphasis on the increase in job market experience for the narrowing of the gender wage gap in the 1980s. Mulligan and Rubinstein (2008), however, claim that changes in selection were responsible.

⁸ According to Blau and Kahn (2006b, table 3) who use the PSID, the raw gender gap in earnings for full-time employed workers was 0.459 in 1979 and 0.227 in 1998. Human capital factors explain 24.6 percent of the raw gender pay gap in 1979 but just 7.93 percent of the gap in 1998.

⁹ On the role of bargaining, see Babcock and Laschever (2003). On competition see Gneezy, Niederle and Rustichini (2003) and Niederle and Vesterlund (2007). Manning and Saidi (2010), however, find little empirical evidence for competition in explaining the gender gap in earnings.

¹⁰ Lazear and Rosen (1990) assume narrowly defined occupations in which there should be no gender gap but they generate one based on different preferences for employment discontinuity between women and men. Employers have higher ability standards for promoting women than men.

¹¹ For a modern version of the field of personnel economics see Lazear (1995).

complicated, multidimensional concept. The term includes the number of hours to be worked and also the need to work particular hours, to be “on call,” give “face time,” be around for clients, be present for group meetings and so forth. Because these idiosyncratic temporal demands are generally more important for the highly-educated workers, I will emphasize the college educated and occupations at the higher end of the earnings distribution.

The alternative explanations for the residual gender pay gap regarding how women compete and bargain relative to men have some merit. But they do not explain why different amounts of time out of the labor force and different numbers of hours worked per day or per week have a large effect on the time-adjusted earnings in some occupations but not in others. They do not explicate why some positions have a highly nonlinear pay structure with regard to hours worked and some are almost perfectly linear. An application of personnel economics assists in explaining these features of the labor market.

Jobs for which bargaining and competing matter the most, I will demonstrate, are also positions that have the greatest nonlinearities of pay with respect to time worked. Field and laboratory experiments often show that women shy away from competition.¹² But these experiments do not consider the types of jobs that reward competition the most. Often those are winner-take-all positions, such as partner in a firm, tenured professor at a university, or top manager. These are also positions for which considerable work hours leads to a higher chance of obtaining the reward, and it is often the case that hours alone get rewarded. Persistence in these positions and continuous time on the job probably matters far more to one’s success than a desire and ability to compete.

The alternative reasons for the residual gender pay gap do not help illuminate why earnings differences by sex expand so greatly with age. They also do not explain why women without children generally have higher earnings than women with children and why the former’s earnings are almost equal to those of comparable men.¹³

But I have gotten ahead of myself. Let us first look at the evolution of gender gaps in earnings over the life-cycle and differences by occupation. These hold clues to what must be in the last chapter for it to be the finale of the grand gender convergence.

In the aggregate and over the life-cycle

The ratio of (mean) annual earnings between male and female workers (full-time, full-year, 25 to 69 years) was 0.72 in 2010 and that of the medians was 0.77. The ratio of the medians for the same group was 0.74 in 2000 but 0.56 in 1980.¹⁴ These aggregate ratios have

¹² For a description of many field and laboratory experiments, see Gneezy and List (2013).

¹³ A large literature on the “child earnings penalty” exists. See, for example, Waldfogel (1998).

¹⁴ Full-time, full-year means 35 hours or more and 40 weeks or more per year throughout this piece. The

been somewhat sticky for the last ten years or so after greatly increasing in the preceding decades, especially in the 1980s. The same is true looking only at college graduates, for whom the ratios are lower—0.65 in 2010 for the means and 0.72 for the medians, about the same as it was in 2000. Interestingly, across the past decade the gender pay gap has narrowed *within* almost all age groups even though the aggregate has not budged as much. How can that be?

The answer concerns what happens to the gender gap over the life-cycle. The ratio of female to male earnings greatly decreases for some time as cohorts age. It is lower for individuals in their forties compared with the same individuals in their twenties. And because the baby boom is still working its way through the population, the aggregate ratio can be fairly stable even though the underlying components are actually increasing.

One way to see change in the earnings gender gap by age is to construct synthetic birth cohorts, as shown in Figure 1a for college graduate men and women working full-time, full-year and in Figure 1b for college graduates with controls for hours, weeks, and further education.¹⁵ The data used are from the U.S. Census and the American Community Survey (ACS) for the years from 1970 to 2010.

The most obvious and important findings from these depictions are that each cohort has a higher ratio of female to male earnings than the preceding one and that the ratio is higher for younger individuals than it is for older individuals, at least up to some age. One part of the story of the preceding metaphorical chapters is that there have been large gains in the earnings of women relative to men. An important clue to what it will take to create gender equality in earnings is that something happens that decreases women's earnings relative to those of men as they age.

Men and women begin their employment with earnings that are fairly similar, both for full-time year-round workers and for all workers with controls for hours and weeks. In the case of the latter group, relative earnings are in the 90 percent range for the most recent cohorts even without any other controls. But these ratios soon decline and in some cases plummet to below the 70 percent level.

Interestingly, in most cases the ratio increases again when individuals are in the forties (for the most recent of the cohorts to be old enough to be in that age bracket). Why it increases is beyond the scope of the present work. It would appear to be less a function of selection since

sample excludes earnings outliers and members of the armed forces. The 2010 ratios are an average for 2009 to 2011 from the American Community Survey micro-data. Those for 1980 and 2000 are computed from the U.S. Census micro-data.

¹⁵ The synthetic cohort ratios are derived from a set of cross-section regressions on white, native-born, non-military full-time, full-year workers. See the notes to Figure 1. Manning and Swaffield (2008) find similar results using British longitudinal and cross-section data.

in most cases the women who left would be drawn disproportionately from the lower part of the earnings distribution and those returning would presumably be the same individuals with less accumulated human capital. If anything, the function should increase and then decrease.

The main conclusion from the aggregate earnings gender gaps is that *the difference in earnings by sex greatly increases during the first several decades of working life*. That conclusion will be reaffirmed by the findings of studies of several highly specific occupations for which the training for both men and women is identical. The two degrees are MBA and JD. The data for these occupations, moreover, is longitudinal (or retrospective) thereby containing actual cohorts, not synthetic ones. In addition, the data contains detailed productivity-related characteristics.

By occupation

Within versus between occupation differences by gender

Another important clue concerning what the last chapter must contain arises from the fact that the majority of the current earnings gap comes from *within* occupation differences in earnings rather than from between occupation differences. What happens within each occupation is far more important than the occupations in which women wind up.

The fact can be demonstrated several ways. One is by observing the coefficient on female in a log earnings regression when a full set of three-digit occupation dummies are added. Table 1 gives the results for four samples from the 2009 to 2011 ACS: two for all education groups and two limited to (four-year) college graduates. For each of these samples, one version is for all workers and one is for those working full-time, full-year. All regressions include age as a quartic, race and year. Measures of time worked (log hours, log weeks) and education levels (above college for the college graduates) are successively added. Occupation dummies (three-digit level) are included in the most complete specification.

Absorbing the effect of all occupations decreases the coefficient on female by no more than one-third. Take the case of college graduates working full-time, full-year (“full-time, BA”). The female coefficient is -0.285 (a ratio of 0.752) with no additional variables. Adding log hours and log weeks reduces the coefficient to -0.230 (0.795). Absorbing all occupations reduces the coefficient on female to -0.163 (0.850), or almost 30 percent of the distance to equality. In the case of all education groups, the inclusion of all occupations decreases the gap by somewhat less. For the full-time, full-year sample that includes the education variables, the gap decreases from -0.247 (0.781) to -0.192 (0.825) or by just 22 percent.

Another way to measure the effect of occupation is to ask what would happen to the aggregate gender gap if one equalized earnings by gender within each occupation or, instead,

evened their proportions for each occupation. The answer is that equalizing earnings within each occupation matters far more than equalizing the proportions by each occupation. The precise results of the exercise will depend on the choice of weights.

Taking the case of gender gaps by occupation for college graduates (full-time, full-year) including age as a quartic, race, year, additional education levels, log hours, and log weeks, the aggregate gap is 0.323 log points. Of that difference, 68 percent is due to the within gap and 32 percent to the between when the male weights and the female earnings are used. If the opposite is used (the female weights and male earnings) 58 percent is due to the within gap and 42 percent to the between.

The main takeaway is that what is going on within occupations—even when there are 469 of them as in the case of the Census and ACS—is far more important to the gender gap in earnings than is the distribution of men and women by occupations. That is an extremely useful clue to what must be in the last chapter. If earnings gaps within occupations are more important than the distribution of individuals by occupations then looking at specific occupations should provide further evidence on how to equalize earnings by gender. Furthermore, it means that changing the gender mix of occupations will not do the trick.

Gender differences in pay for high-earning occupations

To further understand differences by occupations, I estimate log earnings equations using the 2009 to 2011 ACS including various observables, such as a quartic in age, education dummies, race, years, log hours and log weeks. The regression also includes occupation dummies, a female dummy and an interaction of occupation and female. Three versions of the residual gender difference by occupation have been graphed in Figure 2. Each is for full-time, full-year workers, one is for all workers, one is for college graduates, and another is for “young” (under 45 years) workers.

The graphs give the coefficients for approximately the top 95 occupations ranked by male (wage and business) income. I have graphed only the top occupations because they are more easily grouped by occupation type.¹⁶ In addition, they include a large fraction of all college graduate workers: 61 percent of all college graduate men and 45 percent of all college graduate women are in the top group depicted in Figure 2 using the full-time, full-year college sample.¹⁷

¹⁶ Another reason to focus on top earners is that they comprise the bulk of professional service workers for whom the framework to be developed is most relevant (Briscoe 2007).

¹⁷ A smaller fraction of women than men is included because elementary and secondary school teachers are just below the income cutoff. Little would change if the income cutoff was lowered. Note there for all workers there is a very weak positive relationship between the (residual) gender pay gap and earnings for all occupations ($\rho = +0.057$) and a weak negative relationship ($\rho = -0.16$) for the college graduate group (in both cases for occupations with > 25 men and > 25 women).

The findings gleaned from each of the graphs are similar although the levels are a bit different. In almost all cases the coefficient on female for each of the occupations is negative. That should not come as a surprise since it is a reflection of the lower earnings women receive relative to men in almost all occupations. If the individual's past employment history was included, as it will be for specific occupations presented later, the coefficients would be considerably smaller. Presented as in Figure 2, the coefficients give the raw gender gap in pay adjusted for age, education and time worked.

One way to think about the coefficient is that it is the penalty to being a woman relative to a man of equal education and age, given hours and weeks of work for each of the occupations. But why should the penalty differ so greatly by occupation, even for occupations that are high paying?

Each of the occupations has been categorized into one of five sectors: Business, Health, Science, Technology, and a miscellaneous group called "Other." Although the categorization was generally clear (e.g., engineers in Technology; physicians in Health), O*Net occupation descriptions and groupings of the occupations were used for less obvious cases.¹⁸ The list of occupations by category is given in Appendix Table A1.

The clear finding is that the occupations grouped as Business have the largest negative coefficients and that occupations grouped as Technology and Science have the smallest ones. That is, given age and time worked residual differences for Business occupations are large and residual differences in Technology and Science are small. In fact, for the "young" group (less than 45 years old) some Technology and Science occupations have positive coefficients.¹⁹

For the full-time, full-year sample including, in addition to the basic set of variables, log hours, log weeks and education in years, the residual difference for the Business occupations (weighted by the number of individuals in each of the occupations) is -0.240 and the residual difference for the Technology and Science occupations combined is -0.114 . For the sample of college graduates the differences are -0.227 for Business and -0.102 for Science and Technology. Residual differences for the Health and Other groups are heterogeneous.²⁰

These residual differences by occupation provide another important clue about what must be in the last chapter for there to be gender equality. If one can isolate the features of occupations that have high and low residual differences by gender one can figure out what factors make for more equal pay. But before I explore the reasons for these differences I must

¹⁸ The Department of Labor's Occupational Information Network (O*Net) is the successor to the Dictionary of Occupational Titles (DOT), which was first published by the Department of Labor in 1938 and last updated in 1991.

¹⁹ All but one coefficient has a t-statistic exceeding 2.8.

²⁰ These averages are for the 95 occupations for which the groupings are identified.

address the possibility that the coefficients for some of the occupations, in particular the “technology” occupations in which there are relatively few women, are largely driven by selection. My answer will be that selection is not the dominant reason for the small penalty to being a woman working in the technology and science fields.

Potential biases: Technology occupations

The fact that individuals in the technology occupations have among the lowest residual gender gaps may be greeted with some skepticism. These are not occupations in which women are a large fraction and the fields of training for many of them are also not those in which women are abundant. Perhaps the finding is due to selection: the best men and the worst women could leave technology occupations after a brief tenure. The men who leave could begin their own businesses and have titles like CEO and the women who leave could become science teachers. These individuals would not show up in the technology occupations. Another issue is whether the low gender gaps in recent data are because of the industries in which these individuals are hired rather than something about the technology occupations.

I use the National Survey of College Graduates, 2003 (NSCG03) to explore if women with technology degrees have different labor force participation rates than those of other college graduate women. The answer is that they do not have lower participation rates given age (entered as a quartic). In fact, women with BAs or higher degrees in technology fields have somewhat greater participation than other women.²¹ One reason for their slightly higher participation is that having young children (less than two years old) reduces participation for all college graduate women but there is a lesser impact on those with technology degrees. “Tech” appears to enable women to work part-time or to work more flexibly.

Does the smaller gender gap result mainly from the characteristics of the technology occupations or from the features of the industries of the technology employees? The answer is that it results far more from the occupation than from the industry. To examine whether industry is the locus of greater gender equality rather than occupation I create a variable measuring the fraction of the industry’s workforce in one of the identified technology occupations.

To see whether the industry of the technology workers matters a log earnings regression is estimated similar to the previous ones but is limited to individuals in one of the technology occupations. I add a variable measuring the fraction of the industry workforce in technology (see Appendix Table A2). Some industries, such as “computer systems design,” have a large fraction of their workers in technology occupations (around 60 percent) whereas others, such as “motor vehicle manufacturing,” are moderate (around 12 percent) and still others are very low. Engineers and information technology workers are hired in almost all industries. The technology

²¹ All of these results hold if technology field is defined as a BA field rather than including MA and PhD fields. Women with degrees in technology fields have a 2 percentage point higher participation rate.

industry variable is also interacted with female.

The results are that technology workers in industries with more technology workers earn considerably more than workers in other industries, even with occupation fixed effects. But women do not earn disproportionately more than men within the technology industries. The bottom line is that technology occupations and not technology industries more generally are associated with greater gender equality in earnings.²²

A Personnel Economics Theory of Occupational Pay Differences

Micro-foundations of compensating differentials

Residual differences by occupation in earnings by gender, I will demonstrate, are largely due to the value placed on the hours and job continuity of workers, including the self-employed.²³ Individuals in some occupations work 70 hours a week and receive far more than twice the earnings of those who work 35 hours a week. But in other occupations they do not. Some occupations exhibit linearity with respect to time worked whereas others exhibit nonlinearity.²⁴ When earnings are linear with respect to time worked the gender gap is low; when there is nonlinearity the gender gap is higher.

Total hours worked are generally a good metric for time on the job. But often what counts are the particular hours worked. The employee who is around when others are as well may be rewarded more than the employee who leaves at 11 am for two hours but is hard at work for two additional hours in the evening. Even the self-employed may have nonlinear earnings because they cannot fully delegate responsibility.

Gender differences in earnings across occupations and occupational groups substantially concern job flexibility and continuity. By job flexibility I mean a multitude of temporal matters including the number of hours, precise times, predictability and ability to schedule one's own hours.

²² The results are robust to using the entire sample of occupations and comparing technology workers to all workers and they are also robust to using other measures of technology industries.

²³ The model described here contains similarities to that in Mincer and Polachek (1974) and Polachek (1981) in the concern with choice among occupations that depends on expected time employed. The difference is that the Mincer-Polachek sorting depends on differential skill depreciation by occupation whereas my model rests on differences in the productive efficiency of individuals who work for different amounts of time. A recent version of these notions is in Adda, Dustmann and Katrien (2011) who analyze data for non-college women in apprenticeship training programs.

²⁴ Many others have explored the earnings consequences of working lower hours. On physicians, see Sasser (2005) who also uses a compensating differentials framework. Still other researchers have asked whether firms offer an inefficiently small number of low-hour jobs and use high hour jobs to screen. See Gicheva (2013), Lander, Rebitzer and Taylor (1986), and Rebitzer and Taylor (1995).

I will now provide some micro-foundations for the notion that nonlinear pay with respect to hours worked is responsible for the majority of the residual differences observed in earnings by gender. These notions are the micro-foundations underlying the compensating differentials model of pay with respect to the amenity “job-flexibility.”

In many workplaces employees meet with clients and accumulate knowledge about them. If an employee is unavailable and communicating the information to another employee is costly, the value of the individual to the firm will decline. Equivalently, employees often gain from interacting with each other in meetings or through random exchanges. If an employee is not around that individual will be excluded from the information conveyed during these interactions and has lower value unless the information can be fully transferred in a low cost manner.

The point is quite simple. Whenever an employee does not have a perfect substitute nonlinearities can arise.²⁵ When there are perfect substitutes for particular workers and zero transactions costs, there is never a premium in earnings with respect to the number or the timing of hours. If there were perfect substitutes earnings would be linear with respect to hours. But if there are transactions costs that render workers imperfect substitutes for each other, there will be penalties from low hours depending on the value to the firm. A sparse framework will demonstrate these points and develop them further.

Framework to understand the nonlinear hours-wages relationship

Assume that each employee, i , invests in training only prior to the job (e.g., MBA, MD) and that the training is valuable in a hierarchy of positions, j . The positions can be separate occupations or they can be different varieties of the same occupation. Let $0 < \lambda \leq 1$ be the fraction of full-time employment worked by the employee or some metric concerning which hours are worked. Output, Q , for an employee is given by:

$$Q = \begin{cases} \lambda_i k_j & \text{if } \lambda_i > \lambda_j^* \\ \lambda_i k_j \cdot (1 - \delta_j) & \text{if } \lambda_i \leq \lambda_j^* \end{cases}$$

where k_j is output per unit time when time exceeds some amount, δ_j is the reduction in output because the employee works less than some amount in occupation j . In this setup there is a discontinuity in productivity if the worker is absent more than some amount.

Several occupations or positions may exist among which individual i can choose. To begin with assume two positions exist such that $k_1 > k_2$ and that output is reduced when hours do not exceed some level such that $\delta_1 > \delta_2$. In addition, assume $k_1(1 - \delta_1) < k_2(1 - \delta_2)$ so

²⁵ Briscoe (2006, 2007) makes similar points about the ability of employees to “hand off” clients, the role of substitutes and temporal flexibility.

that one occupation or work setting does not dominate the other. Now add a third position, r , characterized by linearity ($\delta_r = 0$) for which $k_r < k_2$. That position, which can be called the reservation occupation, will dominate the other two when λ is sufficiently low. Also assume $k_2(1 - \delta_2) < k_r$.

As shown in Figure 3, an employee will work in occupation 1 as long as $\lambda > \lambda_1^*$ and will then shift to occupation 2 at lower hours and finally to the reservation occupation when $\lambda < \lambda_2^*$. The relationship between output and hours, and thus between earnings and hours, is nonlinear. On a per unit time basis the employee receives more in occupation 1 than 2 and more in occupation 2 than in the reservation occupation, r .

In the framework, the position with the highest slope is also the one with the highest penalty with regard to reduced hours. Rather than stay in that position, an employee who wants lower hours will shift to one that has a lower penalty but also a lower slope. If the level of hours that the worker wants is yet lower, then the worker will take the reservation job, which has complete linearity with respect to hours.

The point of the framework is to emphasize that certain occupations impose heavy penalties on employees who want fewer hours and more flexible employment. The lower remuneration can result in shifts to an entirely different occupation or to a different position within an occupational hierarchy or to being out of the labor force altogether.

Illustrations of the framework will be useful. Lawyers, for example, constitute an occupational group, certainly one professional degree group. But an individual with a law degree can be partner in a large law firm in which there is a premium for working long and continuous hours. The same lawyer could, instead, be employed as general counsel and work fewer and more flexible hours. Finally, the lawyer can work in a small firm that allows short and discontinuous hours at no penalty. These can be thought of as position 1, position 2, and the reservation position in the framework. The remuneration of these lawyers, all of whom have the same formal education, would map out a nonlinear relationship of total earnings with respect to hours or to the flexibility of hours.²⁶

Pharmacy, on the other hand, has nearly linear earnings with respect to time worked. Pharmacists who work more hours earn more, linearly. Those who are in managerial positions in a pharmacy earn more chiefly because they work more hours. Those who work part-time get paid less in a linear fashion.²⁷

The explanation just provided for differences across occupations can be thought of as more a part of personnel economics than human capital theory because the underlying notions

²⁶ See Bertrand, Goldin and Katz (2010) and the sections below on MBAs and lawyers.

²⁷ See Goldin and Katz (2013) and the section below on pharmacists.

are those of compensating differentials. Differences in pay arise because of productivity differences in the workplace, not because of inherent differences in human capital across workers. Some workers want the amenity of flexibility or of lower hours and some firms may find it cheaper to provide.

The framework just outlined can be viewed as the micro-foundations of a compensating differentials model.²⁸ Individuals place different values on the amenity, “temporal flexibility,” and firms or sectors face different costs in providing the amenity. The framework gives reasons why there are different costs and how they might change.²⁹

Occupational Differences from O*Net Characteristics

Do the notions of the framework have explanatory power regarding the estimated gender gaps for the 95 occupations previously identified and classified by group? To explore the relationship between the residual gender earning gap and occupational features I have used detailed occupation descriptions from O*Net online.³⁰

O*Net lists hundreds of separate characteristics grouped in seven categories. The two categories most relevant for the issues at hand are “work context” (57 characteristics) and “work activities” (41 characteristics). Seven characteristics seem most relevant to features of the model and are listed in the notes to Table 2.³¹ These characteristics reflect time pressure, the need for workers to be around at particular times, the flexibility of the occupation with regard to scheduling, the groups and workers the employee must regularly keep in touch with, and the degree to which the worker has close substitutes.

Each of the O*Net characteristics has been normalized to have a mean of zero and a standard deviation of one. I have grouped the technology and science occupations together and compare the values of the seven characteristics with those for occupations in business, health, and law, the largest and also the highest paying of the “other” occupations.

Because there are about twice as many O*Net occupations than Census occupations, the first task was to match occupations across the two sources. In most cases the difference was

²⁸ The classic article on compensating differentials is Rosen (1986).

²⁹ Goldin and Katz (2011, 2013) set forth a compensating differentials model with predictions for changes in the gender gap with shifts in the costs of providing the amenity and in preferences for the amenity.

³⁰ Occupation characteristics in O*Net, the Department of Labor’s Occupational Information Network, are comprehensively used by Acemoglu and Autor (2011) to identify tasks.

³¹ There are also characteristics under the headings of abilities, interest, knowledge, skills and work values, although none seemed to relate to the concepts of the model. A potentially relevant variable is: Work with work group or team: *How important is it to work with others in a group or team in this job?* But this variable has an ambiguous meaning since it is unclear whether the team referred to is one of substitutes (independent workers) or of complements (interdependent workers).

simply that O*Net occupations are cross-referenced by industry. The O*Net characteristic levels were then weighted by the relative number of individuals in the O*Net occupations to get the characteristic values for the Census occupations, for which the residual gender gaps had been computed.

As can be seen in Table 2, technology and science occupations score far below the others on each of the seven measures and in some cases the differences are almost one standard deviation lower. That is to say, in comparison with business occupations those in technology and science have far greater time flexibility, fewer client and worker contacts, less face-to-face contact, fewer interpersonal relationships, and more specific projects with less discretion over them. Each of these characteristics should produce a more linear relationship between hours and earnings and the greater linearity should result in a residual difference in earnings by sex.

The characteristics help differentiate the business from the technology and science occupations rather well. But they do not always capture differences between the health professions and others. For one, they do not capture the time demands among the self-employed and many in the higher paid health occupations (e.g., dentist, podiatrist, physician and veterinarian) have substantial rates of ownership. But they do pick up the fact that most health professionals have considerable contact with clients, have enormous discretion and make decisions affecting the lives of others.³² Within the “other” category lawyers are clearly at the high end of the characteristics with considerable contact, time pressure, structure and discretion.

The scatter plot of the simple mean of the O*Net characteristics for each of the 95 high-income occupations against the mean (adjusted) gender earning gap for each occupation among college graduates (full-time, year-round workers) is given in Figure 4. The relationship is clearly negative with a correlation of -0.384 . A higher value for the characteristics is associated with a lower ratio of (adjusted) female to male earnings (a larger negative value for the log of the gender gap). In addition, the characteristics also pick up some of the within group variance. The relationship is strongest for time pressure, contact with others, and frequency of decision making, but is also reasonable for establishing and maintaining interpersonal relationships and structured versus unstructured work.

Evidence on Nonlinear Pay and the Gender Gap in Earnings

I have thus far established that the gender gap in pay is small at the start of employment but greatly increases with age (even correcting for hours and weeks in a national sample) and that it significantly differs by occupation. I have also shown using the O*Net data that characteristics of work settings are associated with the (adjusted) gender gap in pay such that

³² The flexibility in some of the health fields is not captured well in the aggregate O*Net characteristics. An important outlier here is pharmacy, which I will discuss in detail.

work environments that require more interactions or have more time pressure, for example, are those with larger gender gaps in pay.

Another hint at what must be in the last chapter can be gleaned by adding a log hours \times occupation interaction to the regression containing occupation and log hours main effects. The interaction of log hours and occupation allows a different relationship between hours and earnings for each occupation. As I will later demonstrate using data on occupations in business and law, the impact of hours on the gender gap is quite large and goes far to explain much of the gender earnings gap. Individuals who work long hours in these occupations receive a disproportionate increase in earnings. That is, the elasticity of earnings with respect to hours worked is greater than one. The addition of the interaction to the Figure 2 regressions increases the elasticity of income with respect to hours for the business and law occupations. In fact, almost half of the business and law occupations have an elasticity that exceeds one whereas only one of the science and technology occupations does (and it is that of actuary).

In previous work, Katz and I (2008b) demonstrated that among Harvard College graduates the penalty to time out differed greatly by occupation. Among those who received their BAs around 1990, a 10 percent hiatus in employment time 15 years after the BA, thus amounting to an 18-month break, was associated with a decrease in earnings of 41 percent for those with an MBA, 29 percent for those with a JD or a PhD and 15 percent for those with an MD.³³ In addition, the loss in earnings from time off for MDs was linear in lost experience but was discrete (nonlinear) for MBAs. Any time off for MBAs is heavily penalized. We also found that, among the women in our sample, MDs and PhDs took the shortest non-work spells after a birth and MBAs took the longest. That is, those with the greatest penalty to time out also took the most time out largely because their jobs did not enable shorter or more flexible schedules.

In this section I expand on these findings and explore the widening gender gap in pay with age and differences in the gender gap by occupation using data sets specific to occupations and degrees. I will demonstrate that some occupations have high penalties for even small amounts of time out of the labor force and have nonlinear earnings with respect to hours worked. Other occupations, however, have small penalties for time out and almost linear earnings with respect to hours worked. In the first group of occupations are individuals who have earned an MBA or a JD. In the second group—the occupations with lower penalties for time out and the more linear ones—is one in the health sector (pharmacy).

The data sets I use are for fairly uniform groups of men and women who have received the same advanced degree or work in the same occupation. The information on job experience and time worked is highly detailed. The gender gap in annual earnings for the JDs and MBAs, although large by year 15, is almost entirely explained by various factors, such as hours worked,

³³ Goldin and Katz (2008b, table 2).

time out of the labor force, and years spent in part-time employment. Small differences in time away or in hours translate into large differences in pay. Nonlinearities in pay with respect to time worked can be seen. For the pharmacists, however, hours worked is also of importance in explaining gender differences in pay but earnings are fairly linear in time worked and time out of the labor force is of less importance to contemporaneous pay. In fact, because part-time work is prevalent in pharmacy, women do not take off much time.

Nonlinear and linear occupations

Business (MBA): Nonlinear occupations

At start of their careers, earnings by gender are almost identical among MBAs graduating from the University of Chicago Booth School from 1990 to 2006.³⁴ But five years out a 30 log point difference in annual earnings develops and at 10 to 16 years out the gender gap in earnings grows to 60 log points (that is, women earn 55 percent what men do). Three factors explain 84 percent of the gap. Training prior to MBA receipt, (e.g., finance courses, GPA) accounts for 24 percent. Career interruptions and job experience account for 30 percent, and differences in weekly hours are the remaining 30 percent. Importantly, about two-thirds of the total penalty from job interruptions is due to taking *any* time out.

At 10 to 16 years out 23 percent of University of Chicago Booth School MBA women who are in the labor force work part-time and, interestingly, more than half of those working part-time employ themselves. Around 17 percent are not currently employed and 60 percent work full-time (51 percent do for those with children). Cumulative time not working is about one year for all women 10 to 16 years after the MBA.

Not surprisingly children are the main contributors to women's labor supply changes. Women with children work 24 percent fewer hours per week than men or than women without children. The impact of children on female labor supply differs strongly by spousal income. MBA moms with high-earning spouses have labor force rates that are 18.5 percentage points lower than those with lesser-earnings spouses.³⁵ They work 19 percent fewer hours per week (when working) than those with spouses below the high-income level. The impact of higher income husbands may be a pure income effect but it more likely results from a combination of an income and a substitution effect in which the family requires some parental home time and the

³⁴ These data come from a survey of about 2,500 University of Chicago Booth School MBA graduates from 1990 to 2006 matched with administrative school data. The survey asked retrospective questions yielding more than 18,000 person-years on earnings, hours and other employment information, and details on marriage and family. See Bertrand, Goldin and Katz (2010) for details on the data.

³⁵ Annual earnings exceeding \$200K, in 2006\$, are used for the high-earning spouses. About 22 percent of MBA moms are not in the labor force at 10 to 16 years out.

high-flyer husband offers little.³⁶

Another important result is that the impact of a birth on labor supply grows over time in an individual, fixed-effects estimation. A year after a first birth, women's hours, conditional on working, are reduced by 17 percent and their participation by 13 percentage points. But three to four years later, hours decline by 24 percent and participation by 18 percentage points. Some MBA moms try to stay in the fast lane but ultimately find it is unworkable. The increased impact years after the first birth, moreover, is not due to effect of additional births.

Part-time work in the corporate sector is uncommon and part-timers are often self-employed (more than half are at 10 to 16 years out). Differences in career interruptions and hours worked by sex are not large but the corporate and financial sectors impose heavy penalties on deviation from the norm. Some female MBAs with children, especially those with high earning husbands, find the tradeoffs too steep and leave or engage in self-employment.

In sum, the appeal of an MBA for women is large—incomes are substantial even if they are far lower than those of their male peers. But some women with children find the inflexibility of the work insurmountable.

Law (JD): Nonlinear occupations

The gender gap in earnings between male and female JDs, graduating from the University of Michigan Law School from 1982 to 1991, is nil at the start of employment. The gap is small and insignificant at year 5, after controlling for hours, weeks and time off, as can be seen in Table 3, cols. (1) to (3).³⁷ But as in the case of the MBAs the gap balloons to around 55 log points by year 15 in a longitudinal sample (col. 4). The remaining gap at year 15 is reduced to around 22 log points when time worked during the year is included and to 13 log points once work absences and job tenure are added (cols. 5 and 6).³⁸

Of great importance with regard to the issues raised here is that annual earnings are clearly nonlinear with respect to hours in year 15. The coefficient on log hours in the log

³⁶ MBA mothers with high-income spouses, it should be noted, are not negatively selected on initial earnings, hours and MBA performance. If anything, they are positively selected.

³⁷ The University of Michigan Alumni Survey Research Dataset is used, which includes alumni surveys from 1967 through 2006 for persons graduating from 1952 to 2001 together with administrative data on each alumnus. The surveys were sent to classes 5, 15, 25, 35 and 45 years after receiving their JD. Because response rates for the cross-section data are high (in the 60 percent range), surveys were later linked, where possible, to create a longitudinal dataset. The information used here is from the longitudinal data linking individuals from graduation to years 5 and 15. See Wood, Corcoran and Courant (1993) for similar work using a much earlier form of the cross-section data and Noonan, Corcoran and Courant (2005) for work that uses the more recent longitudinal samples.

³⁸ The gender gap is less than 10 log points if making partner by year 15 or remaining in a law firm from year five to year 15 is included.

earnings regression is significantly greater than one and that finding is robust to various specifications. Because those who work in law firms also report their hourly billing rate or fee, I also include the relationship between hours and the hourly fee reported in cols. (7) and (8). That, too, displays nonlinearity. The more hours worked, the higher the hourly fee reported.

The nonlinearity of annual earnings with respect to hours worked and the relationship between hourly earnings and hours are graphed in Figure 5 together with characteristics of the JDs in each of four hour-intervals used (10-34, 35-44, 45-55, and 55+ hours). The annual earnings graph bears a striking resemblance to the representation of the framework in Figure 3. The nonlinearity of annual earnings with respect to hours worked is clear.

The fraction female at 15 years is 0.288 but the fraction female decreases as hours increase from 0.826 for the 0 to 34 hours group to 0.182 for the 55 hours plus group. The fraction of women who have children at 15 years out also decreases as hours increase from 0.852 for the lowest hours bin to 0.536 for the highest. As hours worked increase so does firm size and fraction partner, while the incidence of solo practice decreases. Of some interest with respect to why nonlinearities in pay arise with respect to hours worked, among JDs who work in a law firm twice the fraction of time by the average lawyer is spent representing a Fortune 500 company in the highest hours bin than in the smallest hours bin. Similarly, the fraction of time representing “rich” people increases substantially (from about 0.025 to 0.09) when a lawyer shifts from working part-time to full-time.

As in the case of MBAs the reason for the reduction in hours of work at 15 years out is largely due to the arrival of children. And also similar to the MBA case is that the decrease in participation is due to an interaction between children and the income of the spouse. About 16.5 percent of JD women, and 21 percent of those with children of any age, are not in the labor force by year 15.

Spousal income is an important determinant of who stays and who leaves employment at year 15. JD women with children who are married to men in the upper 30 percent of the earnings distribution (more than \$200K per year, in 2007\$) have lower participation rates than JD women married to lower-income husbands or who do not have children but are married to a high-income husband. Using the high-income cutoff for the husbands of female JDs reveals that 21.6 percent of those with children are not in the labor force at 15 years but that 10.4 percent are not in the labor force for those with lower income husbands.³⁹ There are, however, almost no differences among those with no children. Almost none of those women, independent of the income of their husbands, is out of the labor force.

³⁹ As in the case of the MBAs, JD women with high-income spouses who are not in the labor force at 15 years are not negatively selected on the basis of observables and, if anything, are positively selected. The calculation uses the cross-section sample to increase sample size.

Leaving the labor force for women with a JD appears to involve an interaction of spousal income and the presence of children. The reasons would seem the same as offered for the MBAs. Children require a modicum of parental time, high-income husbands provide little of it and part-time work for JDs is insufficiently remunerative for some to remain employed.

Pharmacy: A linear occupation

The occupation of pharmacist is an excellent example of one that has fairly linear earnings with respect to hours worked and a negligible penalty to time out of the labor force. Managers of pharmacies get paid more because they work more hours. Female pharmacists with children get paid less because they work fewer hours. Pharmacists, particularly women, often work part-time. But there is no part-time penalty.⁴⁰

Pharmacy is a high income occupation—the eighth highest for men and third highest for women—that, in recent decades, has required a specialized six-year combined BS-doctoral degree. I will briefly summarize the findings from a study of the pharmacy profession by Goldin and Katz (2013) that uses, primarily, data from the National Pharmacist Workforce Surveys for 2000, 2004, and 2009.

Most pharmacists today work for non-independent retailers, mainly large chains, or in hospitals—about 75 percent do. But four decades ago around 25 percent were employed in these sectors. Self-ownership and employment by independent pharmacies declined greatly in the interim.

At the same time, women have increased their numbers in the profession. They are now about 55 percent of all active pharmacists and 65 percent of new hires. Women were always a reasonable fraction of pharmacists. Before the large increase in retail chain employment, women were often the part-time assistants of male pharmacists who managed their own pharmacies.

Today the occupation has among the lowest gender earnings gaps among high-earning occupations. The (unadjusted) ratio of earnings for female to male full-time, full-year pharmacists is 0.85 whereas it was 0.60 in 1970. The hours-adjusted ratio is from 0.93 to 0.95.⁴¹

Several changes in the pharmacy profession have been responsible for the increase of female to male earnings. The first is the decrease in self-ownership and the rise of large corporation and hospital employment. As corporate ownership and hospital employment increased, the portion of earnings that came from self-employment decreased. The ratio of the (time-adjusted) earnings of female to male pharmacists, in consequence, increased as the rents

⁴⁰ Künn-Nelen, De Grip and Fouarge (2013) demonstrate greater firm productivity in pharmacy with an increase in part-time work using data from the Netherlands.

⁴¹ Goldin and Katz (2013), table 1 for the time trends and table 3, cols. (2) and (3) for the adjusted ratios.

from ownership decreased and because men were disproportionately the owners.

The second change involves decreased the costs to flexible employment in pharmacy. Pharmacists have become better substitutes for each other with the increased standardization of procedures and drugs. The extensive use of computer systems that track clients across pharmacies, insurance companies and physicians mean that any licensed pharmacist knows a client's needs as well as any other. If a pharmacist is assisting a customer and takes a break, another can seamlessly step in. In consequence, there is little change in productivity for short-hour workers and for those with labor force breaks. Other factors mentioned in the O*Net section are also of importance. For example, there is less need for interdependent teams in pharmacy and for extensive contact with other employees.⁴²

Female pharmacists have fairly high labor force participation rates and only a small fraction have substantial interruptions from employment. Rather than taking off time, female pharmacists with children go on part-time schedules. In fact, more than 40 percent of female pharmacists with children work part-time from the time they are in their early thirties to about 50 years old. Male pharmacists work around 45 hours a week, about nine hours more than the average female pharmacist.

The position of pharmacist became among the most egalitarian of all professions today. The facts in Goldin and Katz (2013) are consistent with the labor market effects of changes in technology and in the structure of the industry. They are less consistent with change stemming from an increase in the demand for family-friendly workplace amenities. In addition, the changes do not appear to have resulted from legislation or anti-discrimination policy or licensing requirements or regulations specific to the pharmacy profession. Rather, a host of structural changes outside the realm of the labor market (e.g., increased economies of scale in pharmacies, standardization of drugs, computer use, linked records through insurers) increased the demand for pharmacists and reorganized work in ways that have made pharmacy a more family-friendly and female-welcoming profession.

What the Last Chapter Must Contain

The reasoning of this essay is as follows. A gender gap in earnings exists today that greatly expands with age, to some point, and differs significantly by occupation. The gap is much lower than it had once been and the decline has been largely due to an increase in the productive human capital of women relative to men. Education at all levels increased for women relative to men and the fields that women pursue in college and beyond shifted to the more remunerative and career-oriented ones. Job experience of women also expanded with increased

⁴² The O*Net characteristic "establishing and maintaining interpersonal relationships" for pharmacists is among the lowest in the health group.

labor force participation. The portion of the difference in earnings by gender that was once due to differences in productive characteristics has largely been eliminated.

What, then, is the cause of the remaining pay gap? Quite simply the gap exists because hours of work in many occupations are worth more when given at particular moments and when the hours are more continuous. That is, in many occupations earnings have a nonlinear relationship with respect to hours. A flexible schedule comes at a high price, particularly in the corporate, finance and legal worlds.

A compensating differentials model explains wage differences by the costs of flexibility. The framework developed here shows why there are higher or lower costs of time flexibility and the underlying causes of nonlinearity of earnings with respect to time worked. Much has to do with the presence of good substitutes for individual workers when there are sufficiently low transactions costs of relaying information. Evidence from O*Net on occupational characteristics demonstrates that certain features of occupations that create time demands and reduce the degree of substitution across workers are associated with larger gender gaps.

Data for MBAs and JDs shows large increases in gender pay gaps with time since degree and also reveals the relationship between the increasing gender pay gap and the desire for time flexibility due to the arrival of children. Lower hours mean lower earnings in a nonlinear fashion. Lower potential earnings, particularly among those with higher-earning spouses, often means lower labor force participation. Pharmacists, on the other hand, have pay that is more linear with respect to hours of work. Female pharmacists with children often work part-time and remain in the labor force rather than exiting.

What must be in the last chapter? The last chapter must be concerned with how worker time is allocated, used and remunerated and it must involve a reduction in the dependence of remuneration on particular segments of time. It must involve greater independence and autonomy for certain types workers and the ability of workers to substitute seamlessly for each other. Flexibility at work has become a prized benefit but flexibility is of less value if it comes as a high price in terms of earnings. The various types of temporal flexibility require changes in the structure of work so that their cost is reduced.

There are many occupations and sectors that have moved in the direction of less costly flexibility. Firms in many sectors, including healthcare, banking and real estate, are trying to convince clients that their employees are good substitutes for each other. When clients perceive there is a greater degree of substitutability among workers a more linear payment schedule emerges.

Pharmacists are now better substitutes for each other than they once were and their earnings are fairly linear with regard to time worked. Larger scale in healthcare has enabled

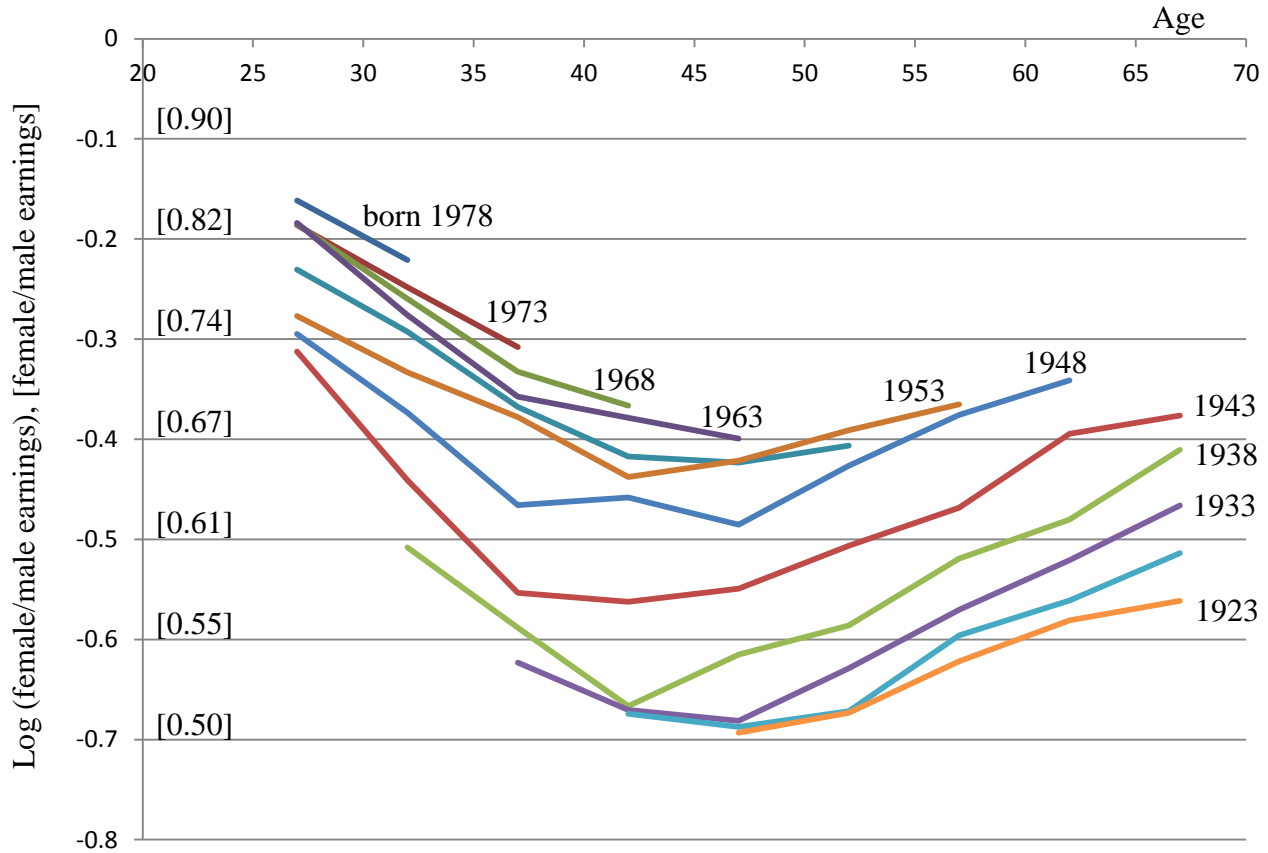
teamwork that has freed physicians from irregular and long hours. Most small veterinary practices no longer have weekend, night and emergency hours and, instead, have clients use the increasing number of large regional veterinary hospitals. Self-employment has declined in a large number of professions the past several decades including dentists, lawyers, optometrists, pharmacists, physicians, and veterinarians. The decline has produced a reduction in the premium to long and unpredictable hours.

Some changes have occurred organically often due to economies of scale (as in the cases of physicians, pharmacists and veterinarians), some changes have been prompted by pressure on the part of employees (as in the case of various physician specialties such as pediatricians), and other changes have occurred because of a desire to reduce costs.

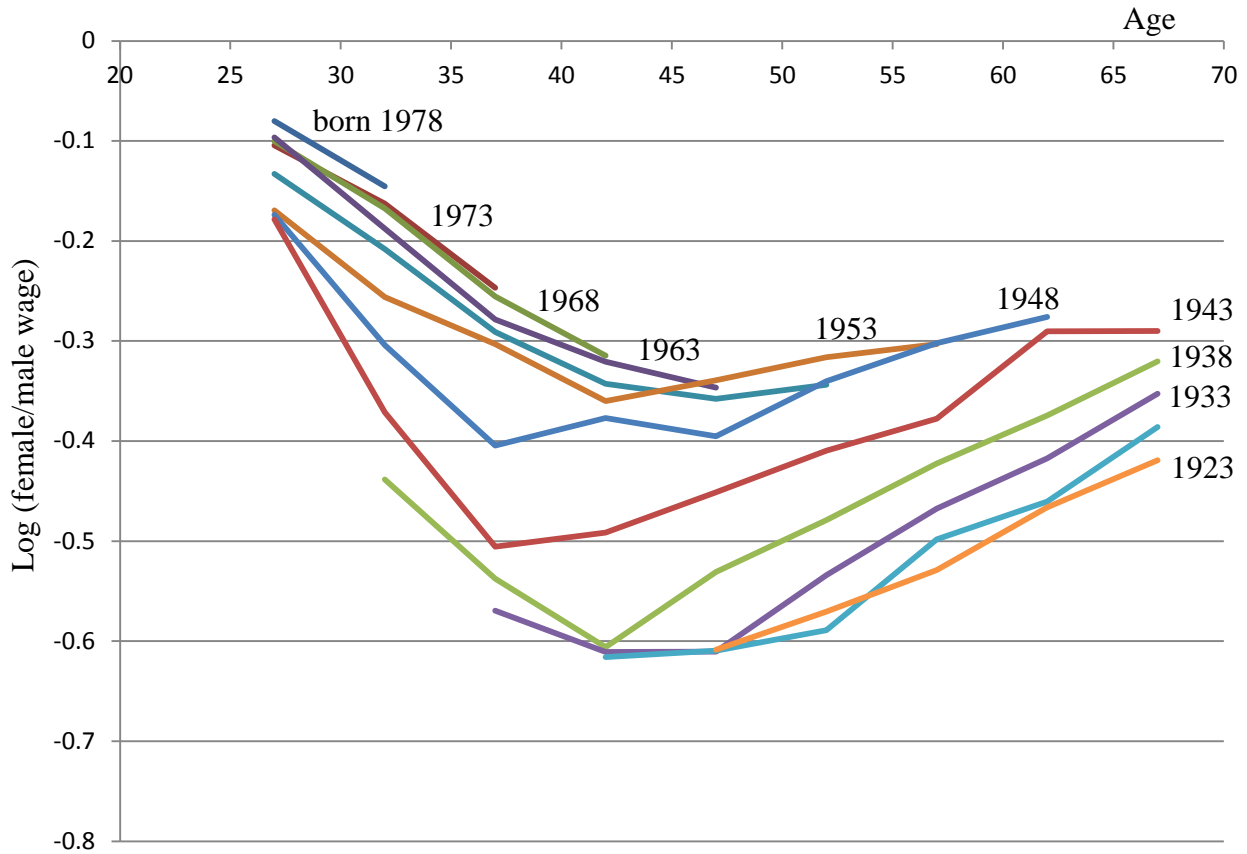
What the last chapter must contain for gender equality is not a zero sum game in which women gain and men lose. Many workers will benefit from greater flexibility, although those who do not value the amenity will likely lose from its lower price. The rapidly growing sectors of the economy and newer industries and occupations, such as those in health and information technologies, appear to be moving in the direction of more flexibility and greater linearity of earnings with respect to time worked. The last chapter needs more of that.

Figure 1: Relative Earnings of (Full-Time, Full-Year) College Graduate Men and Women for Synthetic Cohorts: Born 1923 to 1978

Part A: No controls



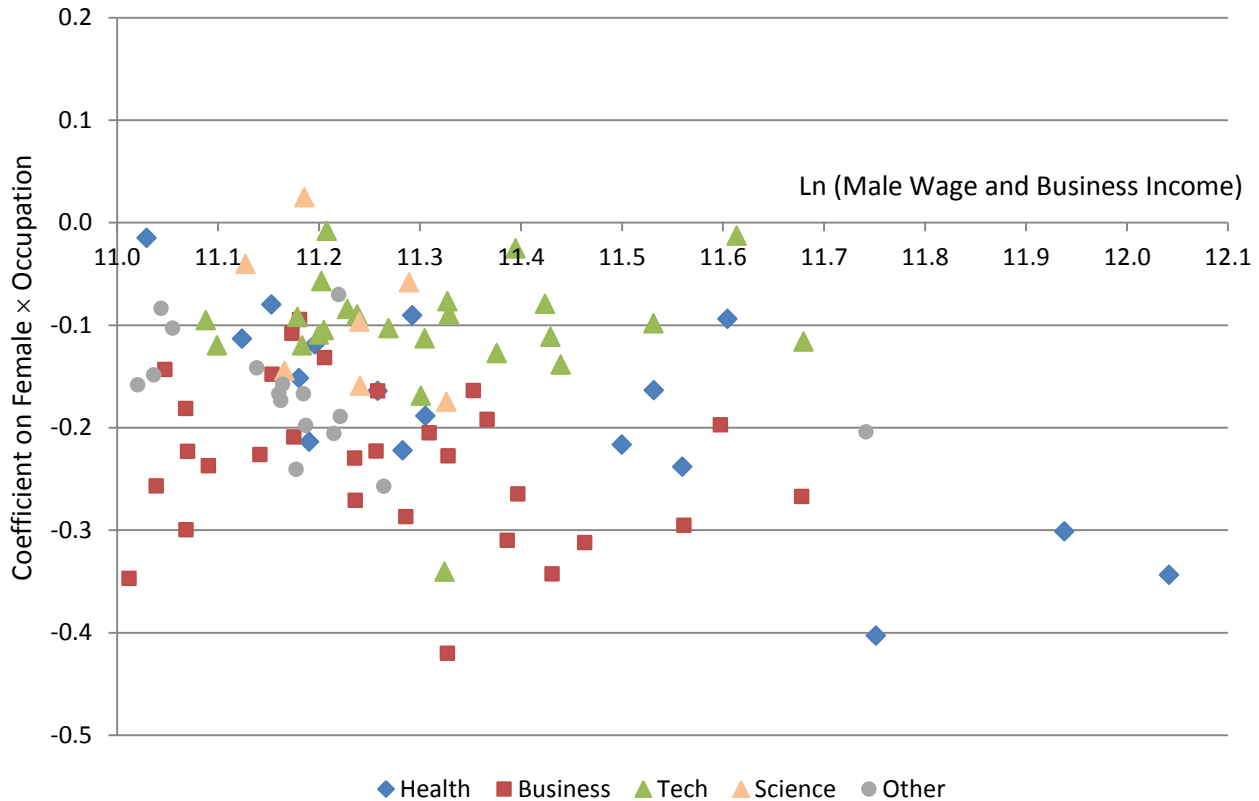
Part B: With controls for work time and education



Sources and Notes: U.S. Census 1970, 1980, 1990, 2000, and American Community Survey 2004-6 (for 2005), 2009-11 (for 2010) for full-time (35+ hours), full-year (40+ weeks) college-graduate (16+ years of schooling) men and women (white, native-born, non-military, 25 to 69 years old), using trimmed annual earnings data (exceeding 1,400 hours \times 0.5 \times 2009 minimum wage) corrected for income truncation (top-coded values \times 1.5). Part B contains controls for education beyond 16 years, log hours and log weeks. Age is entered in five-year intervals with an interaction with female. In each graph the lines connect the coefficients on the five-year intervals for each birth cohort.

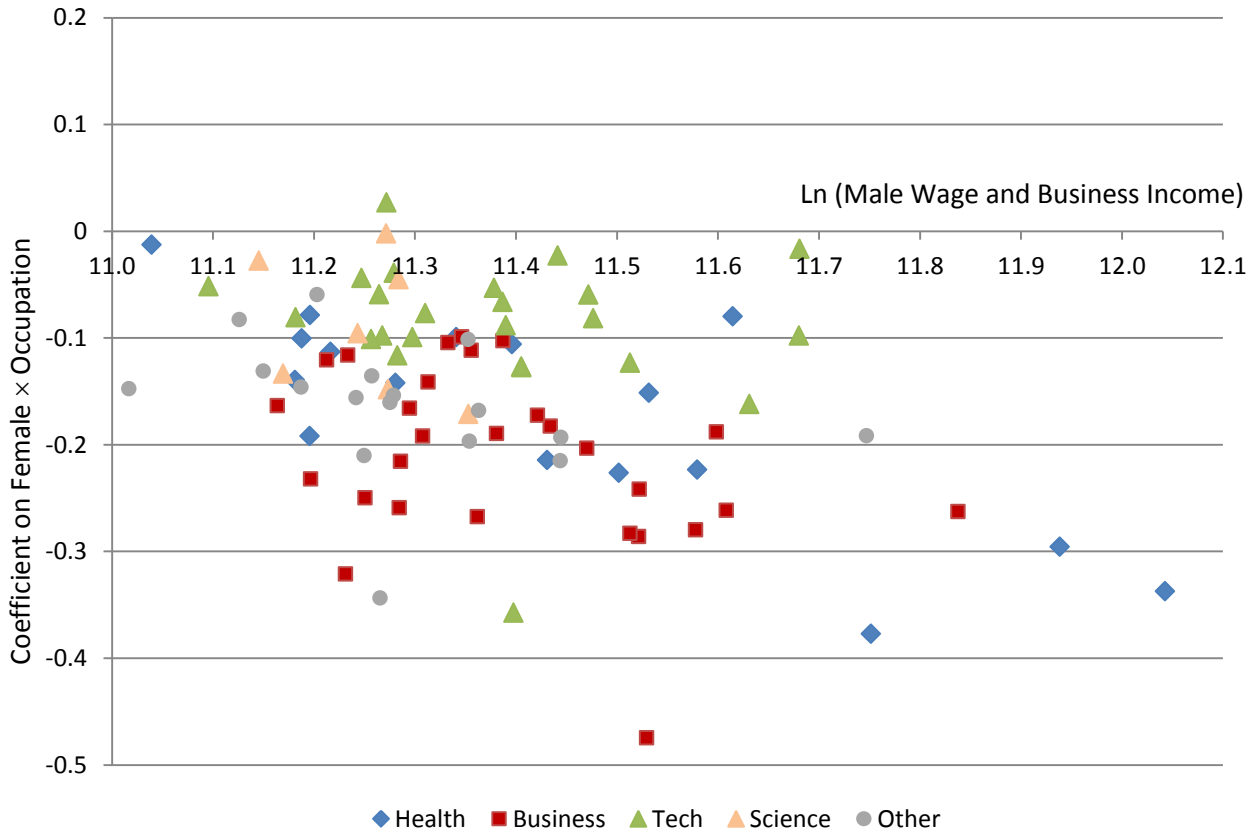
Figure 2: Gender Pay Gaps by Occupation: 2009 to 2011

Part A: Full-time, full-year for the approximately 95 highest (male) income occupations



Sources and Notes: American Community Survey 2009 to 2011. Sample consists of full-time, full-year individuals 25 to 64 years old excluding those in the military using trimmed annual earnings data (exceeding 1,400 hours \times 0.5 \times 2009 minimum wage). Regression contains age in a quartic, race, log hours, log weeks, education levels, census year, all occupations (469) and an interaction with female and occupation. Part A contains all full-time, full-year workers (2,603,968 observations); part B has those with at least four years of college (964,705 observations); part C has the group < 45 years old among those included in part A. Each of the symbols in part A is an occupation for which the mean annual income for males exceeds \$60,000 (current \$) and is limited to occupations with at least 25 males and 25 females. For parts B and C the same occupations are graphed.

Part B: Full-time, full-year, college graduates (four years of college) for the approximately 95 highest (male) income occupations



Part C: Full-time, full-year, less than 45 years old for the approximately 95 highest (male) income occupations

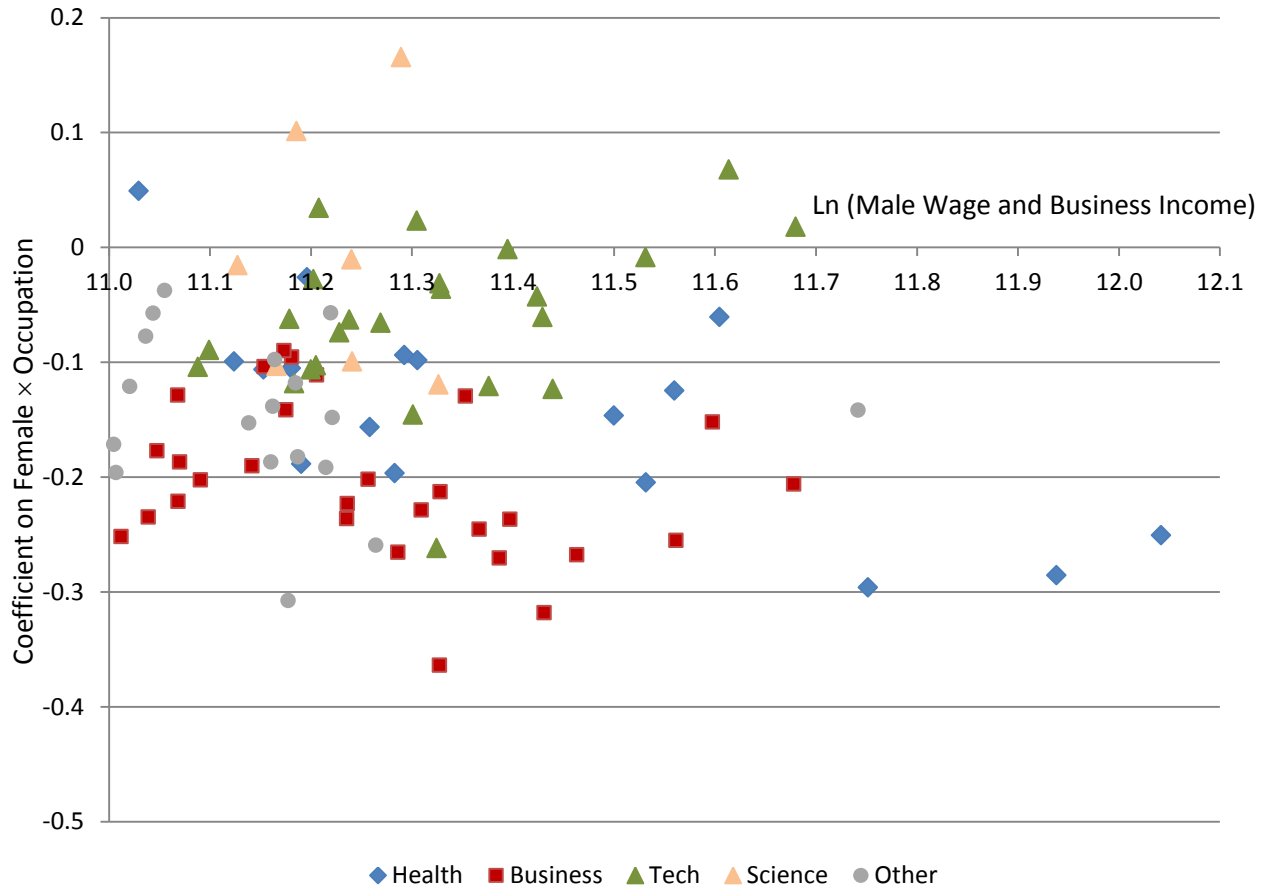
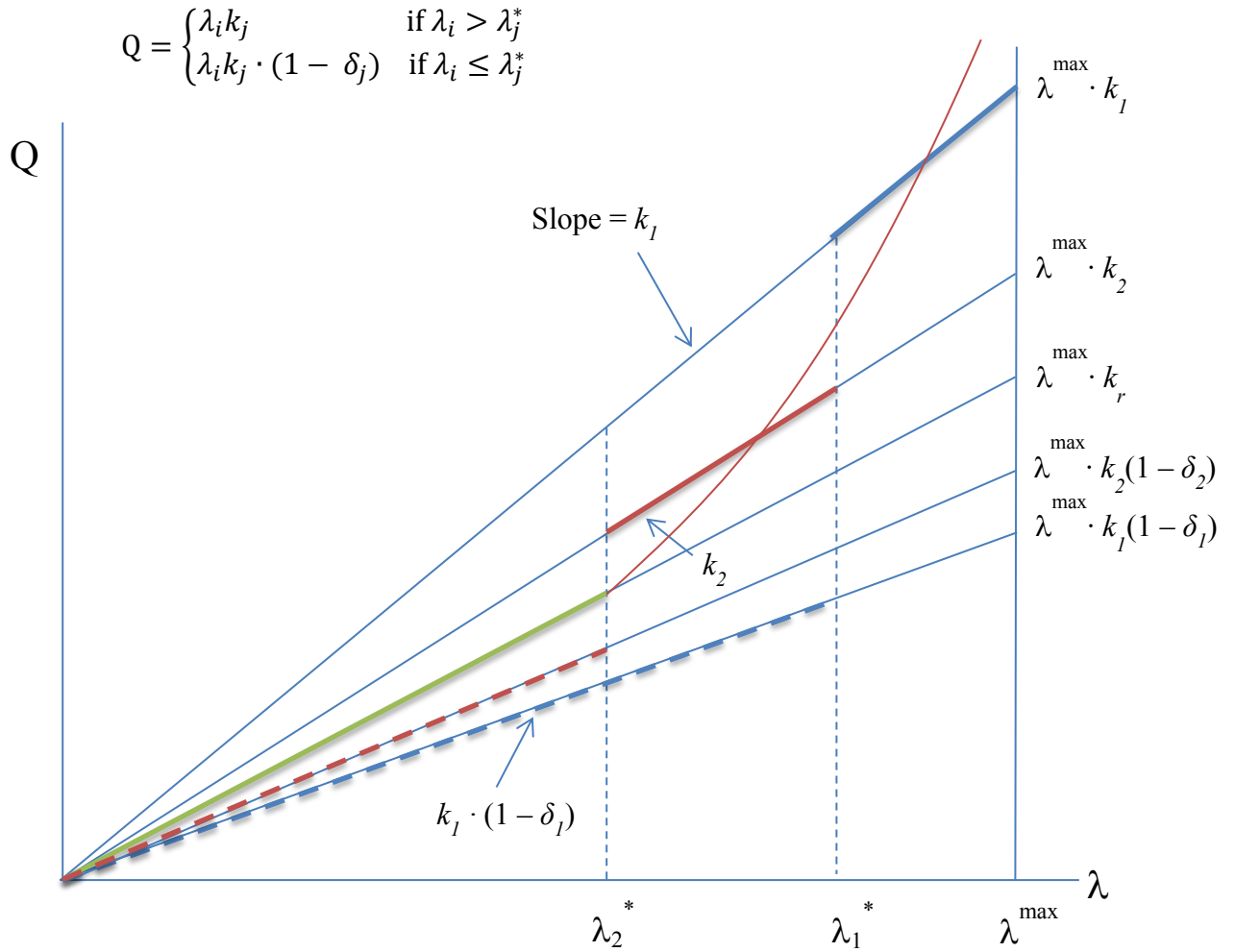
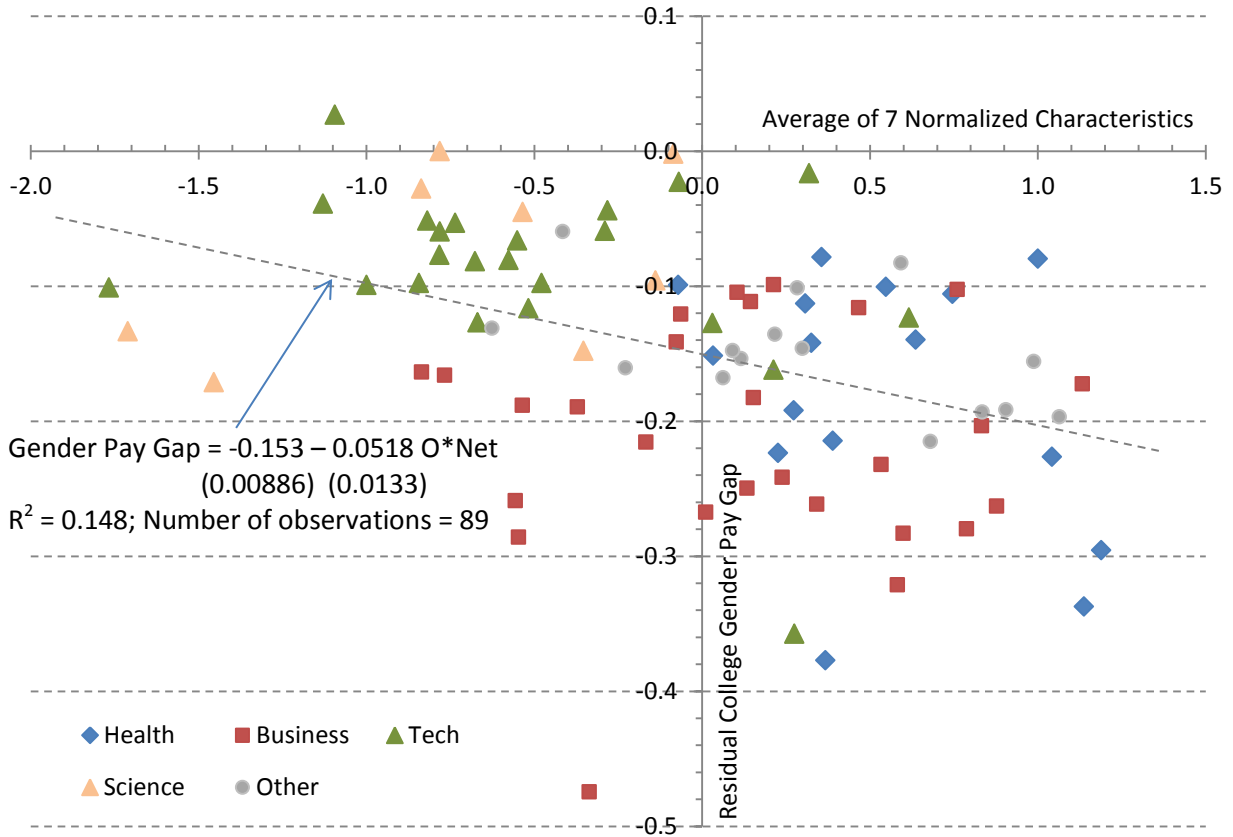


Figure 3: A Theory of Occupational Pay Differences



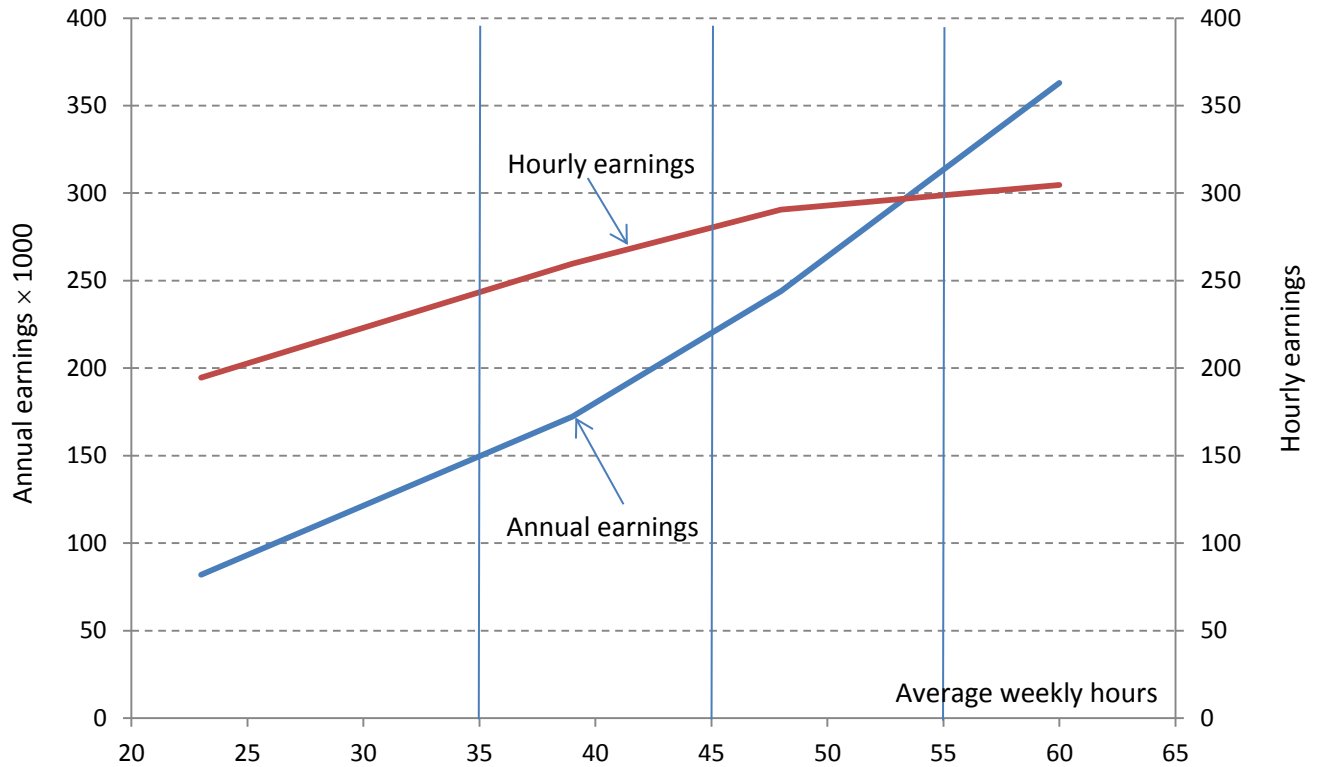
Notes: Each of the lines gives the relationship between output, Q , in some occupation and the time input, λ , of a worker where $0 < \lambda < \lambda^{\max}$. When the time input is reduced below some level, λ^* , output decreases discretely for occupations 1 and 2. Occupation r has a linear relationship between time worked and earnings throughout. An individual who works between λ_1^* and λ^{\max} will be in occupation 1, an individual between λ_1^* and λ_2^* will work in 2 and all others will work in r .

Figure 4: O*Net Characteristics and the Residual College Gender Pay Gap by Occupation



Sources and Notes: The college gender pay gap is from Figure 2, part B; the O*Net characteristics are described in Table 2. Only occupations with 25 or more male and female observations for the college, full-time sample are included. Standard errors are in parentheses under coefficients.

Figure 5: Hours, Earnings, and Characteristics of Law Occupations Fifteen Years after the JD



| Job-hours feature (mean) | 10 to 34 hours | 35 to 44 hours | 45 to 54 hours | 55 hours plus |
|--------------------------|----------------|----------------|----------------|---------------|
| Fraction of men in bin | 0.021 | 0.165 | 0.486 | 0.328 |
| Fraction of women in bin | 0.243 | 0.218 | 0.359 | 0.180 |
| Fraction female (0.288) | 0.826 | 0.349 | 0.231 | 0.182 |
| With children (0.698) | 0.852 | 0.798 | 0.617 | 0.536 |
| Work setting: | | | | |
| Government (0.107) | 0.0943 | 0.160 | 0.127 | 0.0456 |
| Corporate (0.156) | 0.0755 | 0.134 | 0.184 | 0.147 |
| Non-practicing (0.210) | 0.283 | 0.265 | 0.155 | 0.241 |
| Law firm (0.492) | 0.425 | 0.403 | 0.514 | 0.534 |
| If in a law firm: | | | | |
| Partner (0.693) | 0.311 | 0.490 | 0.739 | 0.809 |
| Solo practice (0.0937) | 0.233 | 0.177 | 0.0646 | 0.0660 |
| Firm size mean (255) | 188 | 252 | 249 | 278 |
| Firm size median (125) | 30 | 50 | 140 | 135 |
| Client: | | | | |
| Fortune 500 (0.249) | 0.145 | 0.189 | 0.229 | 0.278 |
| “Rich” (0.0916) | 0.0249 | 0.0862 | 0.0952 | 0.0974 |

Sources and Notes: University of Michigan Law School Alumni Survey Research Dataset, Longitudinal Sample for individuals graduating from 1982 to 1991 who returned both the five-year and 15-year surveys. Data given here are for those working > 9 hours a week at year 15. The work-setting category “other” accounts for the remaining fraction. “Firm size,” “Fortune 500,” and “Rich” are all conditional on working in a law firm. Client variables are the (average of the) fraction of time lawyers stated they worked with such clients.

Table 1: Residual Gender Differences in Earnings and the Role of Occupation

| Sample | Variables included | Female Coefficient | Standard Error | R ² |
|---------------|------------------------------------|--------------------|----------------|----------------|
| Full-time | Basic | -0.248 | 0.00101 | 0.112 |
| Full-time | Basic, time | -0.193 | 0.00100 | 0.163 |
| Full-time | Basic, time, education | -0.247 | 0.000905 | 0.339 |
| Full-time | Basic, time, education, occupation | -0.192 | 0.00104 | 0.453 |
| All | Basic | -0.320 | 0.00105 | 0.102 |
| All | Basic, time | -0.196 | 0.000925 | 0.353 |
| All | Basic, time, education | -0.245 | 0.000847 | 0.475 |
| All | Basic, time, education, occupation | -0.191 | 0.000963 | 0.563 |
| Full-time, BA | Basic | -0.285 | 0.00159 | 0.131 |
| Full-time, BA | Basic, time | -0.230 | 0.00158 | 0.177 |
| Full-time, BA | Basic, time, education | -0.233 | 0.00155 | 0.216 |
| Full-time, BA | Basic, time, education, occupation | -0.163 | 0.00158 | 0.374 |
| All, BA | Basic | -0.384 | 0.00173 | 0.119 |
| All, BA | Basic, time | -0.227 | 0.00151 | 0.380 |
| All, BA | Basic, time, education | -0.229 | 0.00148 | 0.407 |
| All, BA | Basic, time, education, occupation | -0.163 | 0.00151 | 0.525 |

Sources and Notes: American Community Survey 2009 to 2011. “Basic” regression is the log of annual earnings regressed on the female dummy, age as a quartic, race and year. “Time” adds log hours per week and log weeks; “education” adds dummies for education categories (and those above a BA for the college graduate sample). “Occupation” adds three-digit occupation dummies. “Full-time” is 35 and above hours per week and 40 and above weeks per year. “All” includes workers 25 to 64 years old with positive earnings and positive hours worked during the past year. The “full-time” sample consists of full-time, full-year individuals 25 to 64 years old excluding those in the military using trimmed annual earnings data (exceeding 1,400 hours \times 0.5 \times 2009 minimum wage). The “BA” sample includes workers with at least a (four-year) college degree. The number of observations is 2,603,968 for full-time, 3,291,168 for all, 964,705 for full-time BA or more, and 1,162,638 for all BA or more.

Table 2: O*Net Characteristics: Means (Normalized) by Occupational Group

| O*Net characteristics | Technology and Science | Business | Health | Law |
|---|------------------------|----------|--------|-------|
| 1. Time pressure | -0.488 | 0.255 | 0.107 | 1.51 |
| 2. Contact with others | -0.844 | 0.171 | 0.671 | 0.483 |
| 3. Face-to-face discussions | -0.308 | -0.237 | 0.729 | 0.229 |
| 4. Frequency of decision making | -0.730 | -0.0917 | 0.674 | 1.33 |
| 5. Establishing and maintaining interpersonal relationships | -0.611 | 0.548 | 0.276 | 0.781 |
| 6. Structured vs. unstructured work | -0.517 | 0.313 | 0.394 | 1.22 |
| 7. Freedom to make decisions | -0.463 | -0.00533 | 0.974 | 0.764 |
| Number of occupations | 31 | 28 | 16 | 1 |

Sources and Notes: The data were taken from O*Net Online: <http://www.onetonline.org/>. The occupations are those in Figure 2, part A. When there is more than one O*Net occupation for an ACS occupation, the characteristic is weighted by the number of workers in each of the O*Net occupations. Each of the O*Net characteristics has been normalized to have a mean of 0 and a standard deviation of 1. The work setting characteristics and questions most relevant to the issues raised here are:

1. Time pressure: *How often does this job require the worker to meet strict deadlines?*
Lower pressure means worker does not have to be around at particular times.
2. Contact with others: *How much does this job require the worker to be in contact with others (face-to-face, by telephone, or otherwise) in order to perform it?*
Less contact means greater flexibility.
3. Face-to-face discussions: *How often do you have to have face-to-face discussions with individuals or teams in this job?*
More face-to-face discussions mean less flexibility.
4. Frequency of decision making: *How frequently is the worker required to make decisions that affect other people, the financial resources and/or the image and reputation of the organization?*
The more decisions that affect other people the more need to be on call.
5. Establishing and maintaining interpersonal relationships: *Developing constructive and cooperative working relationships with others, and maintaining them over time.*
The more working relationships, the more groups and workers employee must be around.
6. Structured versus unstructured work: *To what extent is this job structured for the worker, rather than allowing the worker to determine tasks, priorities, and goals?*
If the job is highly structured to the worker, there would be a lower chance that the worker would have close substitutes.
7. Freedom to make decisions: *How much decision making freedom, without supervision, does the job offer.*
Generally means that the worker is given a project rather than determining what each client should receive and thus workers are better substitutes for each other the lower are these freedoms

Table 3: Earnings Equations for JDs: University of Michigan Law School Alumni Survey, Longitudinal Sample

| | Dependent variable: Log (annual earnings) | | | | | | Log (hourly fee) | |
|------------------------------|---|---------------------|----------------------|--------------------|--------------------|---------------------|----------------------|----------------------|
| | Year 5 | | | Year 15 | | | Year 15 | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Female | -0.100 (0.0262) | -0.0375 (0.0240) | -0.0158 (0.0228) | -0.549 (0.0498) | -0.215 (0.0456) | -0.130 (0.0455) | -0.00345 (0.0366) | 0.0302 (0.0368) |
| Log (hours per week) | | 0.757 (0.0497) | 0.563 (0.0521) | | 1.34 (0.0758) | 1.163 (0.0814) | 0.442 (0.0541) | 0.311 (0.0589) |
| Log (weeks per year) | | 0.522 (0.0771) | 0.331 (0.0752) | | 0.846 (0.123) | 0.711 (0.120) | | |
| Years in current job | | | 0.0423 (0.00615) | | | 0.0251 (0.00394) | | 0.00886 (0.00280) |
| Years not employed by year t | | | -0.379 (0.0545) | | | -0.0406 (0.0274) | | -0.0683 (0.0253) |
| Years part-time by year t | | | -0.244 (0.0339) | | | -0.0533 (0.0115) | | -0.0263 (0.00854) |
| Time off, BA to law school | | | -0.0283 (0.00800) | | | -0.0649 (0.0145) | | -0.0257 (0.0107) |
| Dummy variables | | | | | | | | |
| Law school performance | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Survey year | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Missing job experience | No | No | Yes | No | No | Yes | No | Yes |
| Missing weeks per year | No | Yes | Yes | No | Yes | Yes | No | No |
| Constant | 11.5 (0.0161) | 6.35 (0.329) | 8.00 (0.340) | 12.2 (0.0296) | 3.70 (0.487) | 4.78 (0.504) | 3.94 0.213 | 4.41 0.231 |
| Observations | 1,449 | 1,449 | 1,448 | 1,299 | 1,299 | 1,298 | 695 | 694 |
| R squared | 0.0747 | 0.245 | 0.332 | 0.129 | 0.359 | 0.408 | 0.238 | 0.287 |

Sources and Notes: University of Michigan Law School Alumni Survey Research Dataset, Longitudinal Sample for individuals graduating from 1982 to 1991 who returned both the five-year and 15-year surveys. Regression sample includes individuals working > 9 hours per week in the given year. Law school performance includes law school GPA at graduation and whether on law review. Sample for cols. (7) and (8) is restricted to those working in law firms who reported an hourly fee. Standard errors are in parentheses.

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Appendix Table A1: American Community Survey Occupations and Classifications by Group

| Occ. # | Occupation title | Occ. # | Occupation title |
|-----------|---|-----------|---|
| | <i>Technology Occupations</i> | | <i>Business Occupations</i> |
| 11 | Computer and information systems managers | 1 | Chief executives and legislators |
| 30 | Engineering managers | 2 | General and operations managers |
| 100 | Computer scientists and systems analysts | 4 | Advertising and promotions managers |
| 101 | Computer programmers | 5 | Marketing and sales managers |
| 102 | Computer software engineers | 6 | Public relations managers |
| 104* | Computer support specialists | 10 | Administrative services managers |
| 110 | Network and computer systems admins. | 12 | Financial managers |
| 111* | Network systems, data analysts | 13 | Human resources managers |
| 120 | Actuaries | 14 | Industrial production managers |
| 122 | Operations research analysts | 15 | Purchasing managers |
| 132 | Aerospace engineers | 60 | Cost estimators |
| 134 | Biomedical and agricultural engineers | 71 | Management analysts |
| 135 | Chemical engineers | 73 | Other business operations specialists |
| 136 | Civil Engineers | 80 | Accountants and auditors |
| 140 | Computer hardware engineers | 82 | Budget analysts |
| 141 | Electrical and electronics engineers | 84 | Financial analysts |
| 142 | Environmental engineers | 85 | Personal financial advisors |
| 143 | Industrial engineers, incl. health and safety | 86 | Insurance underwriters |
| 144 | Marine engineers and naval architects | 90 | Financial examiners |
| 145 | Materials engineers | 91 | Loan counselors and officers |
| 146 | Mechanical engineers | 95 | Financial specialists, all other |
| 152 | Petroleum, mining and geological engineers | 106 | Database administrators |
| 153 | Misc. engineers including nuclear engineers | 180 | Economists |
| 155* | Engineering technicians, except drafters | 181 | Market and survey researchers |
| 284 | Technical writers | 481 | Insurance sales agents |
| 493 | Sales engineers | 482 | Securities, commodities, financial sales agents |
| 903 | Aircraft pilots and flight engineers | 484 | Sales representatives, services, all other |
| | | 485 | Sales representatives, wholesale and mfg. |
| | | 520 | Brokerage clerks |

Table A1 (continued)

| Occ. # | Occupation title | Occ. # | Occupation title |
|-----------|--|-----------|--|
| | <i>Health Occupations</i> | | <i>Other Occupations</i> |
| 35 | Medical and health services managers | 22 | Construction managers |
| 36 | Natural sciences managers | 23 | Education administrators |
| 182 | Psychologists | 32 | Funeral directors, undertakers, misc. managers |
| 300 | Chiropractors | 43 | Misc. managers including postmasters |
| 301 | Dentists | 56 | Compliance officers, with exceptions |
| 304 | Optometrists | 130 | Architects, except naval |
| 305 | Pharmacists | 184 | Urban and regional planners |
| 306 | Physicians and surgeons | 210 | Lawyers, and judges, magistrates, etc. |
| 311 | Physician assistants | 220 | Postsecondary teachers |
| 312 | Podiatrists | 271 | Producers and directors |
| 313 | Registered nurses | 282 | Public relations specialists |
| 314 | Audiologists | 371 | First-line supervisors of police and detectives |
| 315 | Occupational therapists | 382 | Detectives and criminal investigators |
| 316 | Physical therapists | 471 | First-line supervisors, non-retail sales |
| 320 | Radiation therapists | 490 | Models, demonstrators, product promoters |
| 323 | Speech-language pathologists | 496 | Sales and related workers, all other |
| 325 | Veterinarians | 904 | Air traffic controllers and operations specialists |
| 326 | Health diagnosing and treating practitioners | | |
| | <i>Science Occupations</i> | | |
| 124 | Misc. mathematical science occupations | | |
| 165 | Medical scientists | | |
| 170 | Astronomers and physicists | | |
| 171 | Atmospheric and space scientists | | |
| 172 | Chemists and materials scientists | | |
| 174 | Environmental scientists and geoscientists | | |
| 176 | Physical scientists, all other | | |

* Indicates a technology occupation included in the expanded group of 27 technology occupations used in Table A2.

Appendix Table A2: Role of Industry versus Occupation in the Impact of Technology on the Gender Earnings Gap

| | Dependent variable: Log Wage and Business Annual Income | | | |
|------------------------------------|---|-------------------------------|----------------------------|----------------------------|
| | (1) | (2) | (3) | (4) |
| | Basic Regression | Adding Fraction in Technology | Adding Technology × Female | Adding Occupation × Female |
| Female | -0.129*** (0.00348) | -0.125*** (0.00349) | -0.129*** (0.00485) | -0.122*** (0.0824) |
| Log hours | 0.506*** (0.0118) | 0.499*** (0.0118) | 0.499*** (0.0118) | 0.500*** (0.0118) |
| Log weeks | 1.112*** (0.0493) | 1.129*** (0.0492) | 1.129*** (0.0492) | 1.128*** (0.0491) |
| Fraction of industry in technology | | 0.129*** (0.00724) | 0.125*** (0.00801) | 0.125*** (0.00808) |
| Fraction in technology × female | | | 0.0170 (0.0169) | 0.0187 (0.0178) |
| Other variables included: | | | | |
| Age as a quartic | Yes | Yes | Yes | Yes |
| Dummy variables: | | | | |
| Race | Yes | Yes | Yes | Yes |
| Year | Yes | Yes | Yes | Yes |
| Education | Yes | Yes | Yes | Yes |
| Occupation (27) | Yes | Yes | Yes | Yes |
| Occupation (27) × female | No | No | No | Yes |
| Constant | 1.241** (0.570) | 1.244** (0.569) | 1.245** (0.569) | 1.253** (0.569) |
| Observations | 156,201 | 156,201 | 156,201 | 156,201 |
| R-squared | 0.294 | 0.296 | 0.296 | 0.297 |

Sources and Notes: American Community Survey 2009-2011, 27 technology occupations included (see Table A1). Only full-time, full-year workers, 25 to 64 years old are included. Education is primarily in years but uses census groupings. Fraction in technology is the fraction of the individual's industry employment in the 27 technology occupations (see Table A3). Omitted occupation is computer scientists and systems analysts. Robust standard errors are in parentheses.

*** $p < 0.01$

** $p < 0.05$

* $p < 0.1$

Appendix Table A3: Fraction of Industry Employment in Technology Occupations: 35 Highest Industries (of 267), 2009 to 2011

| Industry | ACS number | Fraction in Technology |
|--|------------|------------------------|
| Computer systems design and related services | 7380 | 0.642 |
| Software publishing | 6490 | 0.458 |
| Aerospace product and parts mfg. | 3590 | 0.410 |
| Computer and peripheral equipment mfg. | 3360 | 0.406 |
| Architectural, engineering, and related services | 7290 | 0.372 |
| Internet publishing and broadcasting | 6672 | 0.372 |
| Electronic component and product mfg., n.e.c. | 3390 | 0.363 |
| Communications, audio, and video equipment mfg. | 3370 | 0.356 |
| Data processing, hosting, and related services | 6695 | 0.308 |
| Navigational, measuring, electromedical, mfg. | 3380 | 0.279 |
| Other telecommunication services | 6690 | 0.270 |
| Aircraft and parts mfg. | 3580 | 0.268 |
| Electronic auctions | 5591 | 0.252 |
| Wired telecommunications carriers | 6680 | 0.225 |
| Air transportation | 6070 | 0.212 |
| Other information services | 6780 | 0.204 |
| Engines, turbines, and power transmission equipment mfg. | 3180 | 0.181 |
| Scientific research and development services | 7460 | 0.180 |
| Commercial and service industry machinery mfg. | 3090 | 0.179 |
| Electronic shopping and mail-order houses | 5590 | 0.169 |
| National security and international affairs | 9590 | 0.165 |
| Medical equipment and supplies mfg. | 3960 | 0.154 |
| Electric and gas and other combinations | 590 | 0.151 |
| Electrical machinery, equipment, and supplies mfg., n.e.c. | 3490 | 0.149 |
| Radio, TV, and computer stores | 4790 | 0.145 |
| Administration of economic programs and space research | 9570 | 0.144 |
| Electric power generation transmission and distribution | 570 | 0.143 |
| Construction mining and oil field machinery mfg. | 3080 | 0.142 |
| Petroleum refining | 2070 | 0.140 |
| Oil and gas extraction | 370 | 0.129 |
| Management of companies and enterprises | 7570 | 0.126 |
| Other transportation equipment mfg. | 3690 | 0.126 |
| Management, scientific and technical consulting services | 7390 | 0.123 |
| Machinery manufacturing, n.e.c. | 3190 | 0.121 |
| Motor vehicles and motor vehicle equipment mfg. | 3570 | 0.120 |

Sources and Notes: American Community Survey 2009-11. “Fraction in technology” is the fraction of full-time, full-year, 25 to 64 year old employees who are in one of the 27 technology occupations in Table A1. 59 percent of all workers in technology occupations are in these highest 35 industries.