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Period Effects, Cohort Effects, and the Narrowing Gender Wage Gap

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Abstract

Despite the abundance of sociological research on the gender wage gap, questions remain. In particular, the role of cohorts is under investigated. Using data from the Current Population Survey, we use Age-Period-Cohort analysis to uniquely estimate age, period, and cohort effects on the gender wage gap. The narrowing of the gender wage gap that occurred between 1975 and 2009 is largely due to cohort effects. Since the mid-1990s, the gender wage gap has continued to close absent of period effects. While gains in female wages contributed to declines in the gender wage gap for cohorts born before 1950, for later cohorts the narrowing of the gender wage gap is primarily a result of declines in male wages.

INTRODUCTION

Between 1970 and 1980, the female-to-male ratio of median annual earnings of full-time year-round workers, a commonly cited measure of the gender wage gap, narrowed from just below 60 percent to 64.2 percent (U.S. Census Bureau 2010). By 1990, the gap had closed to 71.9 percent. Over the next two decades, the gap continued to move toward parity but at a slower pace, hitting 76.9 percent in 2000 and 81.2 percent in 2010.

A large body of research examines overall period trends in the gender wage gap, highlighting the narrowing but persistent wage inequality (Blau & Kahn 2006a, 2006b; Cotter, Hermesen, & Vanneman 2004; O'Neill 2003). Unfortunately, despite the abundance of research on the gender wage gap, important questions remain. In particular, the role of cohorts is under investigated. Cohorts are often discussed descriptively but excluded from multivariate analyses (e.g. Blau & Kahn 2000; Cotter, Hermesen, & Vanneman 2004). Other times, intercohort inequality is directly examined, but the analysis is restricted to a comparison of only two or three cohorts (e.g. Avellar & Smock 2003; Miech, Eaton, & Liang 2003), and frequently further limited to an analysis of certain high prestige occupations like doctors, lawyers, or engineers (e.g. Dinovitzer, Reichman, & Sterling 2009; Morgan 1998; Noonan, Corcoran, & Courant 2005; Prokos & Padavic 2005). These lines of research are undoubtedly important and insightful, but leave questions about the larger temporal trends in gender wage inequality.

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First, existing research on inter-cohort inequality demonstrates that the gender wage gap varies by cohort. Yet, because existing research is largely limited to the comparison of only a handful of cohorts, the full extent of the variation is unknown. While it seems plausible and indeed likely that gender wage inequality for each successive cohort is less great than gender wage inequality in each preceding cohort, existing social science research does not offer a clear account of these variations because it does not specify multivariate models that consider all cohorts while uniquely identifying cohort and period effects. Thus, an obvious and important question remains: to what extent are younger cohorts more equal than older cohorts?

Second, when cohort is excluded from models of the gender wage gap, time trends do not accurately reflect period effects. Specifically, ample research notes a period decline in the gender wage gap. However, because these models do not account for cohort, it is unclear how much of this decline over time is due to period effects and how much is due to cohort effects. If we simultaneously model period and cohort, to what extent is the narrowing of the gender wage gap due to period effects and to what extent is it due to cohort effects?

In the research presented here, we draw data from the Current Population Survey to examine period and cohort effects on the gender wage gap. We offer cohort specific estimates of the gender wage gap, and by simultaneously modeling age, period, and cohort, we offer a reassessment of the time trend in the gender wage gap. By separating period and cohort effects, our analysis offers a more nuanced understanding of temporal changes. Specifically, while past research clearly shows a narrowing of the gender wage gap, we offer estimates of the unique role of period effects and cohort effects in lessening gender wage inequality.

BACKGROUND

Estimating Period and Cohort Effects

Sociologists and demographers have long used age-period-cohort analysis to study time-specific phenomena. Put succinctly, age-period-cohort analysis identifies an outcome of interest (here, the phenomena of interest is the gap in wages between men and women), and then distinguishes three types of time-related variations in the outcome of interest: age effects (variation produced by the physiological or social process of aging), period effects (variations produced by events that simultaneously affect all ages), and cohort effects (variations produced by the timing of when an event was experienced such as birth or entering the labor market).

The distinction between age, period, and cohort effects are particularly important when researching the gender wage gap. We know that social processes associated with aging such as motherhood or tenure produce changes in wages (Budig & England 2001; Budig & Hodges 2010; Cotter et al. 2004). Similarly, we know that period events like the passing of federal legislation can change employment and wage trajectories (Hirsch 2009; Leonard 1984, 1989; Tomaskovic-Devey & Stainback 2007). We also know that variations in the timing of life and labor market experiences such as entering the labor market during a recession can shift career trajectories for men and women (Kondo 2007). Thus, to fully

understand temporal changes in the gender wage gap, we must attempt to separate the three effects.

Methodologically, age effects are integral to age-period-cohort analysis and are thus included in our analyses. Substantively, age effects are not of interest for our purposes. While we include a brief discussion of age effects, we privilege period and cohort effects. In short, while age effects are needed to properly identify period and cohort effects, because our interest is in period and cohort effects, we estimate but only minimally discuss age effects.

Period Effects and the Gender Wage Gap

Descriptively, the gender wage gap follows a simple trend: between 1970 and 1990 the wage gap between men and women steadily narrowed, closing most rapidly in the 1980s; starting in the 1990s, progress stalled; the gap continued to close but at a much slower rate (Blau & Kahn 2000, 2006a, 2006b; Cotter et al. 2004; Marini 1989; O'Neill 2003).

Clearly, there is strong theoretical reason to suspect period effects are the driving force behind the weakening wage gap. Most obviously, we can point to legal changes. Since the 1960s, the US government has passed various forms of equal employment legislation, such as the Civil Rights Act of 1964, the Equal Employment Opportunity Act of 1972, the Pregnancy Discrimination Act of 1978, the Civil Rights acts of 1991. Each of these laws was passed with the intent of lessening gender discrimination.

The path from legislation to period effects on the gender wage gap is straightforward. Rich evidence shows that discrimination plays a role in artificially depressing the wages of women (Bielby & Baron 1986; Budig & England 2001; England et al 1988; Kilbourne et al 1994). Thus, a mechanism to reduce wage inequality is to reduce employment discrimination, and a mechanism to reduce employment discrimination is legislation. Some scholars have even suggested that legal and legislative avenues are a productive means to narrowing the wage gap (Reskin 1988). It would be naïve to argue that equal employment legislation has eliminated gender discrimination from the workplace; however, evidence indicates that legal changes have had notable effects on occupational segregation and career trajectories (Hirsch 2009; Leonard 1984, 1989; Tomaskovic-Devey & Stainback 2007). Thus, legal changes offer strong theoretical motivation to expect period effects on the gender wage gap.

At the same time, as the federal government has offered more legal protections against gender-based discrimination, attitudes have also shifted, offering an additional reason to suspect period effects. Since the 1970s, research has routinely noted increasing egalitarianism in gender attitudes (Brewster & Padavic 2000; Brooks & Bolzendahl 2004; Ferree 1974). For decades, there has been a near linear trend toward more progressive views of women working outside the home, increased support for female politicians, and less prejudiced views in general (Brewster & Padavic 2000; Cherlin & Walters 1981; Ferree 1974; Mason & Lu 1988). However, it is worth noting that Cotter and colleagues (2011) find that the move toward egalitarianism in gender attitudes stalled in the mid-1990s, and others have argued that this period trend is the product of cohort succession (Brooks & Bolzendahl

2004). Still, with attitude change we should expect less discrimination and new employment opportunities for women, and, consequently, period effects on the gender wage gap.

Additionally, while legal changes and shifts in attitudes have the potential to help close the wage gap by increasing women's wages, recent shifts in the macro-economic structure have the potential to help close the wage gap by worsening the labor market position of men. In effect, recent labor market changes have the potential to close the wage gap by lowering the average male wage. Most notably, between 1970 and 1995, the manufacturing industry, home to high wages for low-skill men, declined from 25 percent of total employment to 15 percent (Wright & Dwyer 2003). As a result, men at the bottom of wage distribution lost ground, which helped narrow the gender wage gap without an increase in women's wages (Bernhardt, Morris, & Hancock 1995), and while a shift away from manufacturing industries to service industries in the 1970s resulted in lower wages for both sexes, male wages saw a greater decline (Lorence 1991).

Similarly, the bargaining power and membership rolls of unions declined over the past forty years (Clawson & Clawson 1999). In 1954, close to 40 percent of the private sector workforce was unionized. By 2000, fewer than 10 percent were unionized (Western & Rosenfeld 2011). While the decline of unions has numerous consequences, one key consequence is a decline in wages. Because of uneven union membership rates among women and men, the weakening of unions further depressed the average male wage, which in turn narrowed the gender wage gap (Even and Macpherson 1993).

To summarize, numerous important events and changes occurred over the past forty years. Several equal employment legislations were enacted. The labor market underwent dramatic changes. Common beliefs about gender roles shifted. These changes provide a strong motivation to investigate the role of period effects in narrowing the gender wage gap. However, to fully understand the role of period effects, we must disentangle them from cohort effects.

Cohort Effects and the Gender Wage Gap

Sociologists have long recognized the potential role of cohorts in producing social change (Mannheim 1952; Ryder 1965). The reasoning is simple. Social contexts and historical circumstances vary from cohort to cohort. All birth cohorts uniquely experience social changes. The variation in contexts and timing produce variations in cohorts. Consider an illustrative example. Schuman and Scott (1989) find that major events that occur during adolescence and young adulthood leave a deep-rooted mark, which in turns leads to cohort differences in beliefs about the importance of national and world events, and thus a cohort effect on collective memories.

When applied to the gender wage gap, the implications are clear. Consider another illustrative example, the Equal Pay Act of 1963, which prohibits gender-based pay discrimination among employees within the same establishment who do extensively equal work. Imagine two birth cohorts of women, Cohort A and Cohort B. Members of Cohort A are 45 in 1963. Members of Cohort B are 25 in 1963. The passage of the Equal Pay Act has the potential to increase the wages of all women (a period effect). However, the Equal Pay

Act also has the potential to produce a notable cohort effect. That is, because of the passage of the Equal Pay Act and because wage growth is dependent of past wages, members of Cohort B will likely see a different wage trajectory over their career.

The passage of the Equal Pay Act is only one example of how variations in contexts and circumstances as well as the timing of an event can produce cohort differences. We can also consider that more recent cohorts of women have enjoyed better educational opportunities (Buchmann, DiPrete, & McDaniel 2008) and more egalitarian personal relationships (Thornton and Young-Demarco 2001). Further, women's control over fertility has increased with new birth control technologies (Goldin & Katz 2002), more recent cohorts of women are having fewer children (Chen & Morgan 1991), and more recent cohorts are delaying marriage (Goldstein & Kenney 2001), leading to cohort level variation in marriage patterns and fertility behavior. This is not to say that younger cohorts experience complete gender equality. Rather, these differences highlight the potential for variation in work experiences by cohort.

Given the unique circumstances experienced by each cohort, it seems plausible that cohort effects may play a large role in the closing of the gender wage gap. Numerous studies discuss cohort variations and present descriptive analyses of cohort variation but do not formally identify cohort effects in multivariate analysis (e.g. Blau 1998; Blau & Kahn 2000; Cotter, Hermesen, & Vanneman 2004). Similarly, researchers have charted changes in the gender wage gap overtime within a single cohort (e.g. Alon & Haberfield 2007; Bobbitt-Zeher 2007; Roth 2003; Witkowski & Leicht 1995) or examined changes in the gender wage gap across cohorts within a single occupation group (e.g. Dinovitzer, Reichman, & Sterling 2009; Morgan 1998; Noonan, Corcoran, & Courant 2005; Prokos & Padavic 2005). Others have compared intercohort inequality across two or three cohorts of women (e.g. Miech, Eaton, & Liang 2003).

What is missing from the existing body of research though is a decomposition of the gender wage gap in to period effects and cohort effects. It is unlikely that shifts in the gender wage gap are the product of just period effects or just cohort effects. Instead, it is likely that both period effects and cohort effects play a critical role in the narrowing of the gender wage gap. To better understand temporal changes in the gender wage gap, we must separate period and cohort effects and determine the unique contribution of each. Thus, to fully explore the role of cohorts, we must simultaneously estimate period and cohort effects.

DATA AND METHODS

Sample

We use data from the March supplements of the Current Population Survey (CPS) from 1976 through 2010. The CPS is the most nationally representative survey of individual earnings that is conducted on an annual basis. Unlike the Panel Study of Income Dynamics, which is restricted to persons selected in a few specific years, the CPS sample is designed to be nationally representative in each survey year. We used the CPS data provided by the Integrated Public Use Microdata Series (King et al 2010).

Our sample includes respondents aged 26–60 in the respective survey year who had wage or salary earnings in the prior year. The sample thus consists of wage and salary earners aged 25–59 in 1975–2009. Because many respondents younger than age 25 may still be in school, their wages may not accurately reflect their later earning power. Therefore we exclude these respondents in order to reduce confounding effects due to incomplete educational attainment. Similarly, we also exclude individuals older than 59 because substantial percentages of men and women older than 59 have retired from the labor force. We also exclude respondents born before 1930. While some notable changes did occur earlier, employment opportunities for women did not begin to dramatically expand until the 1960s (Cotter, Hermsen, & Vanneman 2001). Therefore, we focus on cohorts of women whose careers were most likely to benefit from these changes: cohorts born from 1930 onward. Because the labor market forces that influence income from self-owned businesses differ markedly from those impacting wage and salary income, we exclude self-employed persons and those with business income. Our final sample consists of 1,860,126 persons.

Measures

Our dependent variable is the log of the respondent's hourly wage in the year prior to survey data collection. To construct this variable, we divide total annual earnings by total number of hours worked. The latter is calculated by multiplying the usual number of hours worked by the weeks worked in the prior year.¹

Our key independent variables are gender, age, period, and cohort. We measure each age, period, and cohort by five-year intervals. Therefore, age is measured as age 25–29, 30–34, 35–39, etc., with the oldest group being aged 55–59. Period is measured by the time frames 1975–79, 1980–84, and so on; the most recent interval is 2005–2009. Cohort is measured by five-year intervals based on the respondent's year of birth. Our oldest cohort was born in the years 1930–34; the youngest cohort was born in the years 1980–1984.

Additional independent variables include the standard set of covariates used to predict earnings, and in particular those that have been used to explain the gender wage gap (Blau and Kahn 2000), including race/ethnicity, educational attainment, marital status, and whether there is a child under 5 years of age in the household. Race/ethnicity is measured as non-Hispanic White, non-Hispanic African American, Asian American/Pacific Islander, Native American, Latino, or other, with Non-Hispanic White serving as the reference category. Marital status is measured as married, single, or widowed/divorced/separated, with married serving as the reference group. For educational attainment, we include dummy variables for having a bachelor's degree or higher, some college (at least one year of college but less than a bachelor's degree), and not having a high school diploma. The reference group is high school diploma only. The coding of education in the CPS changed in 1992 from a system based on the highest grade of schooling to a code for the highest degree obtained. For years prior to 1992, we classified completion of grade 12 as a having a high

¹We also conduct all analyses using the log of the respondent's annual earnings in the year prior to survey data collection as the dependent variable, and restricting our analysis to persons who usually worked at least 35 hours a week for a minimum of 50 weeks during the year for which earnings are reported. Because the findings from these models are very similar to the findings that use log hourly wages, we only report the findings from log hourly wages. Results for annual wages are available from the authors upon request.

school diploma and completion of 4 or more years of college as having a ‘bachelor’s degree or higher’.

We also include variables for industry and occupation based on the detailed three digit codes defined by the US Census and provided in the IPUMS CPS. The definitions of both industry and occupation have changed over time. We use a variable provided by the IPUMS CPS, which recodes industry and occupation codes for all years to a consistent set of codes based on the 1950 definitions for industry and occupation. The codes based on the 1950 definitions are the only set of codes consistent across all years which are available for the occupation and industry in the year prior to the survey. In one multivariate model, we collapse the industry codes into a set of 14 industry codes based on the two digit codes for industry and occupation from the North American Industrial Classification System (manufacturing is the reference category) and we collapse occupation into a set of 9 occupation codes (farming and 8 codes used by the Equal Employment Opportunity Commission, except we combine professional and technical occupations). Sales is our reference occupation category.

Finally, we include a variable for part-time work (less than 35 hours per week). The CPS does not include a variable for years of work experience.

Method of Analysis

In order to decompose the gender wage gap into age, period, and cohort effects, we rely on a series of ordinary least squares regression models where the unit of analysis is the individual respondent and log hourly wages is the dependent variable. We estimate the base gender wage gap with an indicator (0/1) variable that has a value of 1 for female respondents. Age, period, and cohort differences in the gender wage gap are estimated by a series of interaction terms between gender (female) and variables for age, period, and cohort respectively. In order to allow for the greatest flexibility in terms of age, period, and cohort effects, we model these variables in a semi-parametric manner, with a 0/1 indicator variable for each of the 5-year age, period, and cohort intervals. One five-year interval for each type of effect serves as the reference category for that effect. The reference categories are the ages 25–29, the calendar years 1975–79, and the birth cohorts 1930–34. The models also include main effects for age, period, and cohort, which can be interpreted as the age, period, and cohort effects for male wages. In order to ensure that our findings are nationally representative, all analyses use the probability sampling weights provided by the CPS.

We chose to model age, period, and cohort in this semi-parametric manner because this is a more flexible modeling strategy than assuming *a priori* that the effect of each variable is linear or quadratic. For instance, using a linear and quadratic term does not allow the researcher to incorporate the possibility of the leveling off of period and cohort effects. We chose to use five-year categories because the five-year unit is standard in demographic analysis (Preston, Heuveline, & Guillot 2001).²

We estimate two sets of models. In the first set of models (Models 1–4), we explore how controlling for age and cohort changes time trends in the gender wage gap. In the second set of models (Models 5–8), we explore the contributions of covariates (race/ethnicity, marital status, number of children in the household, education, occupation, and industry) to age,

period, and cohort effects on the gender wage gap. This second set of models allow us to assess the proportion of the age, period, and cohort effects from Model 4 are accounted for by the additional covariates.

A notable criticism of analyses using age, period, and cohort categories is that the findings may be sensitive to the categories chosen (Glenn 2005).³ Therefore we explored the robustness of our findings by conducting two additional models using 4-year intervals (Model 9) and 6-year intervals (Model 10) for age, period, and cohort. The results are very similar to the reported models. Results from the alternative models are presented in the Appendix in Table A5 and Table A6.

RESULTS

Descriptive Statistics

Table 1 shows trends in wages, disaggregated by period and age. Each cell shows one age group in a particular time period. The table allows us to examine the progression of wages across ages in a particular time period or across time periods for a particular age. We can also follow the progression of ‘cohorts’ down the diagonal.⁴ However, any comparison of an age group across time periods or vice versa is also a comparison of cohorts across age groups or time periods. Thus, unmeasured cohort effects confound what appear to be age or period effects. Similarly, the progress of cohorts down the diagonal incorporates period and age effects. Thus, unmeasured age and period effects confound what appear to be cohort effects. Our modeling strategy allows us to move beyond the analytical limitation of this table to analyze age, period, and cohort effects *net of* the other two factors.

Multivariate Results

Figure 1 shows the female by period interaction terms from Models 1–4, in which first period, then period and cohort, then period and age, and finally period, cohort, and age variables are included. Coefficients from these models are presented in Table A1. The figure allows us to examine how controlling for age, and in particular cohort, impacts the effect of aggregate time trends on the gender wage gap. The reference period is 1975–79. When only

²In addition, we strove to achieve a balance between the two issues of multi-collinearity and inappropriate collapsing of categories. If the width of the group intervals chosen is too wide (for instance 10 year categories), the analysis risks combining groups which are substantially dissimilar. This will lead to incorrect parameter estimates. However, choosing a width that is too narrow leads to two potential problems. First, the smaller the width, the greater the chance that the effect in a particular year will be due to some random quality of the sample of people born or working in that particular year. Wider intervals serve in essence to smooth the data, rendering a more interpretable pattern. In addition, due to the nature of age, period, cohort analysis, the narrower the interval, the more likely that high levels of multi-collinearity will result in unstable parameter estimates. A model that uses only the minimum restrictions required (3 reference groups + one additional set of equality constraints between two parameters) is only one degree of freedom removed from perfect multi-collinearity. This is bound to lead to extremely high multi-collinearity. Thus, even though such a model is the most flexible strategy possible, it is not necessarily the most appropriate.

³It should be noted that this general issue is not unique to age, period, and cohort analysis. Any time a model includes a continuous variable, the researcher must make the decision of how to model the variable. For instance, should the variable be treated as having a simple linear effect or is it appropriate to include an additional quadratic term? Generally the most flexible modeling strategy is not to assume any sort of linearity and model the effect in a semi-parametric manner through the use of dummy variables for each value of the variable. When choosing to model effects in a semi-parametric manner, researchers commonly group values into a smaller number of groups for the sake of simplicity of computation and interpretation. For instance, even in cross-sectional models, age is commonly grouped into categories of 5 or 10 years.

⁴Note however that these are not the same cohorts included in our models. Each cohort shown in the table is actually an eight year cohort which spans two of the cohorts included in our models (for instance age 25–29 in 1975–59 is birth years 1946–54, or portions of birth cohorts 1945–59 and 1950–54).

variables for period or period and age are included, Figure 1 shows a time trend where women achieve steady wage gains relative to men over time, indicating a narrowing of the gender wage gap.⁵

Comparing the coefficients in Models 1 and 2 to the coefficients in Models 3 and 4—models which add cohort effects—we see that including cohort leads to a substantial reduction in the time trend. That is, much of what initially appear to be ‘naïve period effects’ are in fact due to cohort effects. Comparing the period only vs. period + cohort time trends, we find that the percentage of the total time trend explained by the cohort effects ranges from 54% (1990–94) to 80% (1980–84) and 85% (2005–09). Comparing the time trends for period + age with the full set of period + age + cohort variables, we see that the percent of the coefficient for a specific time period explained by the cohort effects ranges from 56% (1990–94) to 75% (2005–09) and 77% (1980–84). The percentage of the time trend explained by cohort effects for each set of five years is presented in Table A2.

Finally, Figure 1 shows that controlling for age results in a small increase in the female wage gains, and a reduction in the gender wage gap, which increases (in absolute terms) between 1975 and 2009. This indicates that age effects actually serve to increase the gender wage gap.

Figure 2 and Figure 3 present the overall trends in the gender wage gap by period and cohort as estimated by Model 4, which simultaneously control for age, period, and cohort.⁶ The full models with coefficients for all variables can be found in the appendix (Table A1). In the discussion that follows, ‘unadjusted’ gender wage gaps refer to estimates from Model 4, a model without demographic and employment covariates; ‘adjusted’ wage gaps refer to estimates from Model 8 where we include all covariates. Both the unadjusted and adjusted effects of period and cohort control for the effect of age and cohort and age and period, respectively.

Using the estimates from Model 4 presented in Table A1, Figure 2 shows the unadjusted gender wage gap by period net of age and cohort. We see that the gender wage gap narrows from 1975 to 1994 before rising slightly between 1994 and 1999 and plateauing thereafter. Changes between successive periods up until 1995 are statistically significant ($p < .001$; see Table A1 in Appendix), but there is not a statistically significant change in the gender wage gap between 1995 and 2009.⁷ As shown in Figure 1, while the gender wage gap narrows by .288 log annual wages between 1975 and 2009, only 30% of this change (.087 log hourly wages) is actually due to true period effects. Due to the fact that the gender wage gap plateaus (or rises insignificantly) after 1999, the aggregate drop in the gender wage gap of .077 log hourly wages between 1994 and 2009 is entirely due to cohort effects.⁸

⁵Figure 1 graphs interaction terms between female and period. Males have values of 0 for these interaction terms. Therefore as the values of these interaction terms increase, the gender wage gap decreases.

⁶For Figure 2, the gender wage gap is calculated as the coefficient for female (the gender wage gap in the reference period of 1975–1979) plus the interaction term for female and the respective period (the additional contribution to the gender wage gap in the specific period). Figure 1 and 3 (for cohort and age) are constructed in the same manner, using the interaction terms for female and cohort or female and age respectively.

⁷As shown in Model 4 of Table A1, each of the interaction terms for female and period are significant, indicating that the gender wage gap in each subsequent time period differs from the reference gender wage gap in 1975.

⁸As previously discussed, age effects actually served to increase the gender wage gap between 1995 and 2009.

Figure 3 shows the unadjusted gender wage gap by cohort net of age and period. Here we see that the gender wage gap falls steeply between the 1930–34 birth cohort and the 1950–54 birth cohort. The gender wage gap continues to narrow, but at a slightly slower rate through the 1975–1979 birth cohort, and then levels off. Changes between successive cohorts are statistically significant ($p < .001$), except for differences between the 1975–79 and 1980–84 cohorts (see Table A1).

Because the gender wage gap grows smaller for each successive cohort, as the older cohorts age out of the labor force and are replaced by younger cohorts, the gender wage gap will decline due to the cohort composition of the labor force (cohorts with a greater gender wage gap being replaced by cohorts with a smaller gender wage gap). This phenomenon is referred to as cohort replacement. As discussed, cohort effects account for all reductions in the gender wage gap since the mid 1990s. This suggests that ‘cohort replacement’ is driving recent changes in the gender wage gap.

Finally, in terms of age effects, we see from Model 4 that the gender wage gap widens successively from each age group from 25–29 through 40–44. The gender wage gap then narrows through age 55–59. In fact, the gender wage gap at age 55–59 is not significantly different from the gender wage gap at age 25–29. The finding from Figure 1 that age effects serve to increase the gender wage gap over time is likely a result of more middle-aged women (for whom the gender gap is largest) remaining in the labor force.⁹

Analysis of Covariates

The gender wage gap by period, controlling for age and cohort and adjusted for demographic and employment characteristics, is shown in Model 8 in Table A3. The proportion of each cohort and period effect on the gender wage gap that is explained by the covariates is presented in Table A4. The percentage of the cohort effects on the gender wage gap that are explained by these characteristics ranges from 33% in 1945–49 to 47% in both 1980–84 and 1935–39.¹⁰ Other than for the 1945–49 cohort, the characteristics explain at least 37% of each cohort effect, and between 1955–1984, the percent of the cohort effect explained by the characteristics only varies by 3 percentage points. Although the contribution of these characteristics to the effect of cohort on the gender wage gap is sizeable, more than 50% of the cohort effect for any given cohort cannot be explained by

⁹Given the overlaps between age, period, and cohort membership, multi-collinearity is a potential concern. While the presence of multi-collinearity does not bias parameter estimates, it can lead to substantial increases in the variance of these estimates, making the results less reliable (more unstable). For this reason, Firebaugh (1997) cautions about the potential instability of parameter estimates for age, period, and cohort analysis when using small samples. However, our sample size is very large: 1,860,126, and the smallest number of men or women in any age, period or cohort group is 14,950. Due to the large sample size, the estimates for the variances of our parameters are still quite small, even if they may have been substantially increased due to multi-collinearity. For instance, nearly all of our coefficients are statistically significant at the $p < .001$ level, which indicates that the (absolute value of) the coefficient is more than 3 times the standard error, resulting in a lower bound on the 95% confidence interval (for the absolute value of the coefficient) which is at least 65% of the value of the point estimate and an upper bound which is less than 135% of the point estimate. In fact, for 75% of our parameters, the lower bound of the confidence interval is at least 75% of the point estimate and the upper bound is less than 125% of the value of the point estimate. Overall, relative to many parameter estimates in models of log wages, our parameter estimates are quite precise (they have small confidence intervals relative to the size of the coefficients), which alleviates concerns about potential multi-collinearity leading to unstable estimates.

¹⁰Percentage of the period and cohort effects explained by the covariates is calculated by comparing the size of the coefficient for a specific female by period (or female by cohort) interaction term between the unadjusted (Model 4) and adjusted models (Model 8).

these characteristics. Furthermore, perhaps surprisingly, there is no particular pattern to the contribution of the characteristics to the cohort effects over time.

There is more variation in the percentage of the period effects on the gender wage gap that are explained by the demographic and economic characteristics in Model 8. In addition, the percentage of period effects attributable to the controls is larger on average. The smallest proportion of period effects explained by the covariates is 38% for the 1990–94 period. The 1990–94 period is somewhat of an outlier; at least 48% of all other period effects are explained by the covariates. The second largest amount explained by the covariates is 57% for the 1985–89 period. There is one additional outlier; 88% of the 1980–84 period effect is explained by the demographic and economic characteristics. However, the period effect for the 1980–84 period is very small to begin with (there is not much change in the gender wage gap since the reference period of 1975–79), which could explain the large percentage of the effect that is attributable to the controls. As with the cohort effects, while a sizeable portion of the period effects can be explained by the controls, much of the effect remains to be explained by other factors. And as with the cohort effects, there is little observable pattern in the proportion explained over time. In summary, to conduct a fully comprehensive analysis of the factors which explain the age, period, and cohort effects on the gender wage gap, the analysis would need to include variables not available in the Current Population Survey, such as years of work experience, job tenure, and total children ever born.¹¹ In particular, the increase in women's work experience related to increasing percentages of women in the labor force across successive periods and cohorts likely would explain a substantial proportion of the period and cohort effects on the gender wage gap (Blau and Kahn 2006b; England 2010; Cotter, Hermsen and Vanneman 2004).

Relationship between Period and Cohort Effects and Male and Female Wages

Figures 4 and 5 show the relationship between the unadjusted gender wage gaps from Figure 2 and 3 with male and female wages by period (controlling for age and cohort) and cohort (controlling for age and period) respectively.¹² Figure 4 indicates that from 1975–1990, the gender wage gap decreased as a result of the combination of women's wages increasing while male wages stayed relatively flat. From 1990–1994 onward, both male and female wages rose at approximately the same rate and the gender wage gap therefore flattened over that period. Correlation coefficients between the gender wage gap by period with male and female wages are $-.09$ and $-.64$ respectively, indicating that overall, while this is not obvious visually from the graph, changes in the gender wage gap by period are more closely related to changes in female wages.

Figure 5 indicates interesting specific relationships between trends in the gender wage gap by cohort and cohort trends in male and female wages. For birth cohorts 1930–34 through 1945–49, the gender wage gap is a mirror image in the female wage trajectory, with female wages rising and male wages remaining constant. However, for birth cohorts from 1950–54

¹¹Our covariates account for a smaller portion of the period specific gender wage gap compared to results found in Blau and Kahn (2006a). This may be due to the fact that we do not control for such factors as years of work experience, total number of children born or union representation. It also may be related to the fact that Blau and Kahn do not control for cohort effects in their model; therefore the unadjusted wage gap itself is measured in a completely different manner.

¹²Figure 4 and 5 are based on coefficients from Model 4.

through 1975–79, the gender wage gap closely resembles the male wage trends, as male wages drop for successive cohorts and female wages remain constant. Between the final two cohorts (1975–79 and 1980–84), male and female wages follow the same pattern as the gender wage gap remains flat. Over the entire set of cohorts, the gender wage gap is more strongly correlated with male wages (correlation = .83) than female wages (correlation = -.64).

DISCUSSION AND CONCLUSION

The issue of selection into employment may complicate our findings. Male and female wages are based on men and women who happen to be employed at a specific point in time. Generally, it is reasonable to expect that men and women who participate in the labor force and who are employed at any given time will have higher wages than those who drop out of the labor force. This is likely to be especially true for women. It is well known that women who have greater potential earning power (for instance higher levels of education) are more likely to remain in the labor force after having children (Rindfuss and Brewster 2000). Therefore, it is likely that ignoring selection effects will under-estimate the true level of the gender wage gap.

For the purposes of our analysis, the key question is whether selection effects act differentially across ages, periods, and cohorts. It is true that the percentage of women employed has increased both for recent periods and younger cohorts (Cotter, Hermesen and Vanneman 2004). The opposite trend has been observed for men. When the majority of women did not work outside the home, as for earlier time periods and cohorts, those who were employed were likely to have especially high earning potential compared to their counterparts who did not work outside the home. In the current labor market, where a majority of women work outside the home, women who are not employed are thus likely to have especially low earning power. Taken together, these patterns indicate that we are also likely to have underestimated the impact of period and cohort effects on the gender wage gap. In other words, the magnitude (absolute value) of each effect (e.g. gender by period or gender by cohort interaction) is likely larger than presented. However, since the effects of cohort and period are relatively smooth over time (both showing a decline in the gender wage gap which eventually stalls), it is likely that the general pattern of our findings over time is robust to selection effects. The eventual slowing of the narrowing of the gender wage gap by period and cohort is also likely to be robust to selection effects as the percentage of women employed in the labor force has remained roughly constant since the early 1990s (Bureau of Labor Statistics 2011). We are also likely to have underestimated the impact of age effects on the gender wage gap, as more women tend to drop out of the labor force in the middle years, and these are likely to be women with less earning power.

One possible mechanism to deal with selection effects is the use of a Heckman Selection model, which would incorporate a first stage equation estimating the probability of being employed before estimating the second stage equation of the impact of gender, age, period and cohort upon log wages. However, Moffitt (2005) cautions that in the absence of an appropriate exclusion restriction, a Heckman selection model is likely to result in biased results. The exclusion restriction refers to the existence of a variable that influences the

outcome of the first stage equation (e.g. employment status) but has no effect on the outcome of the second stage equation (e.g. log wages). In the context of wages and employment status, it is difficult to think of an appropriate exclusion variable, particularly given the constraints of the variables present in the Current Population Survey. Therefore we decided not to use a Heckman selection model. It is worth noting that many of the classic econometric decompositions of the gender wage gap (e.g. Blau and Kahn, 2006b, Budig and England 2001) do not use a Heckman selection model.

The results from the multivariate analysis demonstrate the importance of simultaneously accounting for age, period, and cohort effects. In each case, the impact of age, period, and cohort are transformed when additional effects are accounted for. When age and cohort are controlled for, the narrowing of the gender wage gap after 1994 is shown to be an artifact of cohort replacement effects. That is, because successive cohorts experience a continuous narrowing of the gender wage gap (until the birth cohort of 1980–84) and the younger cohorts are more fully represented in later periods, what appears to be a narrowing of the gender wage gap for all women in the periods after 1994 is in fact due to the presence of additional women of younger cohorts in the labor market.

The fact that changes in the gender wage gap since the mid-1990s are due to cohort replacement has implications for our understanding of workplace inequality for women. Significant declines in the gender wage gap across periods represent changes in the labor market that benefit all women regardless of age or cohort. Such improvements appear to have stalled since the mid 1990s. The changes since then occur entirely due to the labor market experiences of young women joining the labor force, who have since surpassed men of similar cohorts in terms of educational attainment and who have made inroads into many high paying occupations, particularly in professional occupations. The cohorts of women in the labor force in the mid-1990s have failed to make up ground relative to men since that time.

Nevertheless, the period effects from 1975–79 to 1990–94, which show a drop in the gender wage gap of .110 log wages, or approximately 20% of the gender wage gap in 1975, should not be disregarded. Nearly 40% of this period effect is due to women (of all cohorts) moving into formerly male dominated occupations, particularly professional and managerial occupations between the 1970s and the mid 1990s, a trend which has slowed since (Cotter, Hermesen and Vanneman 2004; England 2010).¹³ Many of these were women who took time out of the labor force in their 20s and early 30s, most likely to raise young children, and then returned to the labor force in their 30s and early 40s (Cohen 2013).

The occupational integration of the 1970s and 1990s was certainly facilitated by the enactment and Equal Employment Opportunity Commission (EEOC) enforcement of the Civil Rights Act of 1964, which outlawed recruitment and hiring for jobs on the basis of gender. The slowdown of occupational integration in the current century may be due in part to EEOC cutbacks and subsequent looser enforcement of policies. It also is likely a result of

¹³Whether and the extent to which occupational integration has slowed depends in part on the methodology used. See, for instance, Tomaskovic-Devey et al (2006).

the fact that the occupational integration since the 1970s was concentrated in a subset of the labor market, in particular professional occupations, which now are approaching gender equality, especially for younger cohorts. Occupational segregation among working class occupations has remained relatively constant since the 1970s (England 2010; Hirsch 2009).

The steady decline in the gender wage gap across cohorts from 1930–1980 can be understood as reflecting the occupational opportunities available for women at the time specific cohorts of women entered the labor market. For instance, when women born in 1930s entered the labor market, the majority of women were expected to enter secretarial, teaching, or nursing careers, and to leave the labor market upon marriage or the birth of a child. Both occupational opportunities for women and attitudes toward working mothers had changed dramatically by the time the younger cohorts in our sample entered the labor market. The professional opportunities available for women reflected both the social norms of the time in terms of what were considered ‘appropriate’ jobs for women in general (and mothers in particular), as well as legislation (or lack thereof), which served to create (or prevent) equal employment opportunities (Goldin 1990; England 2010).

As cohort replacement continues to occur throughout the first half of the 21st century, in the absence of period effects contributing to an entrenchment of the gender wage gap, the overall gender wage gap will continue to decline for many years. However, this trend will not necessarily result in eventual elimination of the gender wage gap. Our analysis also indicates that cohort effects are slowing—there is no significant difference in the gender wage gap between the two most recent cohorts. It is too early to tell whether cohort effects have plateaued or whether younger cohort will continue to experience further declines in the gender wage gap.

However, certain trends, such as the fact that women of younger cohorts now have surpassed men in terms of education and achieved parity of representation in certain occupations (e.g. medicine), would indicate that the slowing of cohort effects may be permanent. In order to see additional declines in the gender wage gaps across future cohorts, women would have to either substantially surpass men in educational attainment and/or the professional occupations, trends which seem unlikely, or make inroads into areas which still have high levels of occupational segregation, such as upper level managerial positions and male dominated working class occupations (England 2010; Stone 2007; U.S. Congress Joint Economic Committee 2010).

Finally, the relationship between trends in the gender wage gap and male and female wages across specific time periods and cohorts provide additional insight into the nature not only of the gender wage gap but also of recent changes in male wages. The overall time trend of stagnant wages for men (particularly those without a college degree) since the 1970s is well known (Bernhardt, Morris, & Handcock 1995). However, Figure 4 and 5 indicate the nuances present within this trend. The figures show that this is in fact due to a combination of sometimes contrasting period and cohort effects over time. Figure 5 indicates that successive cohorts of men born since 1945 have fared progressively worse in the labor market. However, period effects in Figure 4 show male wages dropping from 1975–1990 but then steadily increasing through 2009. This combination of the period and cohort trends

suggests that men in older cohorts have done relatively well since the early 1990s, benefitting from period effects that lead to rising wages. For younger cohorts of men, however, the increase of wages due to period effects is not enough to offset the decline in wages due to cohort effects.

Both period effects (on male wages) from 1975–90 and the cohort effects for men born since 1950 can be understood in terms of the decline of the manufacturing industry and its associated relatively high paying unionized jobs. Much of the loss of manufacturing jobs occurred in the 1980s, which is reflected in the drop in male wages between 1975–90. The lower wages of successive cohorts reflects in part the fact that many fewer members of younger cohorts are able to enter into jobs in the manufacturing industry to begin with (Kalleberg 2011).

As shown in Figure 5, the trends in the gender wage gap by cohort for birth cohorts 1930–1944 are driven by the steady increase in female wages for these cohorts. Male wages remained constant for these cohorts. These are the female cohorts who entered the labor market in the 1960s and 1970s when employment opportunities were first beginning to open for women outside of traditionally female dominated fields. It is notable that wages have remained constant for female cohorts born 1945–1979. Thus, while women in cohorts born since 1950 have made impressive gains in terms of educational attainment, occupational integration, and work experience, these achievements have essentially allowed them to ‘tread water’, to maintain rather than increase their wages. For these cohorts, the narrowing of the in the gender wage gap is driven by the decline in male wages for each successive cohort.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Appendix

Table A1

OLS Models of Log Hourly Wages by Gender, Age, Period, and Cohort

Variables	<u>Model 1</u>	<u>Model 2</u>	<u>Model 3</u>	<u>Model 4</u>
	Coef SE	Coef SE	Coef SE	Coef SE
Female	-0.526*** (0.00)	-0.401*** (0.00)	-0.620*** (0.01)	-0.553*** (0.01)
Period 1980–1984	-0.084*** (0.00)	-0.105*** (0.00)	-0.046*** (0.00)	-0.074*** (0.00)
Period 1985–1989	-0.075*** (0.00)	-0.112*** (0.00)	0.005 (0.00)	-0.045*** (0.00)
Period 1990–1994	-0.140*** (0.00)	-0.190*** (0.00)	-0.014*** (0.00)	-0.093*** (0.01)
Period 1995–1999	-0.105*** (0.00)	-0.168*** (0.00)	0.072*** (0.00)	-0.041*** (0.01)
Period 2000–2004	-0.043*** (0.00)	-0.115*** (0.00)	0.193*** (0.00)	0.045*** (0.01)
Period 2005–2009	-0.065*** (0.00)	-0.139*** (0.00)	0.245*** (0.00)	0.061*** (0.01)
Female and 1980–1984	0.050*** (0.00)	0.065*** (0.00)	0.010* (0.01)	0.015** (0.01)
Female and 1985–1989	0.116*** (0.00)	0.144*** (0.00)	0.040*** (0.01)	0.047*** (0.01)
Female and 1990–1994	0.211*** (0.00)	0.248*** (0.00)	0.097*** (0.01)	0.110*** (0.01)
Female and 1995–1999	0.223*** (0.00)	0.270*** (0.00)	0.068*** (0.01)	0.091*** (0.01)
Female and 2000–2004	0.257*** (0.00)	0.310*** (0.00)	0.057*** (0.01)	0.090*** (0.01)
Female and 2005–2009	0.288*** (0.00)	0.343*** (0.00)	0.042*** (0.01)	0.087*** (0.02)
Ages 30–34		0.164*** (0.00)		0.124*** (0.00)
Ages 35–39		0.274*** (0.00)		0.201*** (0.00)
Ages 40–44		0.327*** (0.00)		0.225*** (0.01)
Ages 44–49		0.362*** (0.00)		0.230*** (0.01)
Ages 50–54		0.377*** (0.00)		0.210*** (0.01)
Ages 55–59		0.364*** (0.00)		0.165*** (0.01)
Female and Ages 30–34		-0.099*** (0.00)		-0.063*** (0.00)
Female and Ages 35–39		-0.185*** (0.00)		-0.109*** (0.01)
Female and Ages 40–44		-0.226*** (0.00)		-0.109*** (0.01)
Female and Ages 44–49		-0.255*** (0.00)		-0.097*** (0.01)
Female and Ages 50–54		-0.269*** (0.00)		-0.065*** (0.01)

	<u>Model 1</u>	<u>Model 2</u>	<u>Model 3</u>	<u>Model 4</u>
<u>Variables</u>	<u>Coef</u> <u>SE</u>	<u>Coef</u> <u>SE</u>	<u>Coef</u> <u>SE</u>	<u>Coef</u> <u>SE</u>
Female and Ages 55–59	–0.279*** (0.01)			–0.026 (0.02)
Birth Cohort 1935–39			–0.015*** (0.01)	–0.004 (0.01)
Birth Cohort 1940–44			–0.026*** (0.01)	0.007 (0.01)
Birth Cohort 1945–49			–0.070*** (0.00)	0.001 (0.01)
Birth Cohort 1950–54			–0.160*** (0.00)	–0.058*** (0.01)
Birth Cohort 1955–59			–0.230*** (0.00)	–0.110*** (0.01)
Birth Cohort 1960–64			–0.303*** (0.01)	–0.155*** (0.01)
Birth Cohort 1965–69			–0.357*** (0.01)	–0.172*** (0.01)
Birth Cohort 1970–74			–0.431*** (0.01)	–0.196*** (0.01)
Birth Cohort 1975–79			–0.551*** (0.01)	–0.250*** (0.02)
Birth Cohort 1980–84			–0.665*** (0.01)	–0.304*** (0.02)
Female and Birth Cohort 1935–39			0.024*** (0.01)	0.030*** (0.01)
Female and Birth Cohort 1940–44			0.065*** (0.01)	0.070*** (0.01)
Female and Birth Cohort 1945–49			0.140*** (0.01)	0.133*** (0.01)
Female and Birth Cohort 1950–54			0.221*** (0.01)	0.206*** (0.01)
Female and Birth Cohort 1955–59			0.264*** (0.01)	0.249*** (0.01)
Female and Birth Cohort 1960–64			0.297*** (0.01)	0.278*** (0.02)
Female and Birth Cohort 1965–69			0.329*** (0.01)	0.298*** (0.02)
Female and Birth Cohort 1970–74			0.389*** (0.01)	0.337*** (0.02)
Female and Birth Cohort 1975–79			0.453*** (0.01)	0.368*** (0.02)
Female and Birth Cohort 1980–84			0.481*** (0.01)	0.369*** (0.03)
Constant	2.326*** (0.00)	2.140*** (0.00)	2.381*** (0.01)	2.204*** (0.01)

*
p<.05**
p<.01***
p<.001

N=1,860,126

For Model 4, differences between adjacent age, cohort, period, and groupings, as well as interaction terms between female and adjacent age, cohort, period, and groupings, are statistically significant at the $p<.001$ level except for the following: cohort 1935 vs cohort 1940 (statistically significant at the $p<.05$ level), female_age4044 vs female_age4549 (statistically

significant at the $p \leq .05$ level), female and birth cohort 1980–84 vs female and birth cohort 1975–79 (NS), female and period 2000–04 vs female and period 2005–09 (NS), female and period 1995–99 vs female and period 2000–04 (NS), female and age 35–39 vs female and age 40–44 (NS), birth cohort 1940–44 vs birth cohort 1945–49 (NS), age 40–44 vs age 45–49 (NS)

Table A2

Proportion of the Time Trend in the Gender Wage Gap Explained by Cohort Effects

	Period vs. Period + Cohort	Period + Age vs. Period + Age + Cohort
Female and 1980–84	.80	.77
Female and 1985–89	.66	.67
Female and 1990–94	.54	.56
Female and 1995–99	.70	.66
Female and 2000–04	.78	.71
Female and 2005–09	.85	.75

N=1,860,126

Table A3

OLS Models of Log Hourly Wages by Gender, Age, Period, Cohort, and Covariates.

	Model 5	Model 6	Model 7	Model 8
Variables	Coef SE	Coef SE	Coef SE	Coef SE
Female	−0.545*** (0.01)	−0.536*** (0.01)	−0.407*** (0.01)	−0.361*** (0.01)
Period 1980–1984	−0.066*** (0.00)	−0.080*** (0.00)	−0.081*** (0.00)	−0.085*** (0.00)
Period 1985–1989	−0.032*** (0.00)	−0.054*** (0.00)	−0.055*** (0.00)	−0.060*** (0.00)
Period 1990–1994	−0.077*** (0.01)	−0.111*** (0.01)	−0.105*** (0.01)	−0.105*** (0.00)
Period 1995–1999	−0.023** (0.01)	−0.068*** (0.01)	−0.065*** (0.01)	−0.067*** (0.01)
Period 2000–2004	0.065*** (0.01)	0.008 (0.01)	0.010 (0.01)	0.009 (0.01)
Period 2005–2009	0.080*** (0.01)	0.014 (0.01)	0.019* (0.01)	0.018* (0.01)
Female and 1980–1984	0.011* (0.01)	0.009 (0.01)	0.002 (0.01)	0.002 (0.00)
Female and 1985–1989	0.040*** (0.01)	0.035*** (0.01)	0.021*** (0.01)	0.020*** (0.01)
Female and 1990–1994	0.101*** (0.01)	0.091*** (0.01)	0.072*** (0.01)	0.068*** (0.01)
Female and 1995–1999	0.085*** (0.01)	0.073*** (0.01)	0.050*** (0.01)	0.047*** (0.01)
Female and 2000–2004	0.087*** (0.01)	0.076*** (0.01)	0.054*** (0.01)	0.047*** (0.01)
Female and 2005–2009	0.086*** (0.01)	0.068*** (0.01)	0.047*** (0.01)	0.041** (0.01)
Ages 30–34	0.111*** (0.00)	0.099*** (0.00)	0.083*** (0.00)	0.078*** (0.00)
Ages 35–39	0.190*** (0.00)	0.171*** (0.00)	0.148*** (0.00)	0.143*** (0.00)
Ages 40–44	0.221*** (0.01)	0.194*** (0.01)	0.169*** (0.00)	0.165*** (0.00)
Ages 44–49	0.228*** (0.01)	0.198*** (0.01)	0.178*** (0.01)	0.175*** (0.01)
Ages 50–54	0.207*** (0.01)	0.174*** (0.01)	0.161*** (0.01)	0.161*** (0.01)
Ages 55–59	0.159*** (0.01)	0.125*** (0.01)	0.129*** (0.01)	0.134*** (0.01)
Female and Ages 30–34	−0.050*** (0.00)	−0.041*** (0.00)	−0.026*** (0.00)	−0.025*** (0.00)
Female and Ages 35–39	−0.092*** (0.01)	−0.076*** (0.01)	−0.057*** (0.01)	−0.052*** (0.01)
Female and Ages 40–44	−0.094*** (0.01)	−0.078*** (0.01)	−0.058*** (0.01)	−0.052*** (0.01)
Female and Ages 44–49	−0.084*** (0.01)	−0.068*** (0.01)	−0.055*** (0.01)	−0.047*** (0.01)
Female and Ages 50–54	−0.051*** (0.01)	−0.035** (0.01)	−0.025* (0.01)	−0.018 (0.01)

	Model 5	Model 6	Model 7	Model 8
Variables	Coef SE	Coef SE	Coef SE	Coef SE
Female and Ages 55–59	–0.010 (0.02)	0.009 (0.01)	0.014 (0.01)	0.016 (0.01)
Birth Cohort 1935–39	–0.001 (0.01)	–0.027*** (0.00)	–0.016*** (0.00)	–0.013** (0.00)
Birth Cohort 1940–44	0.008 (0.01)	–0.047*** (0.01)	–0.028*** (0.01)	–0.026*** (0.00)
Birth Cohort 1945–49	0.002 (0.01)	–0.093*** (0.01)	–0.063*** (0.01)	–0.058*** (0.01)
Birth Cohort 1950–54	–0.050*** (0.01)	–0.145*** (0.01)	–0.102*** (0.01)	–0.093*** (0.01)
Birth Cohort 1955–59	–0.093*** (0.01)	–0.165*** (0.01)	–0.118*** (0.01)	–0.109*** (0.01)
Birth Cohort 1960–64	–0.128*** (0.01)	–0.193*** (0.01)	–0.140*** (0.01)	–0.129*** (0.01)
Birth Cohort 1965–69	–0.134*** (0.01)	–0.213*** (0.01)	–0.154*** (0.01)	–0.142*** (0.01)
Birth Cohort 1970–74	–0.146*** (0.01)	–0.232*** (0.01)	–0.169*** (0.01)	–0.158*** (0.01)
Birth Cohort 1975–79	–0.184*** (0.02)	–0.262*** (0.01)	–0.200*** (0.01)	–0.185*** (0.01)
Birth Cohort 1980–84	–0.220*** (0.02)	–0.302*** (0.02)	–0.226*** (0.02)	–0.207*** (0.01)
Female and Birth Cohort 1935–39	0.030*** (0.01)	0.032*** (0.01)	0.019** (0.01)	0.016* (0.01)
Female and Birth Cohort 1940–44	0.071*** (0.01)	0.073*** (0.01)	0.048*** (0.01)	0.044*** (0.01)
Female and Birth Cohort 1945–49	0.132*** (0.01)	0.139*** (0.01)	0.098*** (0.01)	0.089*** (0.01)
Female and Birth Cohort 1950–54	0.200*** (0.01)	0.191*** (0.01)	0.139*** (0.01)	0.124*** (0.01)
Female and Birth Cohort 1955–59	0.238*** (0.01)	0.212*** (0.01)	0.160*** (0.01)	0.136*** (0.01)
Female and Birth Cohort 1960–64	0.263*** (0.02)	0.230*** (0.01)	0.176*** (0.01)	0.153*** (0.01)
Female and Birth Cohort 1965–69	0.279*** (0.02)	0.245*** (0.02)	0.186*** (0.02)	0.163*** (0.02)
Female and Birth Cohort 1970–74	0.315*** (0.02)	0.268*** (0.02)	0.209*** (0.02)	0.186*** (0.02)
Female and Birth Cohort 1975–79	0.339*** (0.02)	0.280*** (0.02)	0.224*** (0.02)	0.200*** (0.02)
Female and Birth Cohort 1980–84	0.333*** (0.03)	0.280*** (0.02)	0.221*** (0.02)	0.196*** (0.02)
Asian American/Pacific	0.024*** (0.00)	–0.042*** (0.00)	–0.009** (0.00)	–0.015*** (0.00)
African American/Black	–0.192*** (0.00)	–0.111*** (0.00)	–0.080*** (0.00)	–0.064*** (0.00)
Latino	–0.326*** (0.00)	–0.136*** (0.00)	–0.092*** (0.00)	–0.067*** (0.00)
Native American	–0.171*** (0.01)	–0.099*** (0.01)	–0.087*** (0.01)	–0.072*** (0.01)
Other Race	–0.050*** (0.01)	–0.100*** (0.01)	–0.062*** (0.01)	–0.058*** (0.01)

	Model 5	Model 6	Model 7	Model 8
Variables	Coef SE	Coef SE	Coef SE	Coef SE
Child less than 5 years	0.070*** (0.00)	0.041*** (0.00)	0.045*** (0.00)	0.041*** (0.00)
Widowed/Divorced/Separated	-0.110*** (0.00)	-0.069*** (0.00)	-0.056*** (0.00)	-0.054*** (0.00)
Single	-0.111*** (0.00)	-0.139*** (0.00)	-0.105*** (0.00)	-0.094*** (0.00)
Bachelors Degree or Higher		0.492*** (0.00)	0.326*** (0.00)	0.299*** (0.00)
Some College		0.167*** (0.00)	0.104*** (0.00)	0.080*** (0.00)
No High School Diploma		-0.260*** (0.00)	-0.176*** (0.00)	-0.142*** (0.00)
Professional Occupation			0.132*** (0.00)	
Farming Occupations			-0.483*** (0.01)	
Managerial Occupations			0.165*** (0.00)	
Clerical Occupations			-0.102*** (0.00)	
Craft Worker Occupation			-0.026*** (0.00)	
Operator Occupations			-0.204*** (0.00)	
Service Occupations			-0.229*** (0.00)	
Laborer Occupations			-0.261*** (0.00)	
Retail Trade Industries			-0.323*** (0.00)	
Agriculture/Fishing/Forestry Industries			-0.256*** (0.01)	
Mining Industries			0.145*** (0.01)	
Construction Industries			-0.060*** (0.00)	
Transportation Industries			0.013*** (0.00)	
Telecommunications/Utilities/Sanitation			0.132*** (0.00)	
Wholesale Trade Industries			-0.074*** (0.00)	
Finance/Insurance/Real Estate Industries			-0.017*** (0.00)	
Business Services Industries			-0.120*** (0.00)	
Personal Services Industries			-0.317*** (0.00)	
Recreational Services Industries			-0.178*** (0.00)	
Professional Services Industries			-0.167*** (0.00)	

	<u>Model 5</u>	<u>Model 6</u>	<u>Model 7</u>	<u>Model 8</u>
Variables	Coef SE	Coef SE	Coef SE	Coef SE
Public Administration Industries			0.045*** (0.00)	
Part Time Employment			-0.128*** (0.00)	-0.097*** (0.00)
Constant	2.252*** (0.01)	2.213*** (0.01)	2.340*** (0.01)	2.136*** (0.01)

*
p<.05,

**
p<.01,

p<.001

N=1,860,126

Table A4

Proportion of Period and Cohort Effects on the Gender Wage Gap explained by Covariates

Period	Proportion
Female and 1980–84	.87
Female and 1985–89	.57
Female and 1990–94	.38
Female and 1995–99	.48
Female and 2000–04	.48
Female and 2005–09	.53
Cohort	
Female and 1935–39	.47
Female and 1940–44	.37
Female and 1945–49	.33
Female and 1950–54	.40
Female and 1955–59	.44
Female and 1960–64	.45
Female and 1965–69	.45
Female and 1970–74	.45
Female and 1975–79	.46
Female and 1980–84	.47

Table A5

OLS Model of Log Hourly Wage by Age, Period, Cohort in Four-Year Categories

Variables	Model 9	
	Coef	SE
Female	-0.433***	0.01
Ages 29–32	0.102***	0.00
Ages 33–36	0.184***	0.00
Ages 37–40	0.223***	0.01
Ages 41–44	0.234***	0.01
Ages 45–48	0.237***	0.01
Ages 49–52	0.218***	0.01
Ages 53–56	0.189***	0.01
Ages 57–59	0.150***	0.01
Period 1979–82	-0.051***	0.00
Period 1983–86	-0.042***	0.01
Period 1987–90	-0.036***	0.01
Period 1991–94	-0.082***	0.01
Period 1995–98	-0.057***	0.01
Period 1999–02	0.024*	0.01
Period 2003–06	0.032*	0.01
Period 2007–09	0.061***	0.01
Birth Cohort 1934–37	-0.007	0.01
Birth Cohort 1938–41	-0.004	0.01
Birth Cohort 1942–45	-0.001	0.01
Birth Cohort 1946–49	0	0.01
Birth Cohort 1950–53	-0.049***	0.01
Birth Cohort 1954–57	-0.093***	0.01
Birth Cohort 1958–61	-0.124***	0.01
Birth Cohort 1962–65	-0.156***	0.01
Birth Cohort 1966–69	-0.171***	0.02
Birth Cohort 1970–73	-0.191***	0.02
Birth Cohort 1974–77	-0.225***	0.02
Birth Cohort 1978–81	-0.269***	0.02
Birth Cohort 1982–85	-0.304***	0.02
Female and 1979–82	0	0.01
Female and 1983–86	0.026**	0.01
Female and 1987–90	0.062***	0.01
Female and 1991–94	0.100***	0.01
Female and 1995–98	0.084***	0.01
Female and 1999–02	0.064***	0.02
Female and 2003–06	0.087***	0.02
Female and 2007–09	0.080***	0.02

Variables	Model 9	
	Coef	SE
Female and Birth Cohort 1934–37	0.013	0.01
Female and Birth Cohort 1938–41	0.037***	0.01
Female and Birth Cohort 1942–45	0.066***	0.01
Female and Birth Cohort 1946–49	0.099***	0.01
Female and Birth Cohort 1950–53	0.155***	0.02
Female and Birth Cohort 1954–57	0.187***	0.02
Female and Birth Cohort 1958–61	0.192***	0.02
Female and Birth Cohort 1962–65	0.217***	0.02
Female and Birth Cohort 1966–69	0.221***	0.02
Female and Birth Cohort 1970–73	0.252***	0.03
Female and Birth Cohort 1974–77	0.273***	0.03
Female and Birth Cohort 1978–81	0.272***	0.03
Female and Birth Cohort 1982–85	0.274***	0.04
Female and Ages 29–32	–0.045***	0.01
Female and Ages 33–36	–0.107***	0.01
Female and Ages 37–40	–0.141***	0.01
Female and Ages 41–44	–0.139***	0.01
Female and Ages 45–48	–0.144***	0.01
Female and Ages 49–52	–0.122***	0.02
Female and Ages 53–56	–0.100***	0.02
Female and Ages 57–59	–0.080***	0.02
Constant	2.251***	0.01

*

p<.05,

**

p<.01,

p<.001

N=1,860,126

In terms of cohort effects on the gender wage gap, the coefficients of the 4 and 6 year models mirror the trends of the 5 year models. In addition, in both the 4 and 6 year models, changes between each successive female by cohort interaction are statistically significant excluding the difference between the most recent two cohorts. The female by period trends of the 4 and 6 year models also generally mirror the coefficients from the 5 year model with one slight variation: In the 4 year models, the gender wage gap widened a bit between 1999–2002 (4 year models) and 1999–2004 (4 year models). The average U.S. unemployment in 1999–2002 was lower than at any other time in the sample (particularly in 1999–2000), although this time period also included high unemployment in specific high technology industries related to the crash of the 'dot-com' bubble. This combined set of forces may have led to fewer high wage jobs for women or fewer low wage jobs for men (or more high wage jobs for men and more low wage jobs for women) in the labor market. Combining the years 1999–2000 together in conjunction with the smaller width of the interval allows the effect of these years to become more visible. However, excluding those 4 years, the female by period interaction coefficients between 1995 and 2009 do not differ significantly from each other. We see the same trend to lesser degree in the 6 year model. The female by period coefficient for 1999–04 shows a significant (although small in magnitude) increase from 1993–98. However, the coefficient for 1999–04 is not statistically significantly different from the coefficient for 2005–09 and the coefficient from 1993–98 is also not statistically significantly different from 2005–09. Thus in general, we see the same trend of minimal change from 1993–2009, with the slight increase in the gender wage gap in the 1999–2004 period likely resulting from combining the years 1999–2000 together. In our 5 year models, the emphasis of this two year trend is minimized as the years 1999 and 2000 are in different periods. Nevertheless, the overall pattern in the three models is that from the mid 1990s to the present there is minimal change in the gender wage gap by period.

Table A6

OLS Model of Log Hourly Wage by Age, Period, Cohort in Six-Year Categories

Variables	Model 10	
	Coef	SE
Female	-0.533***	0.01
Ages 31–36	0.133***	0.00
Ages 37–42	0.194***	0.00
Ages 43–48	0.208***	0.01
Ages 49–54	0.184***	0.01
Ages 55–59	0.135***	0.01
Female and Ages 31–36	-0.076***	0.00
Female and Ages 37–42	-0.121***	0.01
Female and Ages 43–48	-0.118***	0.01
Female and Ages 49–54	-0.087***	0.01
Female and Ages 55–59	-0.054***	0.01
Period 1981–86	-0.053***	0.00
Period 1987–92	-0.049***	0.00
Period 1993–98	-0.050***	0.01
Period 1999–04	0.064***	0.01
Period 2005–2009	0.087***	0.01
Female and 1981–86	0.029***	0.01
Female and 1987–92	0.097***	0.01
Female and 1993–98	0.126***	0.01
Female and 1999–04	0.116***	0.01
Female and 2005–2009	0.122***	0.01
Birth Cohort 1936–41	0	0.00
Birth Cohort 1942–47	0.006	0.01
Birth Cohort 1948–53	-0.046***	0.01
Birth Cohort 1954–59	-0.115***	0.01
Birth Cohort 1960–65	-0.171***	0.01
Birth Cohort 1966–71	-0.192***	0.01
Birth Cohort 1972–77	-0.239***	0.01
Birth Cohort 1978–84	-0.319***	0.01
Female and Birth Cohort 1936–41	0.025***	0.01
Female and Birth Cohort 1942–47	0.073***	0.01
Female and Birth Cohort 1948–53	0.157***	0.01
Female and Birth Cohort 1954–59	0.208***	0.01
Female and Birth Cohort 1960–65	0.238***	0.01
Female and Birth Cohort 1966–71	0.255***	0.02
Female and Birth Cohort 1972–77	0.298***	0.02
Female and Birth Cohort 1978–84	0.312***	0.02
Constant	2.215***	0.01

*
p<.05,
**
p<.01,

p<.001
N=1,860,126

Figure 1.
Time Trends in Female Wages Relative to Men, 1975–2009

Figure 2.
Gender Wage Gap by Period, net of Age and Cohort.

Figure 3.
Gender Wage Gap by Cohort, net of Period and Age.

Figure 4.
Male Wages, Female Wages, and the Gender Wage Gap by Period Net of Age and Cohort.

Figure 5.
Male Wages, Female Wages, and the Gender Wage Gap by Cohort Net of Period and Age.

Table 1

Average Gender Wage Gap in Log Hourly Wages by Period and Age Categories.

Period / Age	<u>25–29</u>	<u>30–34</u>	<u>35–39</u>	<u>40–44</u>	<u>45–49</u>	<u>50–54</u>	<u>55–59</u>
1975–79	0.3797	0.5357	0.6183	0.6431	0.6407	0.6250	0.5893
1980–84	0.3113	0.4305	0.5632	0.5976	0.6275	0.6446	0.6131
1985–89	0.2457	0.3584	0.4513	0.5031	0.5490	0.5528	0.5509
1990–94	0.1734	0.2593	0.3446	0.3882	0.4410	0.4531	0.4533
1995–99	0.1490	0.2410	0.3254	0.3435	0.3846	0.4117	0.4377
2000–04	0.1544	0.2365	0.3078	0.3537	0.3514	0.3594	0.3686
2005–09	0.1289	0.2064	0.2836	0.3254	0.3329	0.3215	0.3135

N=1,860,126