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An analysis of changes in labor market discrimination by gender, 1984--2000

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AN ANALYSIS OF CHANGES IN LABOR MARKET
DISCRIMINATION BY GENDER, 1984-2000

by

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Bachelor of Arts
Coe College
2001

A thesis submitted in partial fulfillment
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ABSTRACT

An Analysis of Changes in Labor Market Discrimination by Gender, 1984-2000

by

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Dr. Bradley S. Wimmer, Examination Committee Chair
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The effect of labor market discrimination on the wages of male and female workers has been previously studied (Blinder, 1973; Oaxaca, 1973; Reimers, 1983; Cotton, 1988; Neumark, 1988; and Oaxaca and Ransom, 1994). Changes in the amount of discrimination and the variables that contribute most significantly to its presence over time have not been dealt with in a consistent manner. The following study attempts to improve upon the existing literature by examining the changing nature of labor market discrimination, by gender, over time, and introducing a new methodology. I find that discrimination by gender is present in the labor market in the years studied, and that the amount of discrimination has decreased by a statistically significant amount from 1984 to 2000. In addition difference-in-difference analysis is used to examine potential changes in the return to various levels of educational attainment.
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CHAPTER 1

INTRODUCTION

A literature exists that examines the existence of and effect of discrimination in labor markets. Studies have addressed whether women are discriminated against, and if so, by how much. Various statistical methods have been developed in an attempt to isolate the impact discrimination has on labor markets. Two methodologies that can be employed are the Blinder-Oaxaca wage decomposition and difference-in-difference (DID) analysis. The Blinder-Oaxaca wage decomposition is attractive for its ease of use and for the multitude of information that it provides. The difference-in-difference method adds to the analysis by determining the effect that various treatments have on wages over time.

The purpose of this study is to determine the magnitude of, causes of, and changing nature of wage discrimination, by gender, present in 1984 and 2000. The literature has been studied to identify the proper specification of the model to be employed. This study examines the wage discrimination present in two ways. The first is by employing Blinder-Oaxaca wage decompositions to the data for 1984 and 2000. This enables us to determine how much of the difference in mean wages of men and women is due to individual characteristics, and how much is due to other factors, e.g. discrimination. Second, difference-in-difference analysis is performed. This analysis introduces a set of interaction terms to isolate the impact that a change in the mean of one variable will have

---

1 Becker (1971) is widely regarded as the theoretical framework for the theory of discrimination.
not only on the wage, and on the mean of another variable. This enables the researcher to examine how changes in the educational attainment of men and women have impacted wages across time. With educational attainment as one of the primary inputs of a human capital earnings function, any significant findings of this nature will go a long way towards helping to understand how wage discrimination by gender has evolved.

The unexplained differential is found to account for seventy-eight percent of the thirty-eight percent total of the difference in mean wages in 1984. By 2000 this total wage differential fell to twenty-seven percent, ninety percent of which is due to the unexplained differential. In both years the driving force behind the unexplained differential seems to be the effect of experience on wages. The difference-in-difference results show that women receive a higher wage relative to men in 2000 than in 1984, regardless of their level of educational attainment.

The paper is outlined as follows: Chapter two provides the theoretical background and empirical strategy to be employed, including theory of discrimination, wage decompositions, human capital theory, and difference-in-difference estimation. Chapter three reviews the existing literature on wage discrimination. Chapter 4 describes the data employed by the study, outlines the model used by the study, and discusses the empirical results of the wage regressions, wage decompositions, and difference-in-difference analysis. Chapter 5 concludes the study.
CHAPTER 2

THEORETICAL BACKGROUND AND EMPIRICAL STRATEGY

To estimate the impact of discrimination on labor market outcomes over the past 20 years I use 1984 and 2000 data from the Current Population Survey (CPS). The chosen years are 1984 and 2000 because 1984 is late enough to avoid some of the problems present in earlier CPS data, yet early enough to provide interesting differences when compared to 2000 data. The data used is recent enough to avoid the impact of any significant legislation impacting gender, race, or age discrimination, as noted by Neumark and Stock (2001). The sample is limited to respondents who are between the ages of 18 and 65, the individuals most likely to be full-time workers. After eliminating observations with missing variables the sample contains 56,013 observations for 1984, and 51,108 observations for 2000.

According to the CPS data the average hourly wage for men was thirty-eight percent higher than women in 1984. By 2000 the wage gap had decreased to approximately twenty-seven percent.

This study examines two possible explanations for the existence of wage gaps. First, wage gaps might be the result of differences in productivity between the groups in question. The second potential reason for wage gaps is the presence of wage gaps.

---

2 CPS data were chosen over other available data sources due to its large sample size and the multitude of variables that it provides. Further discussion of the issues associated with choosing a data source is included in the literature review.
discrimination.³ To isolate the effect that labor market discrimination has on market outcomes, I control for differences in productivity. In what follows I provide a summary of Becker's (1971) theory of discrimination, Blinder (1973) and Oaxaca's (1973) methodology for decomposing wage differentials into the portion of the wage differential that is due to differences in productivity (referred to throughout this paper as the explained differential) and the portion that might be attributed to labor market discrimination. I also present the problems associated with measuring productivity accurately, and an explanation of the issues involved in performing difference-in-difference (DID) analysis.

Becker’s Theory of Discrimination

A framework for the economic analysis of labor-market discrimination was first put forth in Gary Becker’s 1957 Doctoral Dissertation, The Economics of Discrimination. The three types of discrimination ordinarily cited are employer discrimination, employee discrimination, and consumer discrimination. Employer discrimination exists when an employer refuses to hire workers whose marginal products are greater than their marginal cost due to the disutility associated with prejudice. Employee discrimination exists when a worker experiences some degree of disutility from working alongside a worker who is different from his or herself. For instance, employee discrimination is present when white workers require higher wages when employed by integrated firms than in segregated firms. Finally, consumer discrimination exists when consumers receive negative utility when purchasing a good or service produced from someone of a different

³ It is worth noting that lack of access of quality education or other social factors might also be due to discrimination.
race, gender, etc. The discriminating consumer incorporates the cost of this disutility into the actual price, \( p \), of a good produced by an integrated firm as \( p(1+d) \), where \( d \), the discrimination coefficient, represents the percent cost of discrimination.

According to Becker's theory, firms in competitive markets that discriminate achieve lower profits than those that do not discriminate. Becker concludes that employers who pay a premium for an attribute that has no impact on the worker's actual productivity should not survive in a competitive market. Firms that choose not to discriminate hire the workers who are equally productive but command lower wages because of discrimination and drive the discriminatory firms out of business. Similar analyses can be applied to employee and consumer discrimination, with slightly different results. According to Becker, employee discrimination leads to segregated labor markets, while consumer discrimination can lead to a persistent difference in average wages between groups.

To model employer discrimination, Becker asserts that employers may have a taste for discrimination. To incorporate this notion into a model, Becker assumes that employers maximize utility by hiring workers from a specific group and receive disutility when hiring workers from groups they do not prefer. For example, consider a market that consists of male and female workers. The employer faces prices for labor of \( W_M \) for male workers and \( W_F \) for female workers. Assuming that male and female workers have equal levels of productivity, when discrimination is absent \( W_M \) should equal \( W_F \).

Discriminating employers associate a nonpecuniary cost to hiring female workers and the cost of employing female laborers is perceived to equal \( W_F(1+d) \). The employer will thus only hire female workers if \( W_F(1+d) = W_M \). Algebraically, if \( d > 0 \) then \( W_M > W_F \); male workers receive a higher wage than female workers. Prejudice changes the
employer's perception of the true cost of employing female workers and the degree to which employers discriminate is increasing in \( d \), the discrimination coefficient.\(^4\)

Blinder-Oaxaca Wage Decomposition

Alan Blinder (1973) and Ronald Oaxaca (1973) provide a methodology to decompose wages into that which is attributable to their individual characteristics, and the unexplained component. The unexplained component is possibly due to labor-market discrimination. To isolate the discrimination coefficient, \( d \), we control for differences in individual characteristics that impact the earnings capabilities, e.g., human capital, occupation, marital status, etc. Only by accounting for these factors can we obtain an estimate of the magnitude of the discrimination coefficient.

Let us return to the situation where there are only two types of workers in the labor market, male and female.\(^5\) If wages (\( W \)) are a log-linear function of a vector of characteristics (\( X' \)) for men and women we then have the following wage equations for male employees (\( M \)), and female employees (\( F \)) respectively:

\[
\begin{align*}
\text{(1)} & \quad \ln (W_M) = \beta_M X_M' \\
\text{(2)} & \quad \ln (W_F) = \beta_F X_F'
\end{align*}
\]

\(^4\) Some economists have also argued that nepotism exists in the labor market, whereby minority employers prefer to hire minority employees, leading to a negative discrimination coefficient and precisely the opposite interpretation.

\(^5\) The following example follows exposition describing the Oaxaca decomposition by Human Resources Development Canada (2002).
where the $\beta$s represent the coefficients associated with each characteristic. Given the appropriate data for each group we proceed by performing regression analysis to obtain estimates of $\beta$.

From the properties of ordinary least squares estimation we know that the estimated regression line must run through the sample means of each of the variables. The gap in average wages is then

$$\ln (\bar{W}_M) - \ln (\bar{W}_F) = \alpha_M + \beta_M \bar{X}_M' - (\alpha_F + \beta_F \bar{X}_F')$$

where $\alpha$ is the intercept of each estimated regression. Next we add and subtract the product of the individual characteristics and the nondiscriminatory wage structure in order to decompose the equation as follows:

$$\ln (W_M) - \ln (W_F) = \left[ (\bar{X}_M - \bar{X}_F)\beta^* \right] + \left[ (\alpha_M - \alpha_F) + (\beta_M - \beta_F) \bar{X}_M \right] + \left[ (\alpha_F - \alpha_M) + (\beta_F - \beta_M) \bar{X}_F \right]$$

The first set of brackets on the right hand side of the equation contains the amount of the differential that is due to the differences in individual characteristics between the male and female employees and represents the "explained" portion of the wage differential. This interpretation is fairly straightforward as the terms are the product of the nondiscriminatory wage structure and the difference in individual characteristics, on average, between the two groups. The second set of brackets shows the wage premium that male workers receive because of discrimination. This calculation shows the difference between the wage structure faced by male employees and the
nondiscriminatory structure, $\beta^*$, multiplied by the characteristics of the male workers. The third set of brackets contains the amount by which female worker's wages are decreased due to discrimination, which is accomplished by subtracting the wage structure faced by female employees from the nondiscriminatory wage structure and multiplying it by the mean characteristics of the female employees.

A key point debated in the literature is the identification of the appropriate competitive, or nondiscriminatory, wage structure. Blinder (1973) and Oaxaca's (1973) decomposition uses the male wage structure as the competitive structure, as well as the female wage structure assumed to be nondiscriminatory, asserting that the appropriate degree of discrimination then lies somewhere between the two figures. Reimers (1983) uses the mean of the figures computed using both the majority and minority groups structure as $\beta^*$, while Cotton (1988) proposed a weighted average method. Neumark (1988) and Oaxaca and Ransom (1994) each employed the estimates from a sample containing both whites and blacks as the nondiscriminatory structure, showing that Cotton's method is merely a specific case of their more general method. In this study I employ the Oaxaca-Ransom method.

While the methodology is fairly straightforward, a simple numerical example provides insight into the decomposition. For ease of exposition assume that wages are a function of a single independent variable (x).\textsuperscript{6} Assuming a ten percent higher mean wage for male workers than female workers, a decomposition can be performed by running three separate regressions: one for males, one for females, and a third, pooled regression

\textsuperscript{6} The method is the same with multiple variables, with the decomposition yielding results for the impact of discrimination on each variable and the sum of each section representing the overall explained difference in wages, majority group wage premium, and minority group discrimination, respectively.
that includes all male and female workers. For the purpose of our example, the estimated regression line is \( W_M = 0.05 + 0.125X_M \), where \( \bar{X}_M = 1 \). For the female sample the estimated regression line is \( W_F = 0.01 + 0.05X_F \), where \( \bar{X}_F = 0.5 \). The estimated pooled regression line is \( W^* = 0.0367 + 0.1X^* \), where \( \bar{X}^* = 0.8333 \).

The calculation: \( \bar{X}_M - \bar{X}_F = (1-0.5)0.1 = 0.05 \), shows that differences in characteristics account for a five percent wage differential, half of the actual differential. The wage premium received by male employees is calculated as: \( (\alpha_M-\alpha_F) + (\beta_M-\beta^*) \bar{X}_M \)

\[
[(0.05-0.01)+(0.125-0.1)1] = 0.04 + (0.025*1) = 0.065,
\]
telling us that the wage structure faced by males leads to a 6.5 percent higher wage, on average, than we would find in a market without discrimination. The third set of brackets tells us how much lower female employees’ wages are as a result of discrimination, and is calculated as:

\[
[(\alpha_F-\alpha_M) + (\beta^*-\beta_F) \bar{X}_F] = [(0.01-0.05)+(0.1-0.05)0.5] = -0.04+0.025 = -0.015.
\]
This tells us that discrimination leads to 1.5 percent lower wages, on average, for female workers, than would be expected if workers with the characteristics of the average female worker faced the nondiscriminatory wage structure. By summing the second and third terms we find the total amount by which female workers are discriminated against in the labor market, the unexplained differential, to be [6.5% + (1.5%)] = 5%. In the case of this example, males whites are paid ten percent higher on average, half of this differential is due to differences in individual characteristics, while the other half can be attributed to discrimination.

\[\text{Assuming two-thirds of the working population is male, and the remaining third is female.}\]
Measuring Productivity

Jacob Mincer (1974) provides a framework for evaluating the effect education and other forms of human capital investment have on productivity. The accumulation of human capital is, however, a time intensive and costly process, because the time spent acquiring human capital could also be spent working. Mincer shows that rational workers continue to increase their endowment of human capital until the marginal cost of acquiring more human capital (i.e., the time lost and earnings foregone while obtaining education) equals the marginal benefit accrued by obtaining more education (i.e., additional wages).

As described by Spence (1974) the importance of finishing a diploma is representative of market signaling. Rather than simply hiring a group of workers randomly and later keeping those who prove to be valuable workers, firms seek to sort those who are more likely to do the job successfully. Employers view the different diplomas, certifications, etc. as signals of a certain level of productivity that would otherwise be unobservable. When the cost of obtaining a signal is more costly for low-productivity workers than it is for workers with high productivity, the signal effectively sorts high and low-quality workers. Thus, while schooling itself may have no effect on productivity, obtaining a degree may indeed help to identify oneself as a high-productivity worker.

It is also worth noting that treating education as a linear explanatory variable (which is the case in Mincer's model and much of the subsequent research) ignores the "sheepskin effects", first described by Hungerford and Solon (1987). The "sheepskin effects" are the returns to education that result from the earning of extra credentials.
(ordinarily in the form of a degree), as opposed to years of experience. Simply stated, the 12th year of education is worth more than the 11th year of education not solely because of the extra year's accumulation of knowledge, but also because of the assumed earning of the high school diploma, or the diploma signals a certain level of quality.

**Difference-In-Difference Analysis**

Studies have utilized difference-in-difference (DID) models in order to address the potential impact of a policy, or some treatment, on a specific group relative to a control group. Common examples include difference in changes in spending patterns by groups facing a new tax structure compared to those whose tax structure has remained the same, or changes in the health of a group of people subjected to a new drug as compared to those who have not been treated. I adopt this DID approach to examine how the difference in the male-female wage differential has changed from 1984 to 2000. The approach adopted allows a comparison of whether wages for workers with different levels of education have changed in the years studied. In addition, a difference-in-difference-in-difference is calculated to determine whether there has been a statistically significant change in the difference between the return men and women receive for specific levels of educational attainment in the years studied.

In its simplest form, difference-in-difference analysis incorporates interaction terms to ascertain the impact of one indicator variable on another. For instance if we know the impact that education has on wages in two separate years for both males and females, we can perform DID analysis. This is done by first finding the difference between the mean impact of education for men and women in year$_1$ and year$_2$. The difference-in-difference
is then the difference between these two years and shows the change in the difference in earnings between male and female workers that are due to changes in the mean level of educational attainment from year₁ to year₂.

The DID methodology has become quite commonplace in the economics literature over the past few decades. The broad range of applications have ranged from Gruber and Madrian's 1995 study showing the amount that an additional year of health insurance coverage impacts an individual's likelihood of retirement, to Evans and Topoleski's 2002 study showing the impact of legislation that enables casinos to exist on native American reservations have on the economic climate of reservations with and without casinos.
Numerous studies (Blinder, 1973; Oaxaca, 1973; Reimers. 1983; Cotton, 1988; Neumark, 1988; and Oaxaca and Ransom, 1994) have attempted to determine the magnitude of wage discrimination against minority groups. While a number of methods have been employed to examine potential discrimination, this study focuses on those that have employed a wage decomposition methodology similar to that described above.

Blinder (1973) and Oaxaca (1973) independently pioneered the wage decomposition methodology that is today commonplace throughout the literature. Blinder employed the 1968 Panel Study of Income Dynamics, limiting the study to white and black household heads ages twenty-five and older. Blinder’s explanatory variables included education, age, race, formal training, health, length of work with present employer, size of city of residence, region of residence, occupation, union membership, labor market conditions, and veteran status. Blinder finds that women earn fifty-four percent as much as men in his sample, and that seventy percent of this difference is part of the explained differential. Blinder finds that black workers earn forty-nine percent as much as their white counterparts, and that eighty percent of this difference is attributed to the explained differential.

Oaxaca (1973) uses the Survey of Economic Opportunity, 1966-1967, limiting his study to urban workers classified as white or nonwhite, ages sixteen and greater. Oaxaca’
explanatory variables include: education, age, race, and a proxy for market experience, marital status, health, hours of work, size of city of residence, and region of residence. Oaxaca finds that women earn two-thirds as much as men and that roughly seventy percent of the total is due to the explained differential. 8

Reimers (1983) used the 1976 Survey of Income and Education Data to examine the impact of discrimination on the wages of Hispanic and black men. Reimers restricts her sample to males fourteen or older who are civilians (as those in the armed services face a more rigid pay structure than the private sector), were not self employed and not enrolled in school (in order to try and focus on full time workers). Reimer's explanatory variables include education, experience, experience squared, veteran status, a dummy variable for whether or not the worker is foreign born, a series of dummy variables for how long the individual has lived in the United States, a dummy variable for health status, and a dummy variable for whether or not the individual is a government employee. Reimers was the first to convert all salaries into hourly wages. Reimers finds that thirteen to fourteen percent of the twenty-three percent wage differential is due to differences in personal characteristics for black men.

Cotton (1988) and Neumark (1988) devised a method for splitting the unexplained differential into the cost imposed upon the minority group and the advantage bestowed upon the majority group. Cotton employs the Public Use Samples of the 1980 Census, restricting his sample to males ages sixteen and older who had positive earnings and hours worked. Cotton's specification shows twenty-three percent of the wage differential depends on factors other than personal characteristics.

8 Oaxaca uses two slightly different specifications yielding earnings ratios of sixty-five percent and sixty-seven percent, respectively. The accompanying explained differentials are seventy-two percent and sixty-nine percent.
Neumark (1988) uses data from the 1980 National Longitudinal Survey of Young Men and Women. Neumark's study is one of the few in the literature that attempts to measure the discrimination by both race and gender. Neumark finds that within the female sample the explained portion of the wage differential between white and black workers is thirty-one percent. In the male sample he finds that the explained differential accounts for thirty percent of the total difference.

Following these adaptations on the initial decomposition methodology, Oaxaca and Ransom (1994) examine the appropriate specification of the nondiscriminatory wage structure, a method that has since become the standard accepted methodology for decomposing wages (the method employed by this study). Their study uses 1988 Current Population Survey data, and is restricted to individuals twenty-five and older. Oaxaca and Ransom's data suggests that whites are overpaid by one percent on average, while blacks are underpaid by an average of twelve percent, with the unexplained differential accounting for sixty percent of the overall differential. Oaxaca and Ransom's gender decompositions suggest that men are overpaid by ten percent, while women are underpaid by an average of eleven percent, with the unexplained differential accounting for seventy percent of the overall differential.

The previous literature suggests no strong consensus as the appropriate data set to be used for testing wage discrimination. While it is not without flaws (primarily in the lack of some potentially relevant variables), many researchers use CPS data. The CPS is a monthly household survey used to monitor the labor market activities of individuals in the United States, and is administered to 60,000 households nationwide each month. One adult member in each sample household is asked to report on various labor market
activities of a household member. An important implication of this procedure is that some individuals may have been reported upon by another household member. It is useful in the large number of observations it provides, as well as the fact that data has been annually collected for the CPS since 1962.

The literature also suggests a variety of different specifications of models to be employed. The methodology employed for detecting the presence of and/or extent of discrimination is almost universally the Blinder-Oaxaca decomposition, or some variation of it. The only arguable point is the non-discriminatory wage structure to be used as the base for comparison. The original method used both the nondiscriminated against group and the discriminated against group as references groups, with the resulting levels of discrimination providing a range within which the actual level of discrimination falls. Reimers (1983) hypothesized that the correct procedure was instead to take an average of the range. Cotton (1988) and Neumark (1988) sought to improve upon the procedure by employing a weighted-average of the two wage structures, which then should provide us with an exact figure rather than a range. The actual controls incorporated into the models vary considerably from study to study.

Almost uniformly, the literature points to education as the key characteristic in determining the appropriate wage for an individual. However, determining how to implement education into the model is less clear. Most of the early studies include education, potential experience\(^9\), and potential experience squared. O’Neill (1990) notes that by incorporating both education and potential experience (which by definition

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\(^9\) Potential experience is defined as Age-Education-5, and was first incorporated by Mincer (1974) due to a lack of an actual measure of the number of years of experience.
includes education) we are introducing unnecessary multicollinearity, which biases the regression results.

Outside of education, experience and on-the-job training are variables that should hypothetically have a large impact on the wage structure. These variables are difficult to obtain from many available data sources, and thus their treatment varies considerably in the existing literature. The need to capture the effects of these variables has led many researchers to utilize data sets with fewer observations, but more complete data. Neumark (1988) uses NLS data that traces approximately 3000 people, while Reimers (1983) looks at approximately the same number of observations for her study of Hispanic versus non-Hispanic men. By choosing data sets that include measures for actual experience and/or on-the-job training, we are faced with a trade off. No data set exists that includes each of these variables for the entire United States, over time. In order to include them a researcher must be willing to give up either the nationwide or time series component of their analysis.

The literature seems to suggest largely uniform variables for controls outside of education and experience. The typical wage regression includes controls for race, gender, marital status, industry and/or occupation, and region of the country. Depending on the specific purpose of the study and availability of the data other variables might be incorporated as well. I develop a more formal model and discuss my reasons for including specific variables in the next chapter.
In order to estimate the amount of wage discrimination by gender and race, I use a sample of 56,013 respondents to the March 1984 CPS and 50,888 responses to the March 2000 CPS. The sample is limited to individuals who indicate that they are either male or female, as well as being either white or black. The data are further limited to individuals between the ages of eighteen and sixty-five, because those individuals outside this range are less likely to be full-time workers.

Wage is hypothesized to be a function of education (included as a set of dummy variables for highest level of education attained by the worker: high school graduate, those with some college but no degree, college graduate, and those who have earned a graduate or professional degree), age\(^{10}\) and age squared (in order to capture the diminishing marginal return to accumulating age). The other demographic control variables incorporated include: gender, race, number of children under 18 in the household, marital status, whether or not one resides in a metropolitan statistical area (MSA), region in which one resides, and the industry in which the worker’s primary job

---

\(^{10}\) As noted, age is included rather than potential experience due to the multicollinearity that would be introduced by a potential experience variable.
was reported for last year. Hourly wage is constructed by dividing the average weekly wage from last year by the number of hours worked per week last year.

Table two shows the summary statistics for the samples of 1984 and 2000 data. Hourly wage is not adjusted for inflation in the basic regressions, and thus is reported as unadjusted. Table two shows that the mean wage for 1984 is $8.41, $9.96, and $6.63 for the pooled, male and female samples, respectively. The corresponding unadjusted mean wages for 2000 are $16.22, $18.41, and $13.84. The mean hourly wages for 2000 are $9.79 for the pooled sample, $11.11 for the male sample, and $8.35 for the female sample if we use the Consumer Price Index (CPI) to adjust them to be consistent with 1984 price levels. If we use the Gross Domestic Product (GDP) Deflator the mean hourly wages for 2000 are $10.95, $12.43, and $9.43 respectively for pooled, males, and females.

The education variables are dummy variables, with less than a high school degree being the omitted variable. For each individual only the highest level of education attained is equal to one, with all else equal to zero. In order to determine the total percent of high school graduates we need to add the mean of high school graduate, some college, college graduate, and graduate degree. By performing this calculation we see that in 1984, eighty-four percent of the workforce were at least a high school graduate, and in 2000 this had increased to eighty-seven percent. This is consistent with what we would expect, as is the increase in the percent of workers who have at least an undergraduate degree, up to twenty-six percent of the workforce in 2000 from twenty-two percent in 1984.
As one might expect the percentage of the workforce that is black has remained relatively constant; there is a slight decrease in the number of children per worker, from 0.83 per worker in 1984 to 0.80 per worker in 2000.

An additional interesting result is that the number of workers who are married has decreased from sixty-two percent in 1984 to fifty-nine percent in 2000. This result seems consistent with the higher divorce rate and trend of marrying later in life that has developed. Also consistent with trends are the figures for workers who live in MSAs. The urbanization of the United States can be witnessed by the percentage of workers who reside in rural areas decreasing from thirty-three percent to twenty-five percent. The migration west also seems to be evident, as the percentage of workers who live in the western states has increased from twenty percent in 1984 to twenty-seven percent by 2000. One final interesting result is the shift away from a manufacturing economy, with the percentage of workers in the manufacturing sector falling by approximately five percent.

The wage regressions employed by this study are of the following form:

\[
\ln W = \alpha_0 + \beta_1 HS + \beta_2 SC + \beta_3 CG + \beta_4 AD + \beta_5 AGE + \beta_6 AGE^2 + \beta_7 B + \beta_8 Child \\
+ \beta_9 MS + \beta_{10} Rural + \beta_{11} Region + \beta_{12} Ind
\]

where \( \alpha_0 \) is the intercept, HS, SC, CG, and AD are dummy variables for highest level of education attained as either high school graduate (HS), some college but no degree (SC), college graduate (CG), or advanced degree (AD), B is a dummy variable for whether or not the worker is black, Child represents the number of children, MS is a dummy variable for whether the worker is married, Rural is a dummy variable for whether the individual
is married, and region and industry represent sets of dummy variable for region of residence and industry classification of the workers job.

The literature paints a clear picture regarding what we should expect for the coefficients in our regressions. Age and age squared are incorporated, according to the Becker model, and should be positive and negative, respectively. This is the case because age should have a positive impact on wage initially (largely because it proxies for experience), and eventually each year will have a smaller and smaller impact on wages, once training is complete.

One would expect positive returns to each level of education, with the magnitude increasing with each step. That is, a college degree should have a positive impact on wages, and a larger impact than a high school degree and so on. Hypothetically, each additional level of education should increase in magnitude from 1984 to 2000, as today’s labor market hypothetically puts a higher premium on education than it had in the past [Cawley, Heckman, Vytlacil (1998)]. One would expect that the black coefficient would be negative, implying the presence of discrimination. While the coefficients for black should remain negative, it should be smaller in 2000 than in 1984, if discrimination has decreased in the labor market.

Marital status, number of children, region of residence, whether one lives in a rural area, and industry of employment are included primarily as controls. Marital status has had varying results in the previous literature, while number of children typically has had a negative impact on women’s wages. This is so because being a parent typically keeps women out of the labor force for some period of time. Both the rural and region variable represent potential applications to view specific examples of the presence of
discrimination. All of the regions included in the regression should be positive, as the south is the omitted variable. It has long been known that workers in the south earn less than workers anywhere else.

The following table is quite useful in describing the difference-in-difference methodology, given the following formula, assuming a labor market consisting of workers who have no high school diploma or a high school diploma and no more:

\[
\ln \bar{W} = \alpha_0 + \beta_1 D_{2000} + \beta_2 F + \beta_3 F*D_{2000} + \beta_4 HS + \beta_5 HS*F + \beta_6 HS*D_{2000} + \beta_7 HS*F*D_{2000}
\]

where \(D_{2000}\) is a dummy variable for whether or not the observation is in the year 2000, \(F\) is a dummy variable for whether the individual is a female, and \(HS\) is a dummy variable for whether or not the individual has completed high school.\(^{11}\)

<table>
<thead>
<tr>
<th>Table One</th>
<th>Interpretation of Difference-In-Difference Results</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No High School</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td>(\alpha_0 + \beta_2)</td>
</tr>
<tr>
<td>Men</td>
<td>(\alpha_0)</td>
</tr>
<tr>
<td>Difference (W-M)</td>
<td>(\beta_2)</td>
</tr>
<tr>
<td>D-I-D</td>
<td>(\beta_3)</td>
</tr>
<tr>
<td>D-I-D-D-I-D</td>
<td>(\beta_7)</td>
</tr>
</tbody>
</table>

In order to examine the changes in the wage structure of women relative to men, a difference-in-difference analysis is performed. The first row of table one contains the estimated wage for various levels of education for women. Row one column one shows the mean wage of a woman with no high school degree in 1984 is the intercept \((\alpha_0)\) plus

\(^{11}\) All other variables have been suppressed to simplify the discussion.
the coefficient for the female dummy ($\beta_2$). The second column shows the mean wage of a woman with no high school degree in 2000 is equal to the intercept ($\alpha_0$) plus the year 2000 dummy ($\beta_1$), the female dummy ($\beta_2$), and the impact of being a woman in 2000 ($\beta_3$). Columns three and four yield similar expressions for High-School graduates and include additional coefficients associated with the High School dummy.

The second row shows us the returns to education for men. Row one column one shows us the expected wage for a male with no high school diploma in 1984 is the intercept. The second column shows the expected impact on wages for having no high school diploma in 2000 is the intercept, plus the year 2000 dummy. Columns three and four once again yield similar expressions for High-School graduates and include additional coefficients associated with the High School dummy.

In the third row we obtain the difference in mean return to education for women and men by subtracting the second row from the first. In the first column we see the difference in the mean impact of women versus men of having no high school diploma in 1984 is equal to the female dummy ($\beta_2$), found by subtracting the mean wage for a man with no high school diploma in 1984 ($\alpha_0$) from the mean wage for a woman with no high school diploma in 2000 ($\alpha_0+\beta_2$). The second column shows us the difference in the impact of having no diploma for women versus men in 2000 is equal to the impact of being female, plus the impact of being a female in 2000. Columns three and four once again yield similar expressions for High-School graduates and include additional coefficients associated with the High School dummy.

The fourth row shows the difference in the mean difference in the male-female wage gap between 1984 and 2000 for workers with the same levels of education. These are
obtained by subtracting row 3 columns one and three from row three columns two and four. The second column tells us the change in the impact on wages between years for women versus men for those who have no high school diploma and is equal to the coefficient for being a woman in 2000 ($\beta_3$). If this value is positive it means that women with no high school diploma can expect a higher relative wage (as compared to men’s) in 2000 than in 1984. The fourth column tells us the difference in the relative impact of obtaining a high school degree in 2000 as compared to 1984 and is equal to the impact of being a female in 2000 ($\beta_3$) plus the impact of having obtained a high school diploma in 2000, given that you are a female ($\beta_7$). If this value is positive it means that women who have obtained a high school diploma in 2000 see a larger increase in the impact of having a diploma has on their wages, relative to men, in 2000 as compared to 1984.

The fifth row shows us the difference in the return to a high school diploma for females relative to males for 2000 versus 1984 and is equal to the coefficient for obtaining a high school diploma in 2000, given that the individual is female ($\beta_7$). If this value is positive it represents an increase in the difference in return to a high school diploma for women relative to men in 2000 versus 1984.

Empirical Results

Results of Regressions and Decompositions

Tables three and four contain the results from the wage regressions and decompositions for 1984 and 2000. Column one shows the coefficients from the sample-wide (pooled) regressions, with columns two and three containing the coefficients for the male and female regressions respectively. All three regressions follow the same form as
equation (5). Estimates of the t-statistics for each coefficient and their level of significance are reported.

The results of the Oaxaca wage decompositions are shown in columns four through six. Column four shows the amount of the total wage differential that is accounted for by differences in the mean characteristics of male workers as compared to female workers. Column five shows the wage premium the average male receives based upon the difference between the wage structure males faced as compared to the nondiscriminatory wage structure. Column six shows how much less the average female worker receives as a result of the difference between the wage structures faced by women relative to the nondiscriminatory wage structure.

The $R^2$ are consistent with prior research, as are the results of the wage decomposition. The $R^2$ ranges from 0.19 for women to 0.33 for men. These are consistent with Cain's (1986) survey of the previous literature of wage discrimination. The total wage differential is thirty-eight percent for 1984, with the unexplained differential accounting for seventy-eight percent of the total differential and the remaining twenty-two percent attributed to the explained differential. These findings suggest that characteristics account for more of the wage differential than previous studies, including Blinder (1976) and Oaxaca-Ransom (1994).

The key focus of the empirical section of this study is the impact of the educational attainment variables. Table three shows us a slightly higher return to a high school degree for male workers and a college degree, while female workers see a higher return to some college, but no college degree, and especially receiving an advanced degree.
This shows us that while women are still paid less, as their education increases, they are able to tighten the wage gap that exists between men and women.\footnote{The interpretation of coefficients in a log equation is slightly more complicated than first appears. For instance the coefficient for high school graduate, 1984 (0.2248) is interpreted as follows. The percent difference associated with highest level of education attained being a high school diploma is equal to $e$ to the 0.2248 power, minus 1 (percent impact of wage=$e^{0.2248}-1$). This implies a twenty-five percent higher wage for the average worker with a high school diploma and no additional education compared to the average worker with no high school diploma, ceteris paribus.}

Looking at the decompositions for the education variable, only those individuals whose highest educational attainment is a high school degree see both men receiving a wage premium and women receiving a lower than expected wage. The educational attainment variables exhibit the expected signs and are significant at the one percent level. In each sample the return to education for each level is reasonably close, and each successively higher level of educational attainment exhibits a larger coefficient than the previous level of attainment.

Age and age squared also show the expected signs and are significant at the one percent level in all three regressions. Men see a slightly larger return to age (treated as a proxy for experience) than women (1.8 percent), while men's return to experience seems to level off more quickly, as illustrated by the more negative coefficients for age squared. This suggests that while men’s age earnings profile starts out steeper (suggesting higher returns to experience), it levels off more quickly.

The data show that the bulk of the unexplained differential is due to differences in returns to age. Summing the male wage premium for age the two coefficients (0.2468) and the amount by which the average females wage is reduced (0.2133), shows us that the total impact of age and age squared (0.4601) is not only larger than the unexplained differential, but larger than the total wage differential (accounting for 154.6 percent of the
unexplained differential). This implies that men are more likely than women to move into managerial positions as they age.

This has been the finding in previous studies, including Jacob Mincer and Simon Polachek's (1974) paper, which established what has become known as the Mincer-Polachek hypothesis. This hypothesis relies on the fact that human capital is more profitable the longer it is employed. Men’s return to experience is likely to be greater than women’s who are more likely to interrupt their careers to raise children.

The coefficient for black is negative and significant in all cases, though black men see a much larger penalty for their race (19.4 percent lower wages than white men), ceteris paribus than do women (5.1 percent lower wage than white women). Number of children has no statistically significant impact on men’s wages, while, as expected, women see a significant penalty for having children. Marital status has a positive impact on wages, especially for men.\(^\text{13}\) All other variables have the expected signs and are significant at the one percent level of significance.

Other than age and age squared, only number of children, marital status, industry, and the constant account for more than 10 percent of the unexplained differential. Number of children accounts for 10.2 percent, marital status accounts for 30.3 percent, and industry accounts for 17.7 percent. The explained differential is driven largely by industry choice, with 69.3 percent of the explained differential coming from the industry in which a worker is employed. It has also been previously noted that a large portion of the male-female wage differential is due to market segmentation. According to the occupational crowding hypothesis, described by Bergmann (1971) and Sorenson (1990), women are

\(^{13}\) The disparity in the impact of marital status may be due to women who are married being more likely to have children and therefore experience workforce interruptions.
segregated into particular occupations. This crowding is not necessarily due to employer discrimination, but may be due to skill characteristics of jobs that more men possess.

Table four contains the regressions and decompositions for 2000, showing largely the same signs and exhibiting similar trends to the 1984 data. The $R^2$ are once again consistent with past research, ranging from 0.23 for women to 0.30 for men. The total differential has fallen from thirty-eight percent to twenty-seven percent, with ninety percent of the total differential due to the unexplained differential, and only ten percent accounted for by the very narrow differences in characteristics that now exist between the average male worker and the average female workers.

The 2000 data show higher returns to educational attainment for women at each level, but once again educational attainment contributes very little to the totals in the wage decompositions. The difference in age coefficients between men and women is much smaller in the 2000 regressions, but is still the driving force in the unexplained portion of the decompositions, accounting for ninety-six percent of the unexplained differential. The difference in the negative coefficient for race faced by men is much smaller than in 1984, while number of children has a positive and significant impact on men in 2000. All other variables show generally the same trends as in 1984.

Assessing Potential Wage Structure Changes By Gender, 1984-2000

Before proceeding to discern the difference-in-differences for men and women, it is first useful to examine whether the data suggest that there is reason to suspect a change in the wage structure between 1984 and 2000. A simple set of Chow tests can tell us whether some sort of change has occurred in the wage structures faced by men and
women in 2000 as compared to that faced by men and women in 1984. The first step in performing these tests is to pool the 1984 and 2000 data sets for males and females by gender, giving us a total of 106,901 observations. Separate regressions for each gender must then be run for 1984, 2000, and for the pooled sample. With these regressions run we can perform a simple F-test in order to determine if the wage structure is different for 1984 than it is for 2000.

To examine this issue, I control for the effects of inflation on the wages of the individuals in our samples. In order to do this I have used two measures, the Consumer Price Index (CPI) and the Gross Domestic Product (GDP) deflator. Two separate measures are used because the GDP deflator underestimates the impact of price changes on the consumer. The GDP deflator uses a flexible basket of goods, dependent upon the quantity of goods and services purchased in a particular year. The CPI, which uses a flexible basket of goods, overestimates the impact of a price change on consumers. Given the nature of one measure to overestimate inflation and the tendency of the other to underestimate, it would seem useful to use both measures, with the truth lying somewhere in the middle.

Chow tests were performed, using both the CPI adjusted wages and GDP deflator adjusted wages, for the pooled sample of men and the pooled sample of women, with 1984 wages calculated as the base. In each case the F-statistic is sufficient to reject the null hypothesis of no change in the wage structure at the 1 percent level of significance. While the Chow test results are useful, they do not tell us how the wage equations have changed. In order to examine questions of this nature we proceed to perform a difference-in-difference (DID) regression.
Difference-in-Difference Results

Table five presents the results of the DID regression. The first five variables represent the difference in the change in the male-female wage gap between 1984 and 2000 for workers within the five groups of educational attainment. The first row ($\beta_3$ from our table one) shows that women with no high school diploma receive a 6.2% higher wage in 2000 than in 1984. Rows two through five represent the $\beta_3 + \beta_7$'s from table one. In order to determine the t-statistics for these coefficients the variance-covariance matrix for the regression was obtained.\(^{14}\)

The second row shows us that women who are high school graduates receive a 4.1% higher wage, relative to men, in 2000 than in 1984. According to rows three through five, women with some college, a college degree, and an advanced degree receive 9.7%, 9.1%, 10.4% higher wages, respectively, relative to men in 2000 than in 1984. The first five rows tell us that for all levels of educational attainment, women have seen an improvement in their average wages, relative to men, from 1984 to 2000. Each of the DID results is statistically significant at the one percent level. By observing the DIDID results in rows six through nine we can determine whether or not this is due to increases in the relative returns to education for women, or simply due to the impact of a decrease in the amount of wage discrimination faced by the women in each group of educational attainment.

The coefficients and corresponding t-statistics for the DIDID variables are shown in rows six through nine. The interpretation of these coefficients is a little more

\(^{14}\)The formula for obtaining the variance of the sum of two correlated coefficients is $\text{var}(\beta_{12}) = \text{var}(\beta_1) + \text{var}(\beta_2) + 2\text{cov}(\beta_{12})$. 

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complicated. Each one represents the change in the male-female wage differential from 1984 to 2000, from each level of educational attainment relative to the reference group (no high school diploma). A positive value would imply that the return to education for the group in question has increased relative to men from 1984 to 2000. Rows six through nine show that for all levels of education, except for high school graduate, the coefficients are indeed positive. However, none are significant at the five percent level of significance. These results suggest that the mean wages for women in each group of educational attainment has improved, relative to men, from 1984 to 2000. Further, it appears that this improved wage structure for women is not due to a increase in the relative return to any specific level of educational attainment.
CHAPTER 5

CONCLUSION

This study focuses on wage discrimination by gender in the labor market. Using the human capital theory of investment, I first follow the previous literature in developing wage equations for men and women in 1984 and 2000, using CPS data. I then perform Blinder-Oaxaca wage decompositions on data from both years to determine whether the amount and source of discrimination has changed from 1984 to 2000. Finally, I perform difference-in-difference analysis to ascertain if the changes in the wage structure have come from increased returns to education for women relative to men, or from a decrease in the amount of discrimination present in the labor market.

I find that discrimination is present in both years of the study, and that the amount of discrimination has indeed decreased, from a thirty-eight percent unexplained differential in 1984, to a twenty-four percent unexplained differential in 2000. While the unexplained differential is often cited as evidence of discrimination, it is worth noting that it could also be the result of other factors including industry segmentation. I find that educational attainment does not seem to be the driving force for the unexplained differential in either year of the studies decompositions. I then determine that each level of educational attainment has a statistically significant increase in it’s magnitude from 1984 to 2000. The DIDID results do not, however, show that there has been any significant increase in the returns to specific levels of attainment relative to having no
high school degree. Rather, the increases in the mean wages at each level of educational attainment seem to represent an across the board increase in payoffs for obtaining education for women relative to men.

While these findings are significant on their own, there is a great deal that remains to be examined regarding wage discrimination by gender. The impact on wage of experience seems to be a key factor in driving the unexplained wage differential. However, the fact that it is hard to convert an indicator variable and the need for a quadratic term make it difficult to examine further with common econometric methods.

Further, the number of children seems to be a key factor in determining whether a woman faces a wage structure similar to that faced by a man. There are a number of issues pertaining to parentage that could be examined in further study. Whether the impact on wages of having children is different for single mothers than married mothers, whether the impact of having children for women, relative to men, has changed by a significant amount over time, and whether a sample of women without children would exhibit different results for discrimination all seem worthy of consideration.

Overall much has been shown about wage discrimination by gender from 1984-2000. It appears that women can expect to receive a lower wage, ceteris paribus, than men with similar characteristics in each year of the study. It is also the case that this wage gap and the discrimination driving it have decreased over time. Finally, women seem to receive a higher wage, relative to men, in 2000 than in 1984, regardless of their level of educational attainment. The data does not suggest that this is due to increases in the relative returns to education, but rather to an improvement in the overall impact of education on women's wage relative to men.
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APPENDIX I

TABLE 2
SUMMARY STATISTICS

<table>
<thead>
<tr>
<th>Variable</th>
<th>1984</th>
<th></th>
<th></th>
<th>2000</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pooled</td>
<td>Male</td>
<td>Female</td>
<td>Pooled</td>
<td>Male</td>
<td>Female</td>
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<tr>
<td>Hourly Wage*</td>
<td>8.41</td>
<td>9.96</td>
<td>6.63</td>
<td>16.22</td>
<td>18.41</td>
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<td></td>
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<td>0.7537</td>
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<td>0.4262</td>
<td>0.3198</td>
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<td>Graduate</td>
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<td>0.4665</td>
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<td></td>
<td>0.4185</td>
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<td>0.1599</td>
<td>0.1462</td>
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<td></td>
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<td>0.3534</td>
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<td>Advanced Degree</td>
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<td></td>
<td>0.2502</td>
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<td>0.2205</td>
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<td>Age</td>
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<td>36.7337</td>
<td>36.0683</td>
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<td>12.6323</td>
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<td>Marital Status</td>
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<td>0.2501</td>
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<td></td>
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<td>29,939</td>
<td>26,074</td>
<td>50,888</td>
<td>26,430</td>
<td>24,458</td>
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Standard deviations in parentheses
*Hourly wages are not adjusted for inflation
TABLE 3
1984 REGRESSIONS AND DECOMPOSITIONS

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<thead>
<tr>
<th>Variable</th>
<th>$\hat{\beta}_{\text{Pooled}}$</th>
<th>$\hat{\beta}_{\text{Male}}$</th>
<th>$\hat{\beta}_{\text{Female}}$</th>
<th>$\hat{\beta}^*(X_M-X_F)$</th>
<th>($\hat{\beta}_M\hat{\beta}^*)X_M$</th>
<th>($\hat{\beta}^<em>-\hat{\beta}_M^</em>)X_F$</th>
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<td>High School Graduate</td>
<td>0.2248</td>
<td>0.2385</td>
<td>0.2177</td>
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<td>(7.76)**</td>
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</table>

$t$-statistics in parentheses

*Statistically significant at the 5% level

**Statistically significant at the 1% level

+Industry represents the mean of the ten industry control variables
### TABLE 4
2000 REGRESSIONS AND DECOMPOSITIONS

<table>
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<tr>
<th>Variable</th>
<th>β\text{Pooled}</th>
<th>β\text{Male}</th>
<th>β\text{Female}</th>
<th>β^*(X_M - X_F)</th>
<th>(β_M β^*)X_M</th>
<th>(β^* - β_F)X_F</th>
</tr>
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<td>(40.52)**</td>
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<td>-0.0005</td>
<td>-0.0005</td>
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<td>(3.94)**</td>
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<td>0.0001</td>
<td>0.0002</td>
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<td>0.0073</td>
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<td>(7.30)**</td>
<td>(6.32)**</td>
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<td>(18.69)**</td>
<td>(19.14)**</td>
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*Statistically significant at the 5% level
**Statistically significant at the 1% level
†Industry represents the mean of the ten industry control variables

**t-statistics in parentheses**

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TABLE 5
PERCENT CHANGE IN IMPACT OF EDUCATIONAL ATTAINMENT ON MEAN WAGE FOR WOMEN RELATIVE TO MEN, 1984-2000

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<th>Variable</th>
<th>Coefficient</th>
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<tr>
<td>Some College</td>
<td>0.0966</td>
<td>(8.19)**</td>
</tr>
<tr>
<td>College Graduate</td>
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<td>(6.21)**</td>
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<tr>
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<td>(4.42)**</td>
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</tr>
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</tr>
<tr>
<td>Advanced Degree Relative to No High School Diploma</td>
<td>0.0415</td>
<td>(1.46)</td>
</tr>
</tbody>
</table>

t-statistics in parentheses
*Statistically significant at the 5%
**Statistically Significant at the 1% level
VITA

Graduate College
University of Nevada, Las Vegas

Andrew L. Powell

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Las Vegas, Nevada 89123

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Coe College

Special Honors and Awards:
Wall Street Journal Award
Magna Cum Laude

Thesis Title: An Analysis of Changes in Labor Market Discrimination by Gender, 1984-2000

Thesis Examination Committee:
Chairperson, Dr. Bradley S. Wimmer, Ph. D.
Committee Member, Dr. Alan S. Schlottmann, Ph. D.
Committee Member, Dr. C. Jeffrey Waddoups, Ph. D.
Graduate Faculty Representative, Dr. Jordan Lowe, Ph. D.
ORAL DEFENSE RESULTS
THESIS, DISSERTATION/MUSIC DOCUMENT, PROFESSIONAL/SCHOLARLY PAPER, OR PROJECT

THE GRADUATE COLLEGE
The University of Nevada, Las Vegas

STUDENT INFORMATION:
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Date of Oral Defense: 7/18/03
Department: Economics
Degree Sought: MA
Degree Option: Thesis

Title: An Analysis of Changes in Labor Market Discrimination by Gender, 1984-2000

Pass: *Number of credit hours to grant: 6

Not to exceed the total of credit hours on the approved Degree Program form

SIGNATURES:
Advisory Committee Chair: 7/18/03
Additional Committee Member (if applicable): 7/18/03
Department Chair/Graduate Coordinator: 7/18/03

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