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Gender Difference in Wage and Promotion

I. Introduction

Gender difference in the work field has long been studied. Although there have been significant achievements in women's rights and labor force participation, the difference in wage and work opportunities between males and females continues to exist. According to The American Community Survey (ACS), data on full-time employees released by the U.S. Census Bureau in 2021 revealed that women constituted around 44% of the total workforce, but only accounted for roughly 41% of managerial positions. Additionally, the data showed that women earned an estimated 82 cents for every dollar earned by men. Understanding the causes and consequences of the gender difference in salaries can help us identify and address barriers to gender equality and promote fairness and inclusion in the workplace. Therefore, our paper seeks to examine if the gender wage gap and gender promotion difference exist in the United States and identify the gender inequality in earnings with respect to the promotion pattern between males and females.

II. Literature Review

Compared to a large amount of literature studying the general wage differences between females and males, relatively few studies have attempted to examine the relationship between the gender wage gap and promotion patterns within male and female populations. Our review of previous literature indicates a lack of uniformity in the findings regarding gender differences in the promotion. While some scholars, such as Becker and Olson (1983), have posited that promotion processes are distinct between males and females, citing factors such as gender-based

pay discrepancies and men getting substantially more promotion opportunities, other scholars (Hersch & Viscusi, 1996) suggest that women are promoted more frequently than men on average, although the nature of these promotions differs from those experienced by men. Hersch and Viscusi (1996) further presented that promotions tend to have a more significant impact on men's wages than on women's. Besides, Blau and Kahn (2017) provided empirical evidence on the factors that influence the gender wage gap, including education attainments, professional background, race, geographic location, and whether one lives in a metropolitan area. and other "human capital specifications". These factors will be included in our regression analysis as control variables. Considering the lack of uniform conclusions on the gender-based promotion disparities and the limited exploration of the relationship between promotion patterns and the gender wage gap, our paper seeks to follow the previous studies and extends the topic by further investigating the effect of gender promotion patterns on the wage gap.

III. Data description

A. Data cleaning & wrangling

The data used for the study is 10 years of longitudinal data from 2012-2022 from the IPUMS CPS database. For the purpose of our research, for each observation, we present the statistical summary of the individual's annual wage (incwage), current position(occupation), and last year's position(occupation) separated by male and female along with other "human capital" control variables specified in Table 1 (see appendix). Women have an average hourly wage of 23.153 compared to men's hourly wage of 29.083, which indicates that there may exist a gender wage gap. In the next section, we will control for other job-related variables to see if the difference still exists.

We decided to perform analyses based on the hourly wage for our research to control the total income wage difference between part-time jobs and full-time jobs. We perform data manipulations using the annual wage, usual hours worked per week from the dataset, and an estimate of on average 48 weeks of work per year for all observations.

$$hlywage = incwage \div (uhrsworkt \times 48)$$

Further, we cleaned the dataset, discarding all rows with empty information, also discarding rows that belong to the column hourly wage less than the 1st percentile and above the 99th percentile, our number of observations after cleaning reduced to 776,860 from 2,008,432.

B. Creation of variables

To determine if an individual received a promotion from the previous year to the current year, all job positions are classified into 2 categories: managerial position and working position. A dummy variable, promotion, is created which takes the value of 1 if there is an occupation change from a working position to a managerial position and 0 otherwise. And another dummy variable, management position, is created that equals 1 if the individual has already operated in a managerial position in the last year and 0 otherwise. The reason to include a dummy variable "management position" is to distinguish individuals who received promotions from those who did not receive promotions but remained in working positions, as well as those who did not receive promotions but were already in managerial positions.

IV. Empirical Result

A. Estimation of hourly wage separated by gender

Table 2 displays the regression estimates of wages explained by variables including sex, education, age, race, marital status, and region. The statistic shows that women receive wages that are 6.656 lower than men, and the difference is significant at the 1 percent confidence level.

The p-values of all other job-related explanatory variables' coefficients show a statistically significant effect on the dependent variable, hourly income. The results prove our hypothesis that women in general receive lower hourly wages than men.

B. Likelihood of promotion between males and females

In this subsection, we performed a logistic regression to estimate the probability of an individual receiving a promotion. Table 3 illustrates that while the coefficient for females is negative, implying that females are less likely to receive promotions, the large p-value of 0.386 indicates that there is insufficient evidence to conclude that the probability of receiving a promotion is significantly different between males and females. This suggests that gender differences are not associated with the likelihood of promotion. This finding is neither consistent with Becker and Olson's results that men are more likely to get promotion opportunities, nor Hersch and Viscusi. Since gender doesn't affect one's probability to get a promotion, we decide to further investigate the gender differences in the effect patterns of promotions on an individual's wages.

C. Promotion and the Gender wage gap

Given that gender does not influence promotion opportunities, we sought to investigate the relationship between gender-specific promotion patterns and wage differences. We conducted two separate regressions for each gender, with promotion as the dependent variable in the first model, and promotion * management position in the second model, to distinguish the effect of those who were previously in managerial positions and had a higher salary. Table 4 and Table 5 present the estimate of wages depending on promotion separated by gender. The coefficients for promotion are negative for both males and females. One possible explanation is that individuals who receive promotions in our sample are typically those who started in lower positions or

lower-paid roles, while those who do not receive promotions generally have higher pay. Table 6 gives the comparison of the average wage between people who receive promotions and people who don't receive promotions and proves the thought. People who get promotions this year receive an average hourly wage of 24.109, while people who don't get promotions receive a higher wage of 26.203. Using a two-sample t-test on these two groups yielded a t-score of -6.083 with a p-value less than 0.000001, indicating a significant difference between the average hourly income wage in the two groups. This result can explain the finding that having a promotion has a negative effect on the wage in the estimate. The coefficient estimate of promotion is -1.77008 for females in Table 5, which is larger than -2.185357 for males in Table 4. To see if there is a difference between the real coefficients of promotion in those two tables, we used the following equation to generate test statistics between the two.

$$Z = \frac{\beta_1 - \beta_2}{\sqrt{(SE\beta_1)^2 + (SE\beta_2)^2}}$$

The significance test of the difference between these two estimates yields a z-score of -2.30403 with a p-value of less than 0.00001. Consequently, the null hypothesis is rejected, indicating that promotion has a greater negative impact on females than on males. This finding could be attributed to the fact that the females who receive promotions are more likely to be in low-paid or low-position groups.

The findings in the second model show similar results to the first model. Table 7 and Table 8 show the estimate of the effect of management position*promotion in both male and female groups. The coefficient of females who get promotions (indicated by 1 1 in mgtpos#promot) is -.9294, suggesting that females have more negative effects on wages than male counterparts(indicated by 1 1 in mgtpos#promot), which has a coefficient of -.9479. In

addition to the difference in the coefficients of getting promotion between ma, the coefficient of females who already hold managerial positions (indicated by 1 0 in mgtpos#position) is 6.3396, which is smaller than the coefficient of males, 6.9204 (indicated by 1 0 in mgtpos#position). The significant tests between the two coefficients give z scores of 93.54051 and 0.10407, indicating evidence suggesting wage gap between those who already hold managerial positions but no significant difference between those who just got promoted**.** Therefore, these two findings indicate that females don't get as many benefits from promotions as males do only if their promotion is recent. Related to the results in the previous subsection, though there is no difference in the probability of getting promotions between males and females, females have less favorable conditions in the job markets, with lower benefits from promotions, contributing to the gender wage gap.

V. Conclusion

The discovery of gender-specific promotion patterns and promotion probabilities provides valuable insights into the labor market. Although men and women do not have significant differences in the likelihood of receiving promotions, women's disadvantages in promotion patterns exacerbate the gender wage gap. One possible explanation for this phenomenon is that women often begin their careers in lower-paid jobs and positions, necessitating a longer career path to climb to the next level. This extended period of career path may negatively impact their gains of receiving promotions. Additionally, women may receive smaller payoffs from promotion opportunities and may not reap the same benefits from holding managerial positions as men. These factors can all contribute to the disparities in wage levels between genders, making it more challenging for women to attain higher-paying positions and higher salaries, even when they are equally qualified and skilled. As a result, it is important to continue working on

addressing the underlying causes of the gender wage gap to ensure equal opportunities for both females and males, and other minorities in the labor market. An important caveat to note in our study is that the data we used from IPUMS only contain one-year time frame data, which means we could only know if this particular person has a promotion from this year to the next year and we can't trace back to the previous working year and their position. So, there will be a problem that this person who already worked for several years gets a promotion, while the other just got into the job so he doesn't get a promotion. Though the data is random sampling and we can assume that the year of working in the position is randomly assigned, the study's accuracy and interpretability can be improved if we have complete information on individuals' career paths.

Table Appendix

Table 1: Statistical Summary separated by gender

	N	Mean	SD	Min	Max
female					
year	378579	2016.752	3.117	2012	2022
month	378579	3	0.000	3	3
region	378579	28.687	10.513	11	42
age	378579	42.024	13.611	15	85
sex	378579	2	0.000	2	2
race	378579	168.35	168.852	100	830
marst	378579	2.938	2.208	1	6
occ	378579	3665.504	2138.576	10	9760
uhrsworkt	378579	37.429	10.844	1	198
wkstat	378579	17.145	11.670	11	42
educ	378579	91.914	22.584	2	125
occly	378579	3666.231	2136.366	10	9840
incwage	378579	42287.231	35722.356	60	510000
hlywage	378579	23.153	17.913	1.126	148.611
male					
year	398281	2016.762	3.119	2012	2022
month	398281	3	0.000	3	3
region	398281	29.057	10.526	11	42
age	398281	42.147	13.576	15	85
sex	398281	1	0.000	1	1
race	398281	164.842	168.398	100	830
marst	398281	2.712	2.231	1	6
occ	398281	4477.964	2946.741	10	9760
uhrsworkt	398281	41.799	10.892	1	198
wkstat	398281	13.739	8.110	11	42
educ	398281	88.231	24.050	2	125
occly	398281	4479.946	2943.560	10	9840
incwage	398281	59148.874	48087.039	100	560000
hlywage	398281	29.084	21.962	1.126	148.443

Table 2: OLS estimate of gender effect on wage

hlywage	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
sex : base male	0	.	.	.	.	.	
female	-6.656	.041	-161.45	0	-6.737	-6.576	***
dum_educ_high	-22.808	.066	-344.61	0	-22.938	-22.678	***
dum_educ_col	-13.754	.062	-220.62	0	-13.876	-13.632	***
age	.19	.002	108.90	0	.186	.193	***
dum_race_white	1.638	.109	14.98	0	1.424	1.852	***
dum_race_black	-.497	.125	-3.99	0	-.741	-.253	***
dum_race_asian	3.663	.133	27.54	0	3.402	3.923	***
dum_mar	5.502	.054	102.26	0	5.397	5.608	***
dum_div	1.874	.074	25.21	0	1.728	2.02	***
dum_reg_ne	1.16	.063	18.34	0	1.036	1.284	***
dum_reg_mid	-1.474	.06	-24.68	0	-1.591	-1.357	***
dum_reg_south	-.627	.054	-11.70	0	-.732	-.522	***
Constant	31.795	.14	227.76	0	31.521	32.068	***

Mean dependent var	26.194	SD dependent var	20.309
R-squared	0.219	Number of obs	776860
F-test	18201.129	Prob > F	0.000
Akaike crit. (AIC)	6690501.603	Bayesian crit. (BIC)	6690651.922

*** p<.01, ** p<.05, * p<.1*

Table 3: Logistic Regression on Promotion

promotion	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
sex : base male	0	.	.	.	.	.	
female	-.03	.034	-0.87	.386	-.097	.038	
dum_educ_high	-.449	.057	-7.89	0	-.56	-.337	***
dum_educ_col	-.034	.051	-0.66	.507	-.133	.066	
age	-.024	.002	-15.02	0	-.027	-.021	***
dum_race_white	.041	.089	0.46	.645	-.133	.215	
dum_race_black	-.121	.104	-1.16	.244	-.325	.083	
dum_race_asian	-.346	.116	-2.99	.003	-.573	-.119	***
dum_mar	.033	.044	0.74	.459	-.054	.119	
dum_div	.261	.061	4.29	0	.142	.38	***
dum_reg_ne	-.041	.053	-0.78	.433	-.144	.062	
dum_reg_mid	-.038	.049	-0.78	.437	-.134	.058	
dum_reg_south	-.071	.044	-1.59	.112	-.158	.016	
Constant	-4.294	.115	-37.49	0	-4.518	-4.069	***

Mean dependent var	0.004	SD dependent var	0.067
Pseudo r-squared	0.010	Number of obs	776860
Chi-square	437.850	Prob > chi2	0.000
Akaike crit. (AIC)	44335.851	Bayesian crit. (BIC)	44486.171

*** p<.01, ** p<.05, * p<.1*

Table 4: OLS Estimate of the effect of promotion in the male group

hlywage	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
promotion	-2.185	.461	-4.74	0	-3.089	-1.282	***
dum_educ_high	-24.878	.102	-244.12	0	-25.078	-24.679	***
dum_educ_col	-15.054	.098	-153.34	0	-15.246	-14.861	***
age	.2	.003	75.77	0	.195	.205	***
dum_race_white	2.313	.167	13.85	0	1.985	2.64	***
dum_race_black	-1.401	.193	-7.26	0	-1.779	-1.023	***
dum_race_asian	3.7	.202	18.29	0	3.303	4.096	***
dum_mar	7.658	.081	94.56	0	7.499	7.816	***
dum_div	2.754	.122	22.60	0	2.515	2.992	***
dum_reg_ne	1.362	.095	14.31	0	1.176	1.549	***
dum_reg_mid	-1.404	.089	-15.70	0	-1.58	-1.229	***
dum_reg_south	-.497	.08	-6.23	0	-.654	-.341	***
Constant	30.815	.212	145.25	0	30.4	31.231	***

Mean dependent var	29.084	SD dependent var	21.962
R-squared	0.223	Number of obs	398281
F-test	9547.025	Prob > F	0.000
Akaike crit. (AIC)	3490426.035	Bayesian crit. (BIC)	3490567.669

*** p<.01, ** p<.05, * p<.1*

Table 5: OLS Estimate of the effect of promotion in the female group

hlywage	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
promotion	-1.77	.391	-4.53	0	-2.537	-1.003	***
dum_educ_high	-20.632	.084	-244.88	0	-20.797	-20.467	***
dum_educ_col	-12.642	.077	-163.60	0	-12.794	-12.491	***
age	.167	.002	74.82	0	.163	.172	***
dum_race_white	.972	.139	6.97	0	.699	1.245	***
dum_race_black	-.071	.157	-0.45	.65	-.379	.236	
dum_race_asian	3.551	.17	20.85	0	3.217	3.885	***
dum_mar	3.219	.07	46.16	0	3.082	3.356	***
dum_div	.881	.09	9.79	0	.705	1.057	***
dum_reg_ne	.98	.082	11.96	0	.819	1.14	***
dum_reg_mid	-1.498	.078	-19.26	0	-1.65	-1.345	***
dum_reg_south	-.779	.07	-11.09	0	-.917	-.641	***
Constant	26.784	.174	153.86	0	26.443	27.125	***

Mean dependent var	23.153	SD dependent var	17.913
R-squared	0.183	Number of obs	378579
F-test	7076.874	Prob > F	0.000
Akaike crit. (AIC)	3182580.468	Bayesian crit. (BIC)	3182721.442

*** p<.01, ** p<.05, * p<.1*

Table 6: Comparison of average hourly wage between people who get promotion and people who don't get promotions

Did not receive promotion

Variable	Obs	Mean	Std. Dev.	Min	Max
hlywage	773365	26.203	20.303	1.126	148.611

Did receive promotion

Variable	Obs	Mean	Std. Dev.	Min	Max
hlywage	3495	24.11	21.34	1.136	145.833

Table 7: OLS Estimate of the effect of promotion*management position in the male group

hlywage	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
mgtpos#promot	.	.	.	.	.	.	
0 1	0	.	.	.	.	.	
1 0	6.92	.081	85.68	0	6.762	7.079	***
1 1	-.948	.457	-2.07	.038	-1.843	-.052	**
dum_educ_high	-24.391	.101	-241.16	0	-24.589	-24.193	***
dum_educ_col	-15.138	.097	-155.60	0	-15.328	-14.947	***
age	.187	.003	71.49	0	.182	.193	***
dum_race_white	2.11	.165	12.76	0	1.786	2.434	***
dum_race_black	-1.228	.191	-6.42	0	-1.602	-.853	***
dum_race_asian	3.829	.2	19.10	0	3.436	4.222	***
dum_mar	7.16	.08	89.00	0	7.003	7.318	***
dum_div	2.502	.121	20.71	0	2.265	2.738	***
dum_reg_ne	1.285	.094	13.62	0	1.1	1.47	***
dum_reg_mid	-1.433	.089	-16.16	0	-1.606	-1.259	***
dum_reg_south	-.562	.079	-7.11	0	-.717	-.407	***
Constant	30.479	.21	144.96	0	30.067	30.891	***

Mean dependent var	29.084	SD dependent var	21.962
R-squared	0.237	Number of obs	398281
F-test	9539.714	Prob > F	0.000
Akaike crit. (AIC)	3483153.931	Bayesian crit. (BIC)	3483306.460

*** $p<.01$, ** $p<.05$, * $p<.1$

Table 8: OLS Estimate of the effect of promotion*management position in the female group

hlywage	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
mgtpos#promot	.	.	.	.	.	.	
0 1	0	.	.	.	.	.	
1 0	6.34	.077	82.46	0	6.189	6.49	***
1 1	-.929	.388	-2.40	.017	-1.689	-.169	**
dum_educ_high	-20.352	.084	-243.52	0	-20.516	-20.189	***
dum_educ_col	-12.63	.077	-164.89	0	-12.78	-12.479	***
age	.161	.002	72.51	0	.157	.165	***
dum_race_white	.919	.138	6.65	0	.648	1.19	***
dum_race_black	.026	.156	0.17	.866	-.279	.331	
dum_race_asian	3.683	.169	21.82	0	3.352	4.014	***
dum_mar	3.017	.069	43.63	0	2.882	3.153	***
dum_div	.766	.089	8.59	0	.591	.941	***
dum_reg_ne	1.027	.081	12.64	0	.868	1.186	***
dum_reg_mid	-1.424	.077	-18.48	0	-1.575	-1.273	***
dum_reg_south	-.773	.07	-11.11	0	-.909	-.637	***
Constant	26.236	.173	151.95	0	25.898	26.575	***

Mean dependent var	23.153	SD dependent var	17.913
R-squared	0.198	Number of obs	378579
F-test	7172.902	Prob > F	0.000
Akaike crit. (AIC)	3175842.539	Bayesian crit. (BIC)	3175994.357

**** p<.01, ** p<.05, * p<.1*

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