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An Analysis of Variation in Human Capital Investment and Sectoral Wage Differentials for Women

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Abstract

This research discusses the variation in human capital investment of women that led to the wage differentials between industrial sectors in the United States from 1980 to 2016. Using the Current Population Survey data, this research found that working in the manufacturing sector offered female workers with higher wages. However, return to education in monetary term was higher in the service sector than in the manufacturing sector. Male faced the same situation in the labor market yet at different rates. In addition, regression results showed that education had the highest impact on women's wage and return to education was higher for women than for men. These findings correspond with previous literature and suggest that education increased the earning capacity for women, especially for those who worked in the service-producing sector.

Keywords

Econometrics, Human Capital, Education, Wage Difference, Women

1. Introduction

The concept of human capital investment was first introduced by Becker (1965) as follows. Human capital investments are "activities that influence future monetary and psychic income by increasing the resources in people". Theoretically, an investment in human capital increases a person's chance in the labor market, improves labor productivity and most commonly, gives rise to that person's future earnings. However, empirical studies showed that the rate of return to education varies across races, genders, educational attainments as well as across sectors (Weisbrod & Karpoff, 1968; Madden, 1978; Krueger & Summers, 1988).

This variation has motivated researcher to take different approaches upon the topic of human capital investment.

With the aims of contributing to the research gap in this topic, this research examines the effect of human capital accumulation on wages across different industries. In application of human capital earnings function (Mincer & Polachek, 1974), this research analyzes the differences in return to education for female workers in the United States between two specific sectors: manufacturing sector and service sector. Estimated results will shed light upon how return to education differs between these two sectors and whether the difference is large enough to motivate women to invest in human capital that later benefits them in the service sector. Furthermore, in order to gain a better insight into the labor market in the US, this research also compares the rate of return to human capital investment between male and female workers.

The remainder of this paper is organized as follows. Part two offers an overview of previous findings about the return to investment in women's education and the inclusion of sectoral wage differentials in this topic. Part three explains the methodology and the dataset that have been used to estimate the main model. Part four presents the estimation results and discusses about these results. The last part concludes this research and highlights areas for further research.

2. Literature Review

Studies on the return to human capital investment were dated back as early as the 1960s. A large pool of research in this field linked the topic of female human capital to the topic of gender wage gap which had generated mixed results over time in the United States. Research around the 1960s found that white female college graduates in the United States received lower economic return than white male fellows (Mincer, 1958; Renshaw, 1960). Since the 1970s, with an increase in college enrollment rate among women, researchers started observing a higher return to college education among women (Madden, 1978; Angle & Wissmann, 1981; Loury, 1997). This trend persisted until the 2000s and was referred to as "reverse gender differentials" (Charles & Luoh, 2003; Goldin et al., 2006; Chiappori et al., 2009).

For that reason, this research employs a recently updated dataset until the year of 2016 to observe new trends in return to human capital among women. Findings in this research, hence, would either confirm the continuation of "reverse gender differentials" (Goldin et al., 2006) or discover a new revolution of return to education between genders. Moreover, the use of data in the period 1980-2016 also helped this research to overcome one difficulty faced by past research which was the low female labor force participation. The absence of women, especially highly educated ones in the labor market, led to the differences of observed wage between female college and non-college graduates. Educated women often got married with educated and wealthy man who eventually made them more likely to quit their jobs afterwards (Becker, 1965).

However, in the dataset employed by this research, women made up nearly half of the labor supply and more than six out of ten women was involved in work outside of the household. Additionally, the fair representation of women enabled this research to avoid the "sample-selection" issue mentioned by Schultz (1993). He argued that private return to education for women can hardly be estimated and compared to that for men since men outnumbered women in the labor market. In other words, experimental studies were likely to produce biased results toward a gender wage gap.

On top of that, researchers in this field paid remarkable attention to high school and college education rather than on all levels of education since the 1980s. By excluding people who were below "some kinds of college" level and using dummy variables for bachelor degree, master degree and PhD degree holders, Angle and Wissmann (1981) found that return to graduate education was the highest, following by college education and the lowest return belonged to doctor education. Krueger and Summers (1988) concluded that both high school and college education enormously elevated wage levels regardless of econometric adjustments in individual ability. In addition, Blau and Kahn (1997) noticed that return to college education including advanced degrees for women has experienced an increase in 1989 compared to that in 1980.

Owning to the importance of high school education and above, this research only included people who finished at least high school. Different from past research which examined college graduates at the lowest, this research included people with high school education because by 2015, about 88% of the US population received high school education while only 33% percent of women had bachelor degree or higher (Ryan & Bauman, 2016). The inclusion of only one third of the population would not provide a big picture into the return to education for women. Furthermore, despite having only two categories which are college and non-college, this research also added two sub-categories. In the non-college category, there are high school graduates and some college graduates while in the college category, there are college graduates and advanced education. Some college graduates refer to graduates who either had records of college education after high school graduation yet did not earn a degree or finished two-year colleges. These added categories will avoid the ignorance of one or two-year education.

Even though college education generates higher return than high school education, the wage levels of people with the same educational attainment still varied greatly across occupation as well as across sectors. Previous literature had proved that there existed inter-industry wage differentials (Krueger & Summers, 1988; Keane, 1993) because the dissimilarity in production technology motivated employers in some industries to pay more for highly qualified workers (Dickens & Katz, 1987). Other research delved into one specific industry to profoundly study the effect of human capital investment on wage. For instance, studies by Lillo-Banuls and Casado-Diaz (2010) rejected any earnings difference between

tourism industry and other industries in Spanish economy using robust regression. On the contrary, Philippon and Reshef (2012) concluded that skill intensity as well as job complexity gave a wage premium to workers in finance industry since the 1990s (Philippon & Reshef, 2012).

Nonetheless, instead of focusing on different industries or on one specific industry, this research divides the economy into two sectors which are good-producing sector and service-producing sector. The exclusion of agricultural sector is connected to the considerably low employment share of this sector. The percentage of American workers in agriculture decreased from 2.8% in 1991 to 1.4% in 2016 (The World Bank Data). Hence, estimation results would highly be biased by including agricultural sector. On the contrary, service sector started growing tremendously since 1950 from 57% to 75% in 2000 and to nearly 80% in 2016 (US Bureau of Labor Statistics). In addition, this structural change questioned the growth of service sector in the United States that was explained by three assumptions which are demand changes, productivity improvement and female labor supply changes (Fuchs, 1980).

However, empirical evidences suggested that income elasticity of demand for services was just as much as that for goods (Fuchs, 1980; Summers, 1985). Furthermore, technology improvement and productivity increase were argued to be faster in the manufacturing than in the service sector yet growth model of sector indicated that the model can be applied well to all sectors including agriculture, manufacturing and service (Ngai & Pissarides, 2007). The contradicting ideas of the above two assumptions led to the final explanation. The expansion of service sector was drawn to the increase in female labor force participation (Lee & Wolpin, 2006).

Despite the close association between service sector and female labor supply, there were not many studies that paid attention to the differences in return to education for women across sectors. Scholars either scrutinized sector wage differentials for the labor market as a whole or investigated the return to human capital investment for female rather than combine these two topics. As a result, this research acknowledged the sectoral wage differentials for women by adding a sector dummy variable as well as a schooling-sector interaction variable in order to discover the differences in return for workers in each sector. These two variables would make the study of return to education for women become clearer and confirm a relationship between service sector and female labor supply if existing.

3. Methodology and Dataset

3.1. Empirical Model and Estimations Methods

This research applies and extends human capital earnings function to estimate the consequences of human capital investment on female earnings profiles in two sectors: manufacturing and service. Human capital earnings function was developed by Mincer and Polachek (1974) to unfold the relationship between

human capital investment and earning profiles in the post-school period. Since the 1970s, this function has been utilized by a number of researches in labor economics (Hill, 1979; Rumberger & Daymont, 1984; Duncan, 1996; Psacharopoulos & Patrinos, 2004).

In the fundamental human capital earnings function, an individual's earning is a function of schooling and experiences as in (1). While s represents the year of schooling, exp represents for the working experience of an individual, usually equal to number of years in work. In this model, β_1 is expected to be positive since the more educated a person, the higher wage a person can receive. β_2 is also expected to be positive two to three decades of working experiences can double the annual wage (Mincer & Polachek, 1974). More notably, while effect of schooling is linear, experience is concave if a person continuously works right after graduating.

$$\ln(\text{wage}) = \beta_0 + \beta_1 s + \beta_2 \exp - \beta_3 \exp 2 \tag{1}$$

As this research aims to analyze the return to education in each sector, a dummy variable to indicate sector and a schooling-sector interaction term were introduced into the function as shown in Equation (2).

$$\begin{aligned}\ln(\text{wage}) = &\beta_0 + \beta_1 \text{educ} + \beta_2 \text{sector} + \beta_3 \text{interact} + \beta_4 \text{weeks}\\ &+ \beta_5 \text{hours} + \beta_6 \text{married} + \beta_7 \text{child} + \beta_8 \text{supply} + \mu_2\end{aligned} \tag{2}$$

Main coefficients to be estimated are those of three variables: educational attainment, sector indicator and the interaction term between education and sectors. As education has positive impact on the earnings level, β_1 is expected to have a positive sign. For manufacturing-producing sector is represented by 0 and service-producing sector is 1, β_2 is expected to have a positive sign which implicitly suggests that people in the service sector received higher wage. The interaction term between sector and education allows this research to test the effect of education on earnings in each sector. The positive sign of β_3 will indicate that return to education in the service sector is higher than that in the manufacturing sector while the negative sign shows the opposite.

Besides, control variables were added into the function to better describe the dependent variable as well. They are divided into three categories which are work experience, family factors and labor market conditions. Due to data limitation, work experience for each individual was not obtained. Two other substitutes for work experience are weeks worked last year and hours worked last week (Madden, 1978; Hill, 1979; Loury, 1997). The longer the weeks and hours a person worked, the higher the wage they would get which means that β_4 and β_5 are expected to be positive.

In regards to family factor, marriage would lower the return to education (Mincer & Polachek, 1974). As a result, women who were married would have lower wages than those who were not. Additionally, the number of children is expected to have a negative impact on wage. That is because, women who had more children spent less time at work due to household responsibilities. The labor market condition was represented by the number of women in labor supply.

The more women in the labor market, the lower the wage they would receive. For that reason, β_6, β_7 and β_8 are supposed to be negative. The full list of variables used in empirical function (2) is shown in Table 1. In order to avoid heteroscedasticity, this research uses robust regression instead of OLS regression to limit the effects of outliers.

$$\ln(\text{wage}) = \beta_{0m} + \beta_{1m}\text{educ} + \beta_{2m}\text{weeks} + \beta_{3m}\text{hours} + \beta_{4m}\text{married} + \beta_{5m}\text{child} + \beta_{6m}\text{supply} + \mu_3 \tag{3}$$

$$\ln(\text{wage}) = \beta_{0s} + \beta_{1s}\text{educ} + \beta_{2s}\text{weeks} + \beta_{3s}\text{hours} + \beta_{4s}\text{married} + \beta_{5s}\text{child} + \beta_{6s}\text{supply} + \mu_4 \tag{4}$$

Along with Equation (2), Equation (3) and Equation (4) are also estimated to further examines the rate of return to education on wages in each sector. The difference between β_{1m} and β_{1s} presents the lag in return to education between sectors. As the return to education is expected to be higher in the service sector, β_{1m} is expected to be smaller than β_{1s}. In addition, the same empirical functions (2), (3) and (4) are estimated for male workers to get deeper insights about the labor market in the United States.

3.2. Descriptive Statistics

This research employs the Current Population Survey (CPS) which was jointly

Table 1. List of variables used in regression.

Variable	Variable name	Variable description
Dependent variable		
Wage log	ln(wage)	Natural logarithm of hourly wage on the current job
Education		
Education	educ	Years of education (educ = 12 - 18)
Sector		
Sector indicator	sectordum	Dummy variable for sector: Manufacturing = 0, Service = 1
Sector x education	interact	Interaction term between sector and education
Work experience		
Working weeks	weeks	Weeks worked last year
Working hours	hours	Hours worked last week
Family factors		
Marital status	married	Dummy variable for marriage: Currently married = 1, Others = 0
Number of children	child	Number of children in the family
Labor market conditions		
Female labor supply	supply	Percentage of female labor supply in the labor market for the current year

sponsored by the United States Census Bureau and the Bureau of Labor Statistics (BLS). The collected dataset in this research presents microdata at individual level on education, working situation and earnings in 37 years, from 1980 to 2016. In this research, it was used as a cross sectional and time series dataset of individual earnings. Out of 60,000 household respondents each year, this research only included people who were in employment and between the age of 18 - 65 as this research focused on people who finished at least high school education. As shown in **Figure 1** and **Figure 2**, the sample concentrated on people who were born in the 1960s and people who were around their 40s.
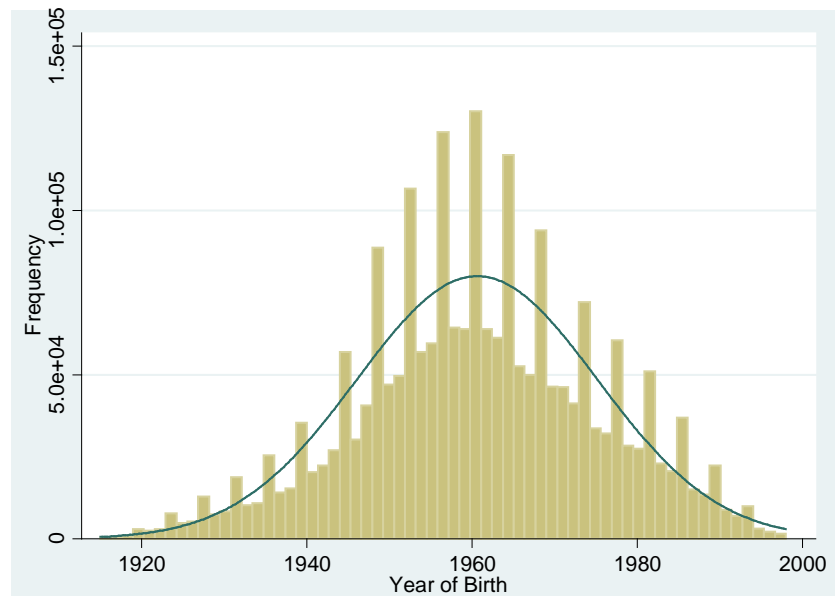

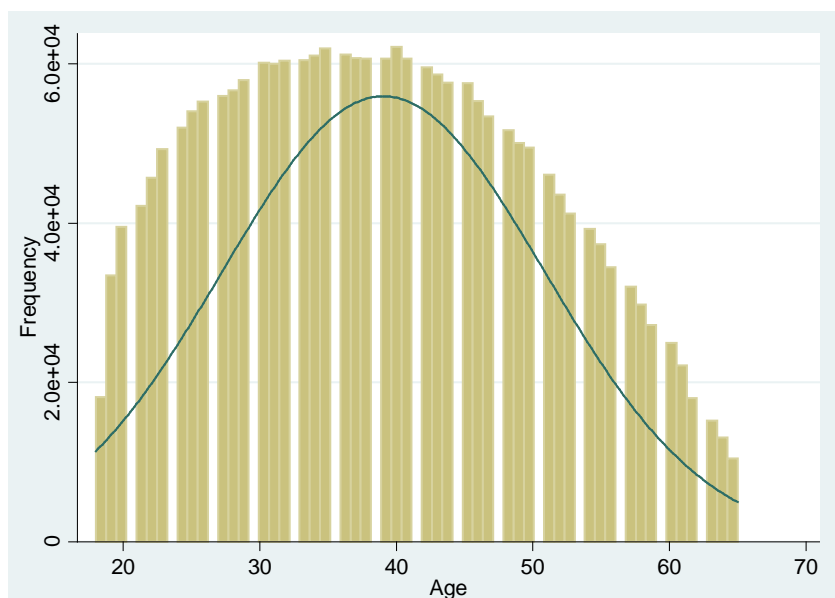**Figure 1.** The distribution of birth year.

Figure 2. The distribution of age.

Observations are divided into 2 sectors by their working industries based on the Current Population Survey. Manufacturing workers were set equal to 0 while service workers were set equal to 1. Due to the vanishing of old industries as well as the emergence of certainly new industries, the classification of industries in the dataset changed over time. More specifically, occupation divisions were made in four periods: 1980 to 1982, 1983 to 1988, 1989 to 2002 and 2003 to 2016.

The employment shares of service sector across age groups and across time periods for each gender are presented in Table 2 below. It was the number of people who were working in service sector over the working population in correspondence with age groups and genders. The employment shares in the service sector among women were always higher than those of men. Women accounted for around 89% for all birth cohorts during 1980-1989. These numbers increased to around 90% during 1990-1999, to around 93% during 2000-2009 and finally to around 95% for all age groups during 2010-2016. The differences in employment shares across age groups among women remained insignificant during all time periods.

The number of working men in the service sector also experienced an increase over years due to the growth of service sector in the United States. However, compared to women, in each time period from 1980 to 2009, older men accounted for a noticeably larger share of employment in the service sector. From 2010 to 2016, the shares were the same for people in 18 - 27 and 58 - 65 age group which might have been the result of service sector's growth in the United States.

This was in conformity with statistics provided by the Bureau of Labor Statistics, the employment shares of service sector increased from 77% in 2006 to 80.3% in 2016 and was projected to be 81% in the coming 2026 (US Bureau of Labor Statistics).

Regarding educational variable, observations that were under high school level have been excluded from the sample. Due to the lack of data in education

Table 2. Service sector employment shares by age, sex and period (%).

Age	Sex	1980-1989	1990-1999	2000-2009	2010-2016
18 - 27	Female	88.43	89.77	93.87	95.87
	Male	50.80	58.71	67.80	74.42
28 - 37	Female	88.47	88.18	93.06	95.15
	Male	56.49	58.99	67.08	71.29
38 - 47	Female	89.16	89.37	92.82	94.89
	Male	61.63	62.83	66.72	72.22
48 - 57	Female	89.94	90.73	93.57	94.59
	Male	61.77	66.46	69.54	71.32
58 - 65	Female	90.73	91.31	93.97	95.27
	Male	66.19	69.31	74.47	74.53

years, the remaining observations were assigned values according to their educational level as follow. The non-college category includes high school graduates and some college graduates. High school graduates were assigned 12 years of education while some college graduates, who either dropped out of college or finished 2-year college, were assigned 14 years of education. The college category includes people with college education or higher. College graduates were assigned 16 years of education. This research assumed that the last category mostly consists of people who finished master degree. Therefore, their years of education were assigned the value of 18.

Figures 3-7 below showed the distribution of female educational attainment in different points of time. Throughout 37 years, along with employment share in the service sector, there was an increase of 56.6% in female college graduates, approximately 18.09% in 1980 to 30.5% in 2000 and eventually 41.77% in 2016.
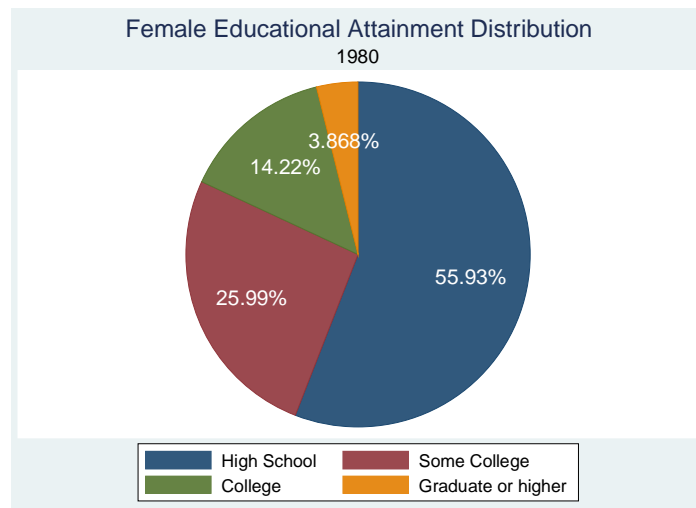

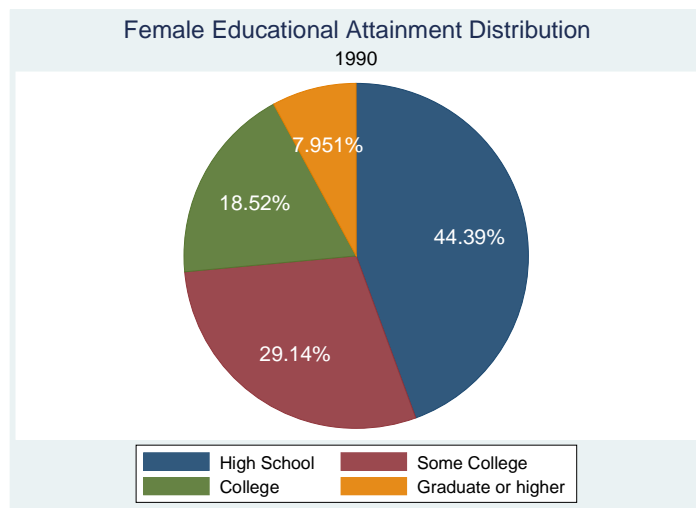Figure 3. Female educational attainment distribution in 1980.

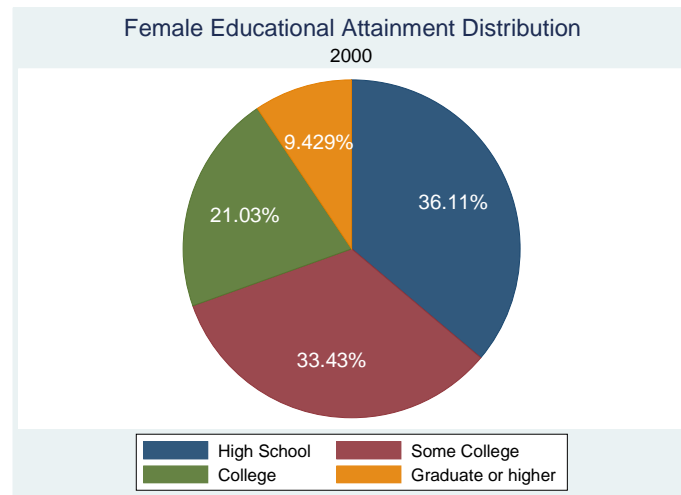Figure 4. Female educational attainment distribution in 1990.

Female Educational Attainment Distribution
2000

9.429%
36.11%
21.03%
33.43%

High School   Some College
College   Graduate or higher

Figure 5. Female educational attainment distribution in 2000.

Female Educational Attainment Distribution
2010

12.82%
28.88%
24.89%
33.4%

High School   Some College
College   Graduate or higher

Figure 6. Female educational attainment distribution in 2010.

Female Educational Attainment Distribution
2016

15.83%
25.72%
25.94%
32.52%

High School   Some College
College   Graduate or higher

Figure 7. Female educational attainment distribution in 2016.

In the non-college section, the number of high-school graduates decreased significantly while people who got some college education remained the same. More importantly, the number of college graduates doubled and the number of graduates in higher education tripled after 37 years. All of these empirical evidences provided a strong support for the fact that women had higher incentive to acquire college education over years in the United States.

Compared with the trend in female educational attainment, college education among male was also on a rise but not as tremendous as among female (presented in Figures 8-12). The number of college graduates doubled after 37 years. More interestingly, the number of male college graduates in 1980 was higher than the number of female college graduates by 3.8% but then became lower in 2016 by 3.88%. In 2016, the percentage of male high school graduates (33%) was also higher than that of female high school graduates (25.72%). This implies that women nowadays have much higher incentive to enter college than men.

Figure 8. Male educational attainment distribution in 1980.

Figure 9. Male educational attainment distribution in 1990.

Male Educational Attainment Distribution
2000

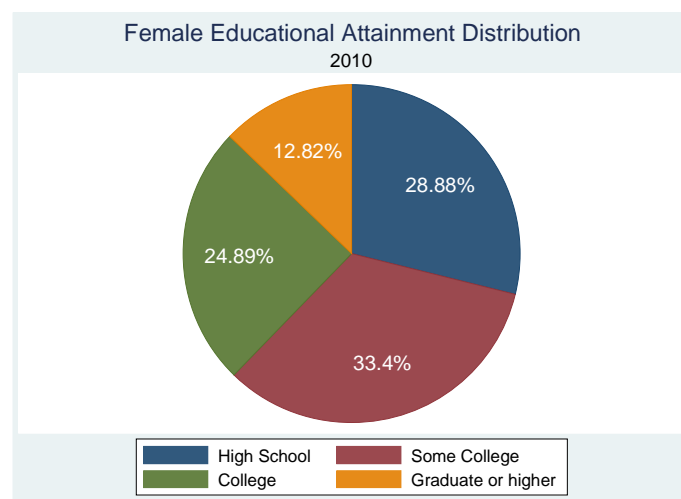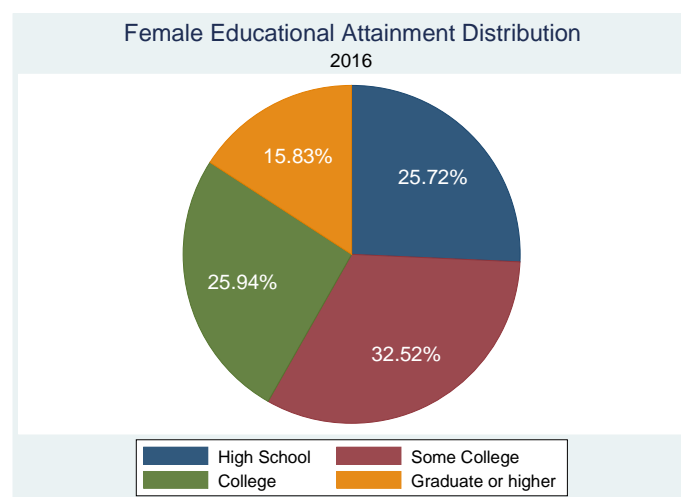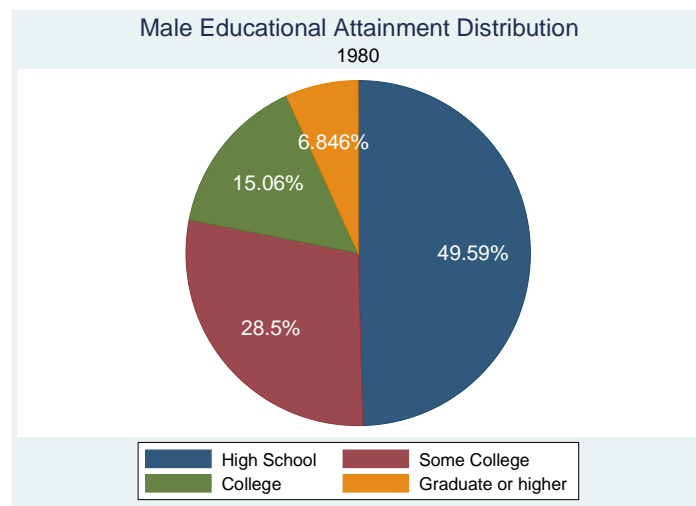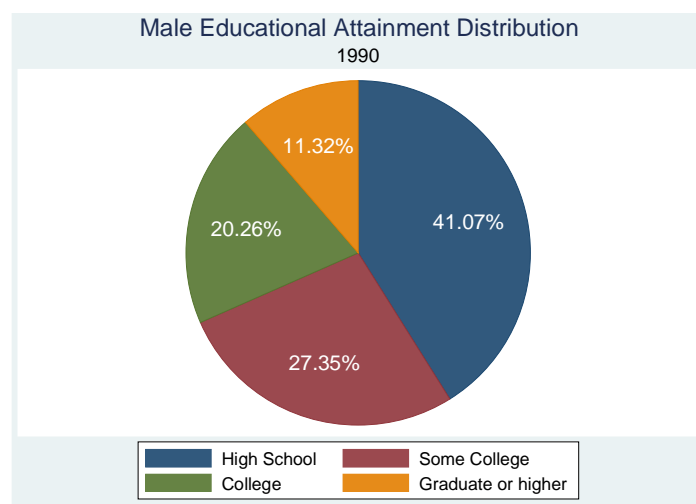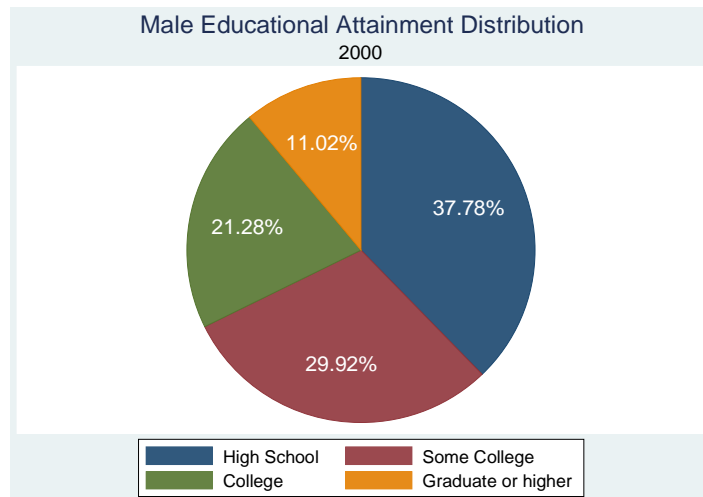**Figure 10.** Male educational attainment distribution in 2000.

Male Educational Attainment Distribution
2010

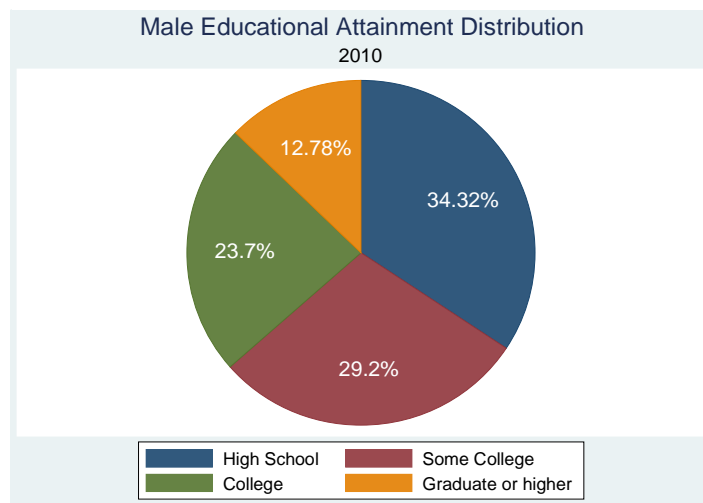**Figure 11.** Male educational attainment distribution in 2010.

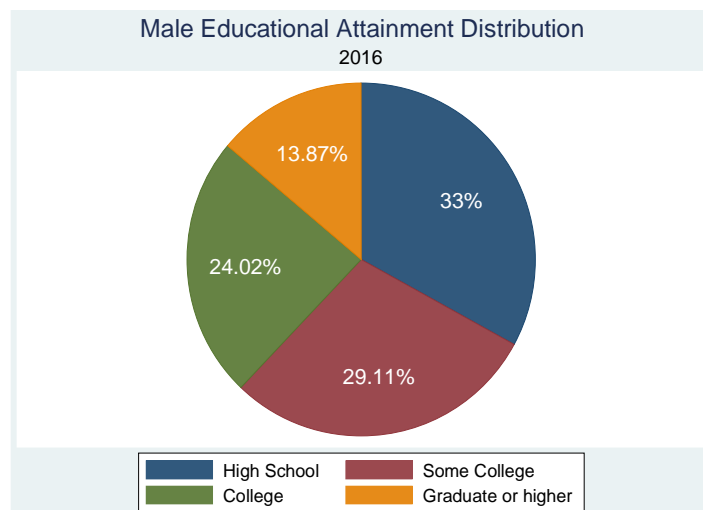**Male Educational Attainment Distribution**
2016

Figure 12. Male educational attainment distribution in 2016.

In order to estimate monetary return, only people who were labelled as "Employed" in the section of labor force status were included in the sample. There were 4 types of employment in the sample: Full-time, full-year; Part-time, full-year; Full-time, part-year and Part-time, part-year. Individual hourly wage was used as the dependent variable in the dataset. In order to minimize outliers, natural logarithm of hourly earnings was taken for each individual. Observations who were unpaid laborers or have hourly earnings lower than 1 were excluded from the sample. The reason why observation with hourly earnings lower than 1 was dropped is because the natural logarithm of wage will be negative in this case.

Table 3 below presented the descriptive statistics for female workers on all variables. There were 1,029,302 observations in total from 1980 to 2016 with 83,709

Table 3. Descriptive statistics of all variables for female workers.

	Variable	Obs	Mean	Stad. Dev.	Min	Max
year	All	1029302	1999.91	10.47	1980	2016
age	All	1029302	39.18	11.69	18	65
	Manufacturing	83709	38.33	11.29	18	65
	Service	945593	39.25	11.72	18	65
ln(wage)	All	1029302	2.78	0.64	0.0003	10.61
	Manufacturing	83709	2.7	0.59	0.0012	8.38
	Service	945593	2.8	0.65	0.0003	10.61
educ	All	1029302	14.09	1.97	12	18
	Manufacturing	83709	13.33	1.78	12	18
	Service	945593	14.16	1.97	12	18
weeks	All	1029302	47.94	9.79	1	52
	Manufacturing	83709	47.72	10.14	1	52
	Service	945593	47.96	9.76	1	52
hours	All	1029302	36.85	11.90	1	99
	Manufacturing	83709	38.24	10.33	1	99
	Service	945593	36.72	12.03	1	99
married	All	1029302	0.59	0.49	0	1
	Manufacturing	83709	0.56	0.50	0	1
	Service	945593	0.59	0.49	0	1
child	All	1029302	0.86	1.07	0	9
	Manufacturing	83709	0.86	1.07	0	9
	Service	945593	0.86	1.07	0	9
supply	All	37	48.83	0.92	46.74	50.08
	Manufacturing	37	57.66	1.17	55.87	60.71
	Service	37	18.29	2.80	14.40	21.94

observations in the manufacturing sector and 945,593 observations in the service sector. The average age of observations was 39.18 with the minimum value of 18 and maximum value of 65. The age values in two sectors were compatible at 38.33 and 39.25, consecutively. The average hourly wage log was 2.78 for the whole labor market, 2.7 for manufacturing sector and 2.8 for service sector. Despite the fact that people with remarkably low wage were excluded from the sample, the differences between minimum and maximum value of wage log remained large, which is about 10. Both the minimum (0.0003) and the maximum values (10.61) of wage log belonged to service sector.

For education variable, the average value is 14.09 which was slightly above college education. Female workers in the manufacturing sector had significantly lower average educational attainment than female workers in the service sector which were 13.33 and 14.16, consecutively. The average educational attainment in manufacturing was below college education. The lowest value of education was high school degree (=12) and the highest value was advanced degree (=18).

Variables that reflect working experience are the number of weeks worked last year and number of hours worked last week. Observations without the value of weeks worked and hours worked were omitted. Weeks worked last week ranged from 1 to 52 weeks. People in both sectors worked for about 48 weeks on average in the previous year. That is because 74.17% of people in the dataset worked full-time and full year. Hours worked last week ranged from 1 to 99 weeks. People in the service sector worked 36.72 hours, lower than that of the manufacturing sector which is 38.24 hours. On average, female workers worked 36.85 hours in the previous week.

Each individual's family factor was reflected through two variables: marital status and number of reported children. Marital status is a dummy variable which is either 1 = married or 0 = others. People who were not in a marriage could be widowed, divorced, separated, or never married before. There are slightly more married people in the dataset in both sectors which were 0.56 in the manufacturing sector and 0.59 in the service sector. On average, 59% of female workers were married.

Regarding the number of children in presence, previous research has emphasized on the number of children under 6 years old as they require more child-care activities from women (Gemici & Wismall, 2014). However, due to the data limitation, this research used the number of child (or children) under 18 years old. The number in child in a family had a minimum value of 0 and a maximum value of 9. The average number of children of workers in each sector as well as in both sectors were 0.86, meaning that most people had one child.

This research also generated a new variable that represents female labor supply of each sector over years. In the manufacturing sector, it was calculated as the percentage of female who were working in the manufacturing sector over the total available workforce and the same was calculated for the service sector. Therefore, there were only 37 values for 37 years; all individual observations in

one year obtained the same value. Women accounted for 57.66% in the service sector on average. While the minimum value was in 2013 at 55.87%, the maximum value was 60.71% in 1981. Descriptive statistics for male workers are presented in Table 4. There were 1,084,866 observations in total with 34.7% worked in the manufacturing sector and 65.3% worked in the service sector. The average values of age were almost the same with female workers at 39. The mean value of wage log was lower for manufacturing workers. All three mean values were higher than those of women. The minimum wage log of men was as same as that of women at 0.0003 but the maximum was higher at 13.00. Both extreme values belonged to the service sector. All educational values of male workers were slightly higher than those of female workers. Generally, men were above college

Table 4. Descriptive statistics of all variables for male workers.

Variable		Obs	Mean	Stad. Dev.	Min	Max
year	All	1084866	1999.62	10.57	1980	2016
	All	1084866	39.36	11.60	18	65
age	Manufacturing	376957	38.34	11.38	18	65
	Service	707909	39.90	11.69	18	65
	All	1084866	3.09	0.68	0.0003	13.00
ln(wage)	Manufacturing	376957	3.05	0.59	0.0021	9.45
	Service	707909	3.11	0.73	0.0003	13.00
	All	1084866	14.13	2.05	12	18
educ	Manufacturing	376957	13.36	1.71	12	18
	Service	707909	14.55	2.10	12	18
	All	1084866	49.45	7.84	1	52
weeks	Manufacturing	376957	49.11	8.17	1	52
	Service	707909	49.62	7.65	1	52
	All	1084866	42.98	12.27	1	99
hours	Manufacturing	376957	42.14	10.73	1	99
	Service	707909	43.43	13.00	1	99
	All	1084866	0.67	0.47	0	1
married	Manufacturing	376957	0.67	0.47	0	1
	Service	707909	0.66	0.47	0	1
	All	1084866	0.90	1.13	0	9
child	Manufacturing	376957	0.94	1.15	0	9
	Service	707909	0.88	1.13	0	9
	All	37	51.44	0.89	50.16	53.45
supply	Manufacturing	37	81.71	2.80	78.06	85.60
	Service	37	42.34	1.17	39.29	44.13

education yet in the manufacturing sector, they were educated somewhere at between some college and college.

Male workers worked from 1 to 52 weeks during the previous year and from 1 to 99 hours during the previous week. On average, they worked more than women, about 49 weeks a year and 43 hours a week. Those in the manufacturing sectors worked somewhat less than the other sector. The proportion of people who were married was higher than female workers. About 67% of male workers was in marriage.

The numbers of children in the households among male workers were higher than those among female worker. One possible explanation can be related to the absence of women with many children in the female observations. Nonetheless, men had one child on average. As for the labor supply of male workers, there are a considerably large number of men in the manufacturing sector (81.71%) while in the service sector, it was nearly half of the working population (42.34%). On average, male made up a little more than half of the labor supply (51.44%).

4. Result and Discussion

Considering the correlation between years of education and hourly wage log across genders in the labor market, the average earning levels of female were lower and more dispersed than those of male in all observed years (as shown in Figure 13 and Figure 14). These results verified the existing gender wage differentials as discussed in previous literature (Corcoran & Duncan, 1979). However, both genders had positive correlations and linear trend lines. The slope was 0.27 for female but was only 0.16 for male. These implied that compared to a slight increase in earnings for male, higher education could make a bigger difference in earnings for female. More interestingly, both female and male experienced a diminishing return to education.
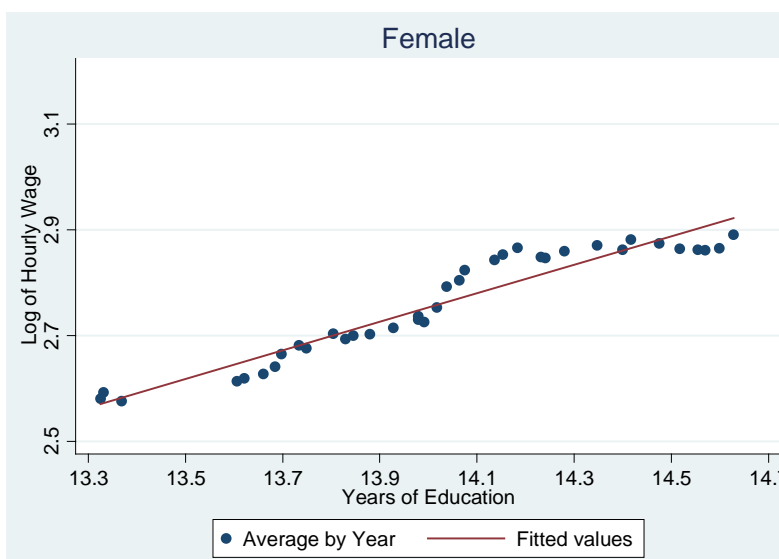

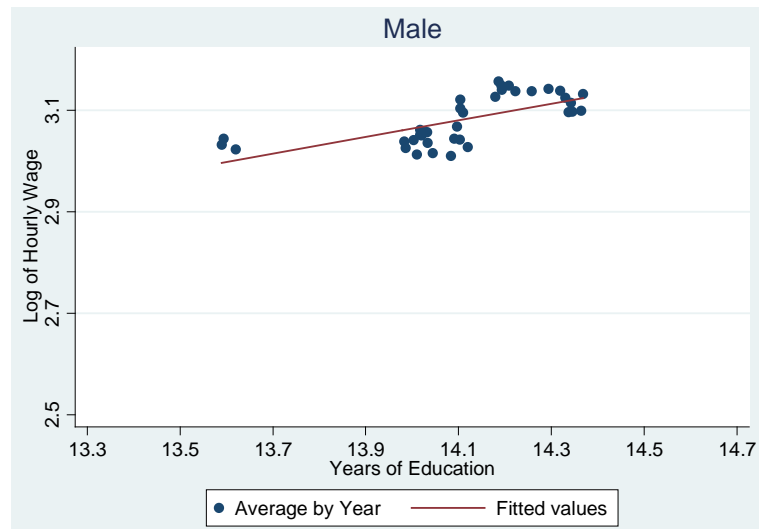**Figure 13.** Log of hourly wage-education, female.

Figure 14. Log of hourly wage-education, male.

The correlations between education and earnings in each sector for female workers have upward trends as expected whereas each sector had different slopes of trend line. The slope in the service sector (0.28) was steeper than in the manufacturing sector (0.23) which suggested that the same increase in educational attainment would lead to a larger increase in earnings for service workers, compared to that for manufacturing workers. Moreover, people who worked in the service sector also acquired higher educational level on average (as shown in Figure 15 and Figure 16).

When it comes to the correlations among male workers, service-producing workers were more educated on average and were paid with slightly higher wages as well (as shown in Figure 17 and Figure 18). The slope in the manufacturing sector was 0.15, lower than that in the service sector which was 0.22. Moreover, the shortest average years of education in the service sector (about 14.1 years) were even higher than the longest average years of education in the manufacturing sector (about 13.6 years). As compared to female workers, the earnings of male workers were very concentrated which inferred that return to education should have been lower for them.

Table 5 presents estimation results from robust regression. For female workers, marital status had the largest impact on wages in the first three regressions while in the last regression, the coefficient of education variable had the largest value at 0.117. In all equations, β_1 was positive and statistically significant as expected, verifying the positive economic return to education. An increase in one year of education raised wage log by around 0.11. For male workers, the impact of education was less than those of sector and marital status. However, β_1 was also positive and statistically significant in all equations at about 0.087. Return to education was higher for female workers compared to male workers.

In regards to the effect of working sector, β_2 was statistically significant yet unexpectedly negative for both genders. The negative value indicated that people
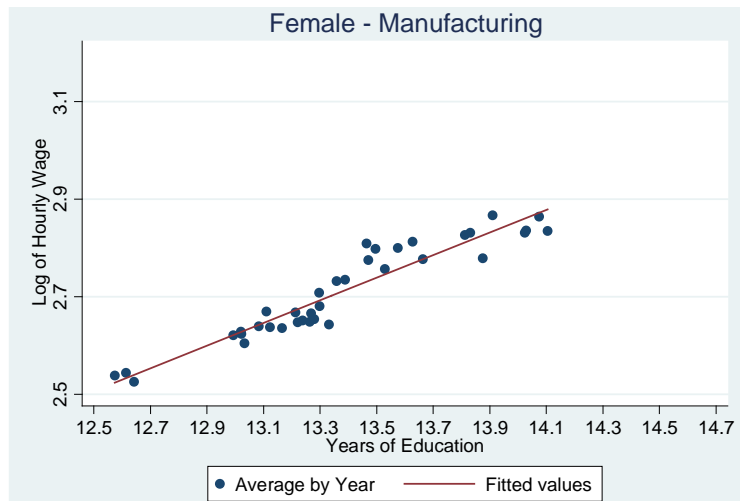
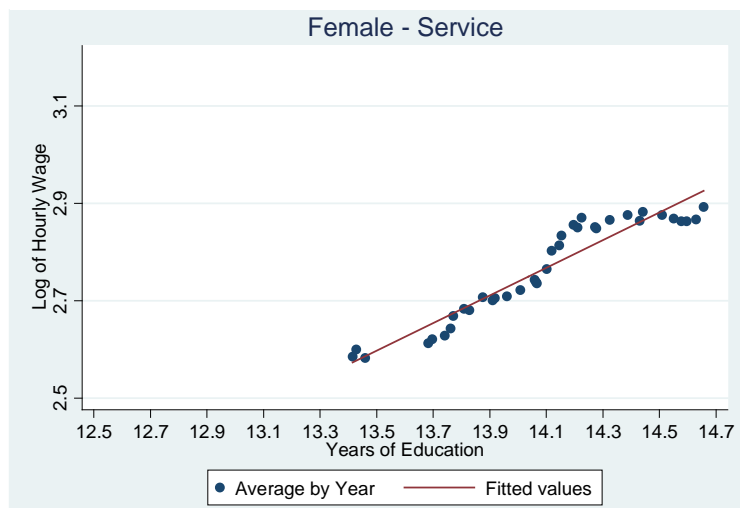**Figure 15.** Log of female hourly wage-education, manufacturing sector.

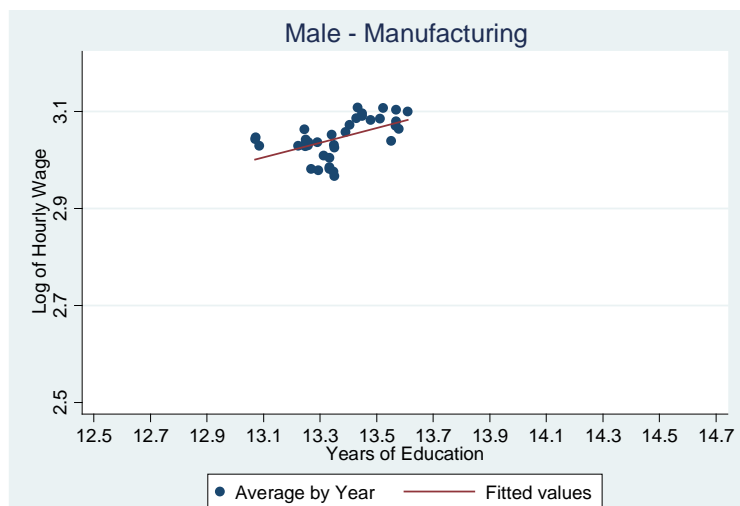**Figure 16.** Log of female hourly wage-education, service sector.

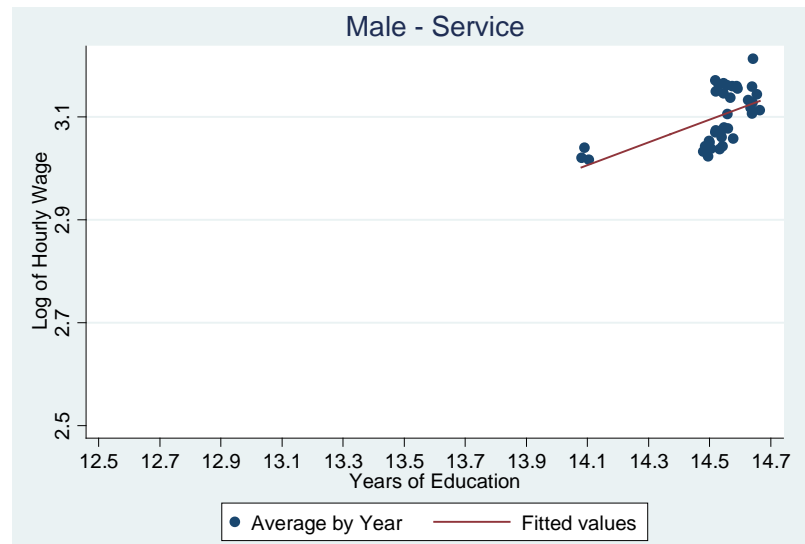**Figure 17.** Log of male hourly wage-education, manufacturing sector.

Figure 18. Log of male hourly wage-education, service sector.

Table 5. Return to human capital investment with the consideration of sectors, by gender.

	Regression using Sector Dummy Variable and Interaction Term							
Coefficient	Female (Obs: 1029302)				Male (Obs: 1084866)			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Educ (β_1)	0.110*** (0.002)	0.111*** (0.002)	0.112*** (0.002)	0.117*** (0.002)	0.085*** (0.001)	0.087*** (0.001)	0.087*** (0.0006)	0.088*** (0.001)
Sectordum (β_2)	−0.047*** (0.004)	−0.066*** (0.004)	−0.064*** (0.004)	−0.050*** (0.004)	−0.202*** (0.003)	−0.201*** (0.003)	−0.201*** (0.003)	−0.195*** (0.003)
Interact (β_3)	0.016*** (0.002)	0.021*** (0.002)	0.019*** (0.002)	0.017*** (0.002)	0.071*** (0.001)	0.072*** (0.001)	0.072*** (0.001)	0.071*** (0.001)
Weeks (β_4)	0.005*** (0.0002)	-	-	-	0.007*** (0.0001)	-	-	-
Hours (β_5)	0.005*** (0.00)	-	-	-	0.002*** (0.00)	-	-	-
Married (β_6)	0.125*** (0.000)	0.125*** (0.001)	0.114*** (0.001)	0.112*** (0.001)	0.329*** (0.001)	0.357*** (0.001)	0.359*** (0.001)	0.357*** (0.001)
Child (β_7)	−0.014*** (0.001)	−0.024*** (0.0005)	-	-	0.002*** (0.0005)	0.002*** (0.0006)	-	-
Supply (β_8)	0.055*** (0.0006)	0.061*** (0.0006)	0.060*** (0.0006)	-	−0.024*** (0.0007)	−0.026*** (0.0007)	−0.026*** (0.0007)	-
Cons. (β_0)	−1.918	−1.805	−0.669	1.079	2.445	2.992	0.391	1.634
R^2	0.1809	0.1645	0.1630	0.1568	0.2038	0.1944	0.1944	0.1933
F statistics	28,412.12	33,171.36	39,241.18	46,557.10	30,612.3	39,704.03	47,594.04	59,106.30

(The p value: *** means $p \leq 0.01$, ** means $p \leq 0.05$, * means $p \leq 0.1$; Standard errors in parenthesis.)

in the manufacturing sector were receiving higher wages than people in the service sector. For female workers, working in service sector lessened a women's

wage by 4% to 6%. The coefficient β_3 of interaction variable between sector and education experienced positive signs in all equations as expected. The positive sign of β_3 proposed that rate of return to education was higher in the service sector than in the manufacturing sector.

For male workers, the trends of coefficients were as same as female workers. β_3 were positive while β_2 was unpredictably negative. Working in service sector reduced their wages by about 20%. This value was much larger than compared to that of women. The positive value of coefficient β_3 inferred the same thing that has been mentioned. In the service sector, the higher the education attainment, the higher payment a male worker can receive than in the manufacturing sector. All in all, the current working sector played a more important role for men.

Additionally, all other variables were statistically significant. The value of R squared for both women and men were the highest in the first equation where all variables were included. A divergence from previous literature was that marital status positively affected wage level for both male and female workers. Moreover, one visible difference between male and female workers was the effect of having children. While the number of children negatively affects female wages, it had a slightly positive effect on male wages which corresponds with Hersch's (1991) research.

Further regressions on each sector were also executed for women as shown in Table 6 and for men as shown in Table 7. These results present a clearer view

Table 6. Return to human capital investment of female workers, by sector.

	Women					
	Manufacturing sector (Obs: 83709)			Service sector (Obs: 945593)		
Coefficient	(1)	(2)	(3)	(1)	(2)	(3)
Educ (β_1)	0.112*** (0.001)	0.114*** (0.001)	0.113*** (0.001)	0.119*** (0.0003)	0.122*** (0.0003)	0.122*** (0.0003)
Weeks (β_2)	0.006*** (0.0003)	-	0.007*** (0.0003)	0.006*** (0.00)	-	0.007*** (0.00)
Hours (β_3)	0.004*** (0.0002)	-	-	0.005*** (0.00)	-	-
Married (β_4)	0.082*** (0.004)	0.084*** (0.0039)	0.072*** (0.004)	0.129*** (0.001)	0.128*** (0.0013)	0.116*** (0.0012)
Child (β_5)	−0.014*** (0.0018)	−0.022** (0.002)	-	−0.013*** (0.0006)	−0.023*** (0.0006)	-
Supply (β_6)	−0.011*** (0.0007)	−0.012*** (0.0007)	−0.011*** (0.0007)	−0.031*** (0.0005)	−0.034*** (0.0005)	−0.030*** (0.0005)
Cons. (β_0)	0.921	1.375	1.025	2.366	2.954	2.356
R^2	0.1542	0.1352	0.1479	0.1790	0.1621	0.1718
F statistics	2155.94	2927.59	3097.58	32,434.00	44,830.22	46,462.85

(The p value: *** means $p \leq 0.01$, ** means $p \leq 0.05$, * means $p \leq 0.1$; Standard errors in parenthesis.)

Table 7. Return to human capital investment of male workers, by sector.

Coefficient	Manufacturing sector (Obs: 376957)			Service sector (Obs: 707909)		
	(1)	(2)	(3)	(1)	(2)	(3)
Educ (β_1)	0.086*** (0.0005)	0.088*** (0.0005)	0.087*** (0.0005)	0.119*** (0.0003)	0.122*** (0.0003)	0.120*** (0.0003)
Weeks (β_2)	0.006*** (0.0002)	-	0.006*** (0.0002)	0.008*** (0.0002)	-	0.009*** (0.0002)
Hours (β_3)	0.002*** (0.0001)	-	-	0.002*** (0.00)	-	-
Married (β_4)	0.298*** (0.002)	0.320*** (0.002)	0.294*** (0.002)	0.345*** (0.002)	0.376*** (0.002)	0.360*** (0.002)
Child (β_5)	−0.009*** (0.0008)	−0.010*** (0.0008)	-	0.008*** (0.0007)	0.009*** (0.0008)	-
Supply (β_6)	0.009*** (0.0003)	0.009*** (0.0003)	0.008*** (0.0003)	0.018*** (0.0007)	0.018*** (0.0007)	0.016*** (0.0007)
Cons. (β_0)	0.622	0.929	0.695	−0.113	0.333	−0.028
R^2	0.1491	0.1397	0.1473	0.2217	0.2119	0.2203
F statistics	9734.48	14,059.75	14,510.30	30,991.49	45,307.50	46,196.28

(The p value: *** means $p \leq 0.01$, ** means $p \leq 0.05$, * means $p \leq 0.1$; Standard errors in parenthesis.)

on how different the situations were in each sector. In all equations, education was statistically significant and still had the largest effect on wage for female workers. As expected, β_{1m} was smaller than β_{1s} (0.112 and 0.119 in the first regressions), suggesting that return to education was higher in the service sector even though the difference was not considerably large. The second-most impactful factor in deciding women's wage was marital status. More remarkably, when it comes to the labor market conditions, the number of women in labor supply has a more powerful impact on wages in the service sector (0.031 compared to 0.011 in the first regressions). R-square had the largest value in the first equation.

For male workers, return to education was also higher in the service sector compared to that in the manufacturing sector, implying that a same increase in education attainment in the service sector led to a higher rise in wages. The differences in rate of return between sectors for men were larger than for women (0.086 and 0.119 in the first regressions). In all equations, marital status still had the largest effect on men's wages which was about three times higher than education. This can be explained by Becker's (1985) research which investigated the sexual division of labor. In short, married men who can specialize in the labor market, while their wives take care of the households, become more productive and earn more than those who are not in marriage.

Regression results verified the positive return to human capital for female

workers in the United States. An additional year of education could raise hourly wage log by nearly 12%. The sectoral wage differences, unexpectedly, favored manufacturing sector. It can be related to the fact that even though there was high-skilled occupation in the service sectors such as accountants, auditors or administrative managers, there were low-paying jobs such as food service or cleaning service as well. Moreover, these low-paying jobs were identified as the secondary market where women were being discriminated with remarkably low wages, which is another debating issue in labor economics (Treiman & Hartmann, 1981). Based on the findings in this research, working in the manufacturing sector generally offered a higher wage for female workers than in the service sectors.

The rate of return to education in different sectors was analyzed through the interaction term between education level and sector indicator which had positive coefficients. The positive values showed that a same investment in education can later provide higher wages in the service sector than in the manufacturing sector. These findings were reinforced by the separate regression on each sector (as in Table 6 and Table 7). The rate of return to education was higher in the service sector than in the manufacturing sector. The difference is about 1% to 7% which was unlikely to be noticeable. Nevertheless, regression results supported that there was a difference in return to education for female workers across two sectors.

In comparison to the rate of return to female, the trends of return to education among male workers were all the same. Although education had positive impact on men's earnings, men experienced a lower return rate to education than women which was in conformity with previous literature (Hill, 1979; Gregory et al., 1989; Duncan, 1996). The gender difference was 0.025 which was about 20%. Gender differentials in return to human capital investment can partially be explained because women over-represented either in professional jobs or in low-paying jobs (Dougherty, 2005). As a result, women received considerably high or low.

Regarding sectors coefficients, whether a man was working in a manufacturing or a service sector had the largest effect on a man's earnings, even higher than the effect of education. More notably, male workers in the manufacturing sector could receive 20% higher than those in the service sector. The schooling-sector interaction term of male observations had higher coefficients than those of female observations. The positive coefficient also implied that return to education for service workers was higher than for manufacturing workers. Furthermore, regression results in each sector strengthened the assumption that in the service sector, return to education was higher in the manufacturing sector.

These findings implied that, getting a job in service sector is greatly recommended for educated ones, especially for women. In other words, if women consider to invest in education with a hope of future returns, they should have a clear vision of their future career. With a same amount of investment in education, it is advisable that women should choose a career in service industry. All in

all, women are better off investing in human capital that benefits their labor productivity in the service sector, although the sectoral differences are not noticeable large in all equations.

5. Conclusion

This research examined the return to human capital investment for female workers using the Current Population Survey by the United States Census Bureau and the Bureau of Labor Statistics. With a dataset in the period of 1980-2016, this research confirmed that human capital investment raised women's hourly wages more in the service sector than in the manufacturing sector. The findings in this research implied that women as well as men were better off investing in human capital that benefits them to work in the service sector. However, working in the manufacturing jobs generally offered both women and men with slightly higher wages. Lower wage offered in service sector might have resulted because occupations in service sectors require a wide range of educational levels; some occupations do not even require education or only require relatively low education.

In addition, estimation results also showed that an increase of one year in education raised wages for women in the United States by about 10%. Rate of return to education for female workers was higher than that for male even though women were receiving lower earnings on average. This result aligns with the "reverse gender differentials" in education that was fore-mentioned. Future research should not only look at sectoral differentials but also consider different occupations within each sector to gain a more insightful view on return to education. A consideration of different birth cohorts as well as different time periods would also lead to a better understanding of this topic.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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